

Waves of COVID-19 Infections

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