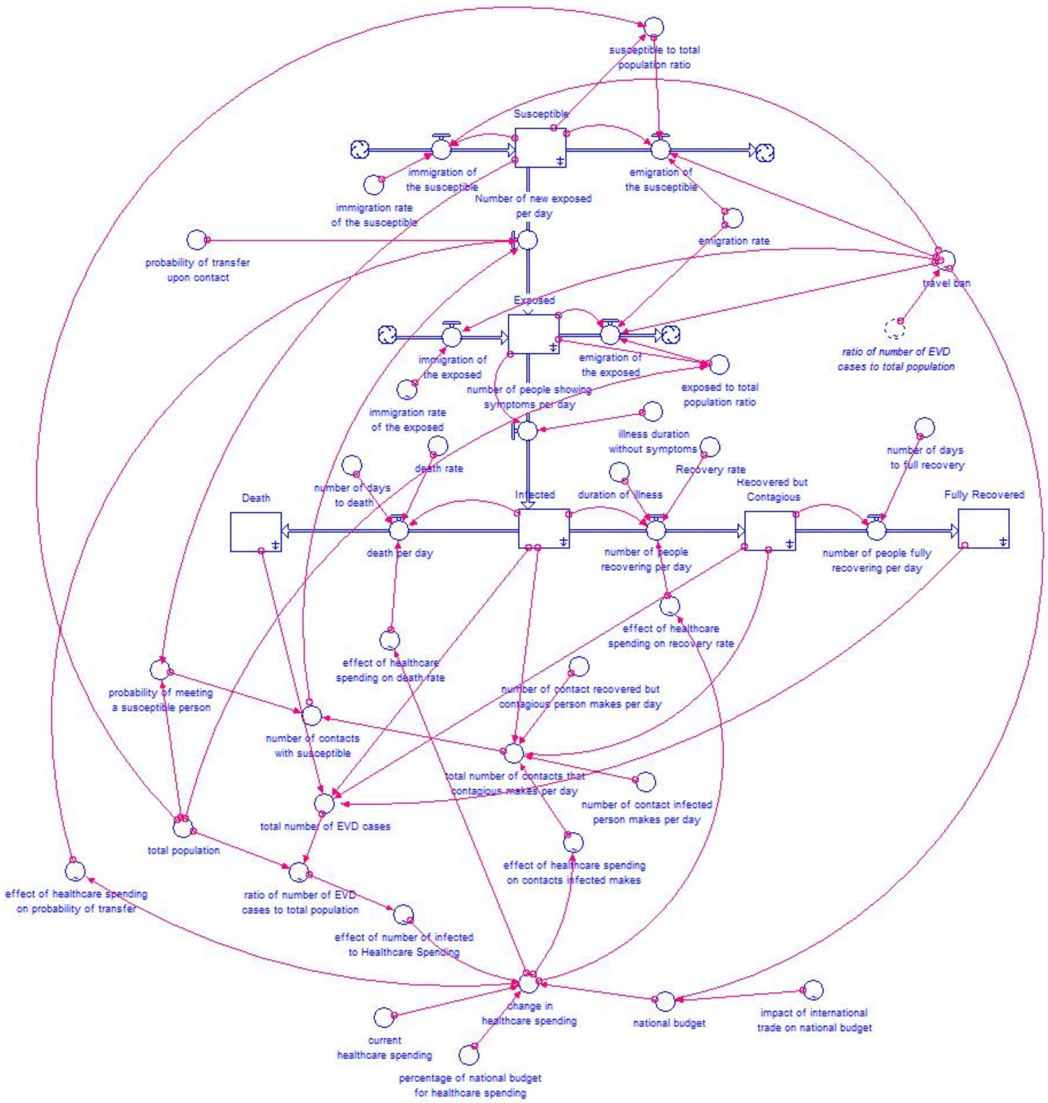
APPENDICES

APPENDIX A - Stock and Flow Diagram



APPENDIX B - Model Parameters

Initial Death: 0 people

Initial Exposed: 1 people

Initial Fully Recovered: 0 people

Initial Infected: 0 people

Initial Recovered but Contagious: 0 people

Current Healthcare Spending: 22,360,000

death rate: 0.55

duration of illness: 14 days

emigration rate: 0.00926/365 people /days

number of contact infected person makes per day: 4 contacts

number of contact recovered but contagious person makes per day: 0.2 contacts

number of days to death: 14 days

number of days to full recovery: 49 days

percentage of national budget for healthcare spending: 4%

probability of transfer upon contact: 0.2

recovery rate: 0.45

total population: 4,400,000 people

APPENDIX C - Model Equations

Death(t) = Death(t - dt) + (death_per_day) * dt

INIT Death = 0

INFLOWS:

death_per_day = Infected*death_rate*effect_of_healthcare_spending_on_death_rate/number_of_days__to_death

Exposed(t) = Exposed(t - dt) + (Number_of_new_exposed__per_day + immigration_of__the_exposed - number_of_people_showing_symptoms_per_day - emigration_of__the_exposed) * dt

INIT Exposed = 1

INFLOWS:

Number_of_new_exposed__per_day = number_of_contacts_with_susceptible*probability_of_transfer_upon_contact*effect_of_healthcare_spending_on_probability_of_transfer
immigration_of__the_exposed = immigration_rate__of_the_exposed*(1-travel_ban)

OUTFLOWS:
number_of_people_showing_symptoms_per_day = Exposed/illness_duration_without_symptoms
emigration_of__the_exposed = exposed_to_total_population_ratio*emigration_rate*Exposed*(1-travel_ban)

Fully_Recovered(t) = Fully_Recovered(t - dt) + (number_of_people_fully_recovering_per_day) * dt

INIT Fully_Recovered = 0

INFLOWS:

number_of_people_fully_recovering_per_day = Recovered_but__Contagious/number_of_days__to_full_recovery

Infected(t) = Infected(t - dt) + (number_of_people_showing_symptoms_per_day - number_of_people__recovering_per_day - death_per_day) * dt

INIT Infected = 0

INFLOWS:
number_of_people_showing_symptoms_per_day = Exposed/illness_duration_without_symptoms

OUTFLOWS:
number_of_people__recovering_per_day = Infected*Recovery_rate*effect_of_healthcare_spending_on_recovery_rate/duration_of_illness

death_per_day = Infected*death_rate*effect_of_healthcare_spending_on_death_rate/number_of_days__to_death

Recovered_but__Contagious(t) = Recovered_but__Contagious(t - dt) + (number_of_people__recovering_per_day - number_of_people_fully_recovering_per_day) * dt

INIT Recovered_but__Contagious = 0

INFLOWS:
number_of_people__recovering_per_day =
Infected*Recovery_rate*effect_of_healthcare_spending_on_recovery_rate/duration_of_illness

OUTFLOWS:
number_of_people_fully_recovering_per_day =
Recovered_but__Contagious/number_of_days__to_full_recovery

Susceptible(t) = Susceptible(t - dt) + (immigration_of__the_susceptible –
Number_of_new_exposed__per_day - emigration_of__the_susceptible) * dt

INIT Susceptible = total_population-Exposed-Infected-Recovered_but__Contagious-
Fully_Recovered-Death

INFLOWS:
immigration_of__the_susceptible = (1-travel_ban)*Susceptible*immigration_rate_of_the_susceptible

OUTFLOWS:
Number_of_new_exposed__per_day =
number_of_contacts_with_susceptible*probability_of_transfer_upon_contact*effect_of_healthcare_spending_on_probability_of_transfer

emigration_of__the_susceptible =
Susceptible*emigration_rate*susceptible_to_total_population_ratio*(1-travel_ban)

change_in__healthcare_spending =
(national_budget*percentage_of_national_budget_for_healthcare_spending*effect_of_number_of_infected_to_Healthcare_Spending)/current__healthcare_spending
current__healthcare_spending = 22360000

death_rate = 0.55

duration_of_illness = 14

emigration_rate = 0.00926/365

exposed_to_total_population_ratio = Exposed/total_population

illness_duration_without_symptoms = 14

immigration_rate_of_the_susceptible = 0.00356/365

national_budget = 559000000*(1-travel_ban*(1-impact_of_international_trade_on_national_budget))

number_of_contacts_with_susceptible =
probability_of_meeting_a_susceptible_person*total_number_of_contacts_that_contagious_makes_per_day

number_of_contact_infected_person_makes_per_day = 4

number_of_contact_recovered_but_contagious_person_makes_per_day = 0.2

number_of_days__to_death = 14

number_of_days__to_full_recovery = 49

percentage_of_national_budget_for_healthcare_spending = 0.04

probability_of_meeting_a_susceptible_person = Susceptible/(total_population-1)

probability_of_transfer_upon_contact = 0.2

Recovery_rate = 0.45

susceptible_to_total_population_ratio = Susceptible/total_population

total_number_of_contacts_that_contagious_makes_per_day = (Infected*effect_of_healthcare_spending_on_contacts_infected_makes*number_of_contact_infected_person_makes_per_day)+(Recovered_but__Contagious*number_of_contact_recovered_but_contagious_person_makes_per_day)

total_number_of_EVD_cases = Death+Fully_Recovered+Infected+Recovered_but__Contagious

total_population = 4400000

effect_of_healthcare_spending_on_contacts_infected_makes = GRAPH(DELAY(change_in__healthcare_spending,14))
(0.00, 1.60), (0.25, 1.56), (0.5, 1.38), (0.75, 0.9), (1.00, 0.5), (1.25, 0.31), (1.50, 0.18), (1.75, 0.1), (2.00, 0.02), (2.25, 0.00), (2.50, 0.00)

effect_of_healthcare_spending_on_death_rate = GRAPH(DELAY(change_in__healthcare_spending,14))
(0.00, 1.20), (0.25, 1.14), (0.5, 1.09), (0.75, 1.04), (1.00, 1.00), (1.25, 0.95), (1.50, 0.9), (1.75, 0.87), (2.00, 0.84), (2.25, 0.81), (2.50, 0.8)

effect_of_healthcare_spending_on_probability_of_transfer = GRAPH(DELAY(change_in__healthcare_spending,14))
(0.00, 1.00), (0.25, 0.94), (0.5, 0.885), (0.75, 0.815), (1.00, 0.74), (1.25, 0.675), (1.50, 0.63), (1.75, 0.57), (2.00, 0.52), (2.25, 0.46), (2.50, 0.4)

effect_of_healthcare_spending_on_recovery_rate = GRAPH(DELAY(change_in__healthcare_spending,14))
(0.00, 0.8), (0.25, 0.85), (0.5, 0.9), (0.75, 0.95), (1.00, 1.00), (1.25, 1.05), (1.50, 1.09), (1.75, 1.13), (2.00, 1.16), (2.25, 1.18), (2.50, 1.20)

effect_of_number_of_infected_to_Healthcare_Spending = GRAPH(ratio_of_number_of_EVD_cases_to_total_population)
(0.00, 1.00), (0.0333, 1.91), (0.0667, 2.25), (0.1, 2.43), (0.133, 2.49), (0.167, 2.50), (0.2, 2.50), (0.233, 2.50), (0.267, 2.50), (0.3, 2.50), (0.333, 2.50), (0.367, 2.50), (0.4, 2.50), (0.433, 2.50), (0.467, 2.50), (0.5, 2.50), (0.533, 2.50), (0.567, 2.50), (0.6, 2.50), (0.633, 2.50), (0.667, 2.50), (0.7, 2.50), (0.733, 2.50), (0.767, 2.50), (0.8, 2.50), (0.833, 2.50), (0.867, 2.50), (0.9, 2.50), (0.933, 2.50), (0.967, 2.50), (1, 2.50)

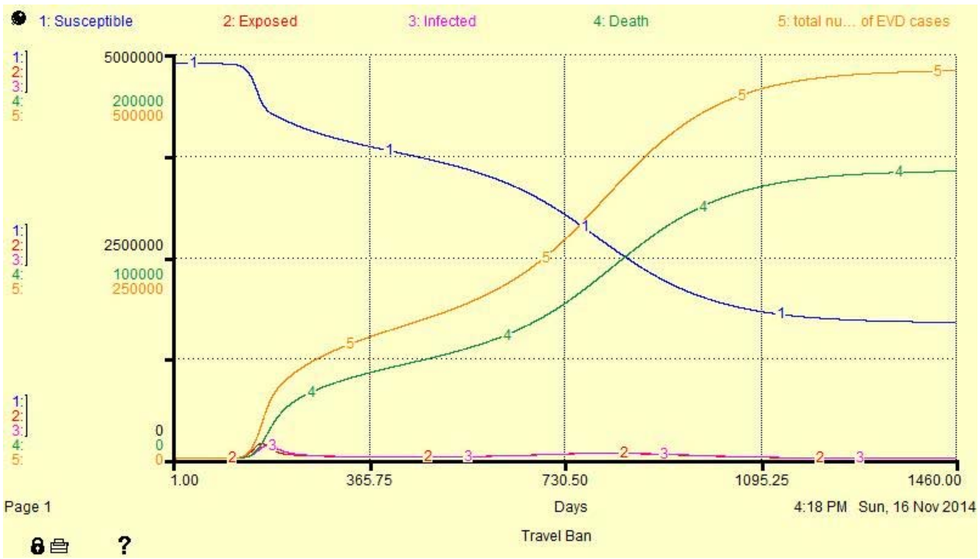
immigration_rate__of_the_exposed = GRAPH(TIME)
(1.00, 2.97), (37.4, 1.21), (73.8, 0.42), (110, 0.15), (147, 0.1), (183, 0.1), (219, 0.1), (256, 0.1), (292, 0.1), (329, 0.1), (365, 0.1)

impact_of_international_trade_on_national_budget = GRAPH(TIME)
(1.00, 1.00), (73.9, 0.94), (147, 0.88), (220, 0.83), (293, 0.78), (366, 0.735), (438, 0.69), (511, 0.655), (584, 0.63), (657, 0.61), (730, 0.6)

ratio_of_number_of_EVD_cases_to_total_population =
GRAPH(total_number_of_EVD_cases/total_population)
(0.00, 0.00), (10.0, 0.00), (20.0, 0.00), (30.0, 0.00), (40.0, 0.00), (50.0, 0.00), (60.0, 0.00), (70.0, 0.00), (80.0, 0.00), (90.0, 0.00), (100, 0.00)

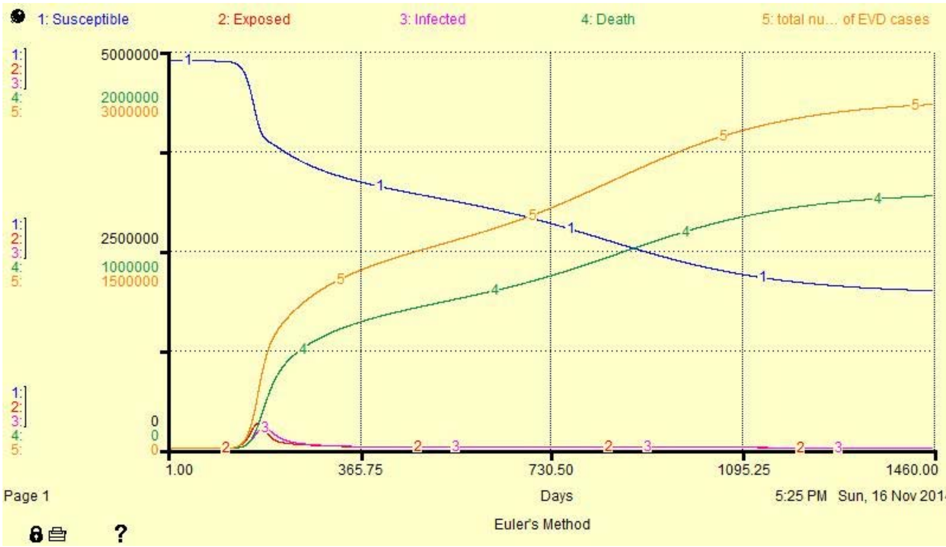
travel_ban = GRAPH(ratio_of_number_of_EVD_cases_to_total_population)
(0.00, 1.00), (0.1, 1.00), (0.2, 1.00), (0.3, 1.00), (0.4, 1.00), (0.5, 1.00), (0.6, 1.00), (0.7, 1.00), (0.8, 1.00), (0.9, 1.00), (1, 1.00)

APPENDIX D - Model Validation

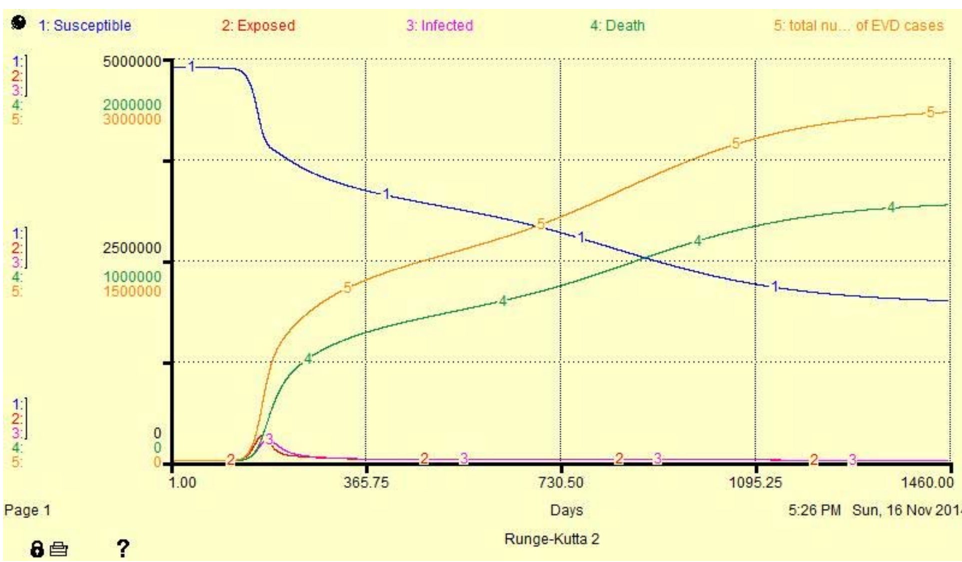


APPENDIX E - Model Verification: Integration Method

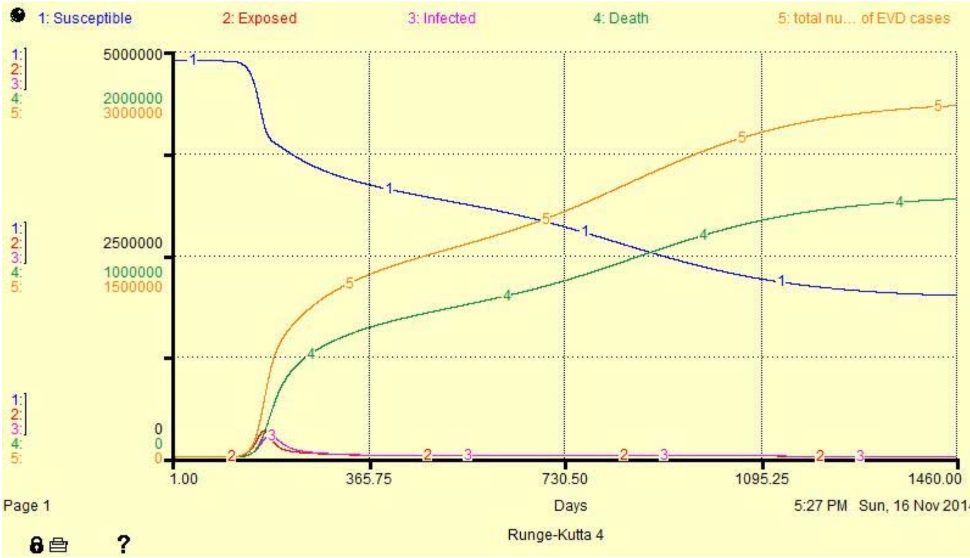
Euler's Method



Runge-Kutta 2

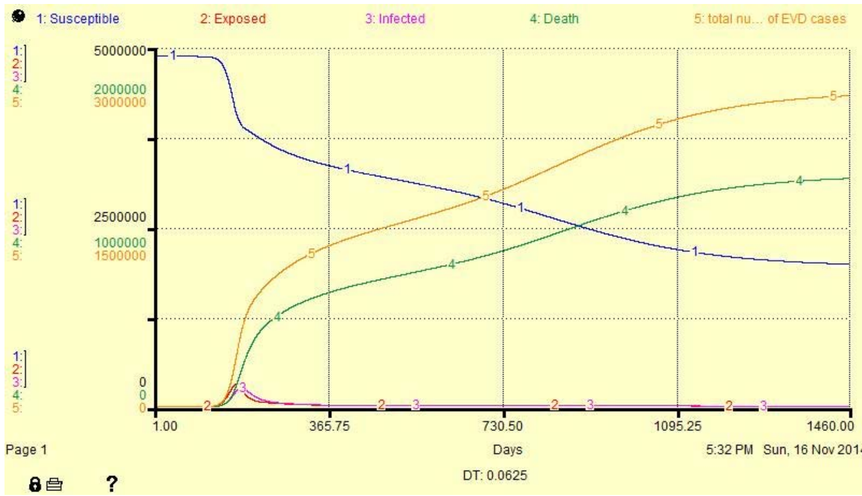


Runge-Kutta 4

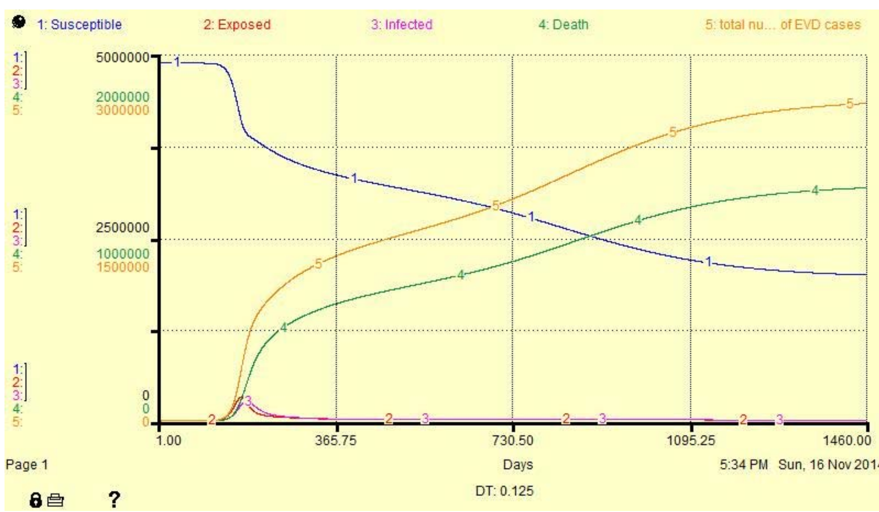


APPENDIX F - Model Verification: Delta Time

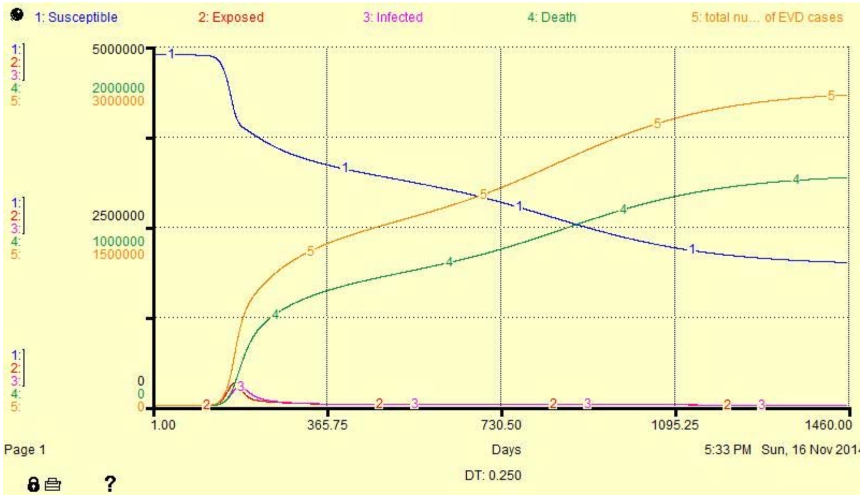
DT: 0.0625



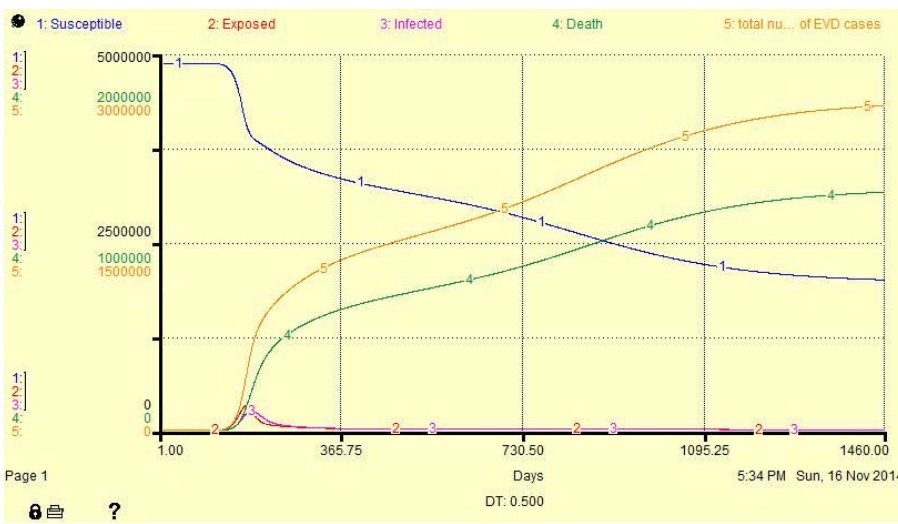
DT: 0.125



DT: 0.250

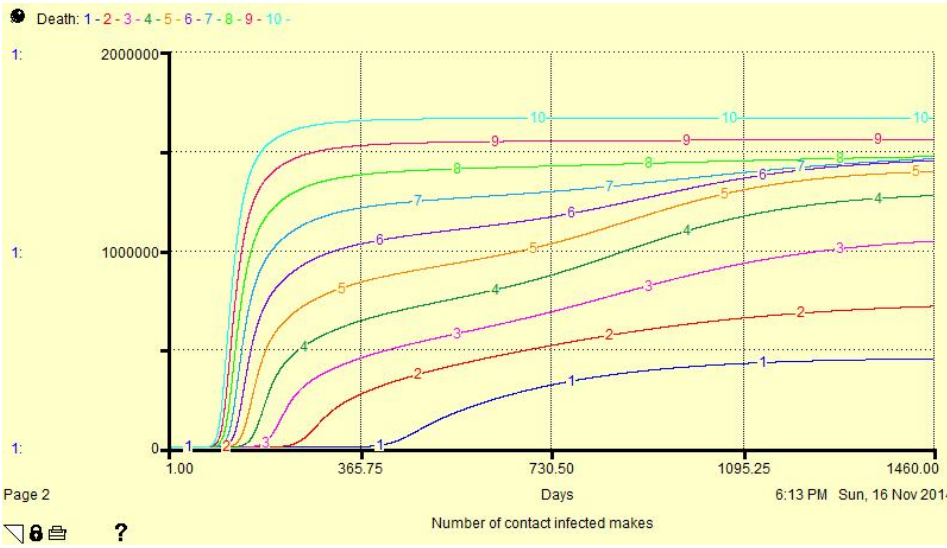


DT: 0.500

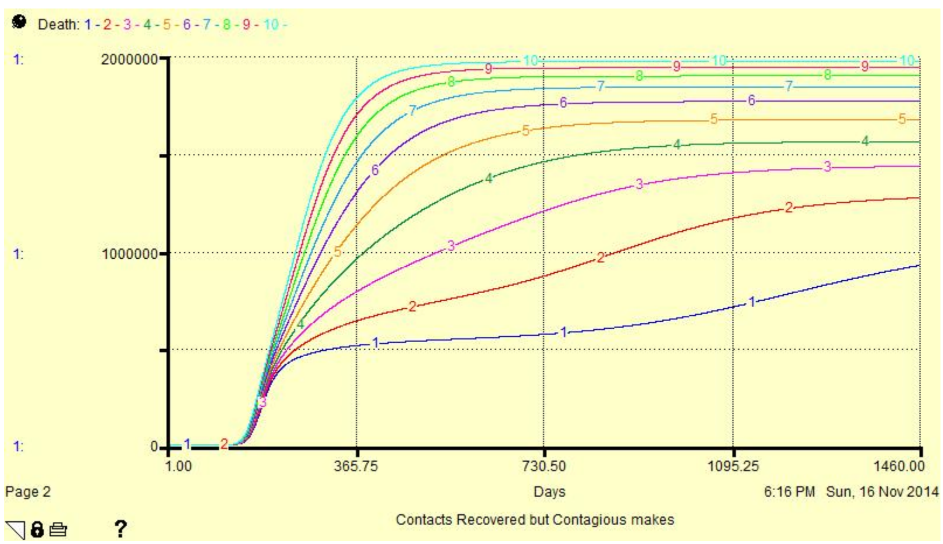


APPENDIX G - Sensitivity Analysis

Number of contacts infected makes



Number of contacts recovered but contagious makes



Probability of transfer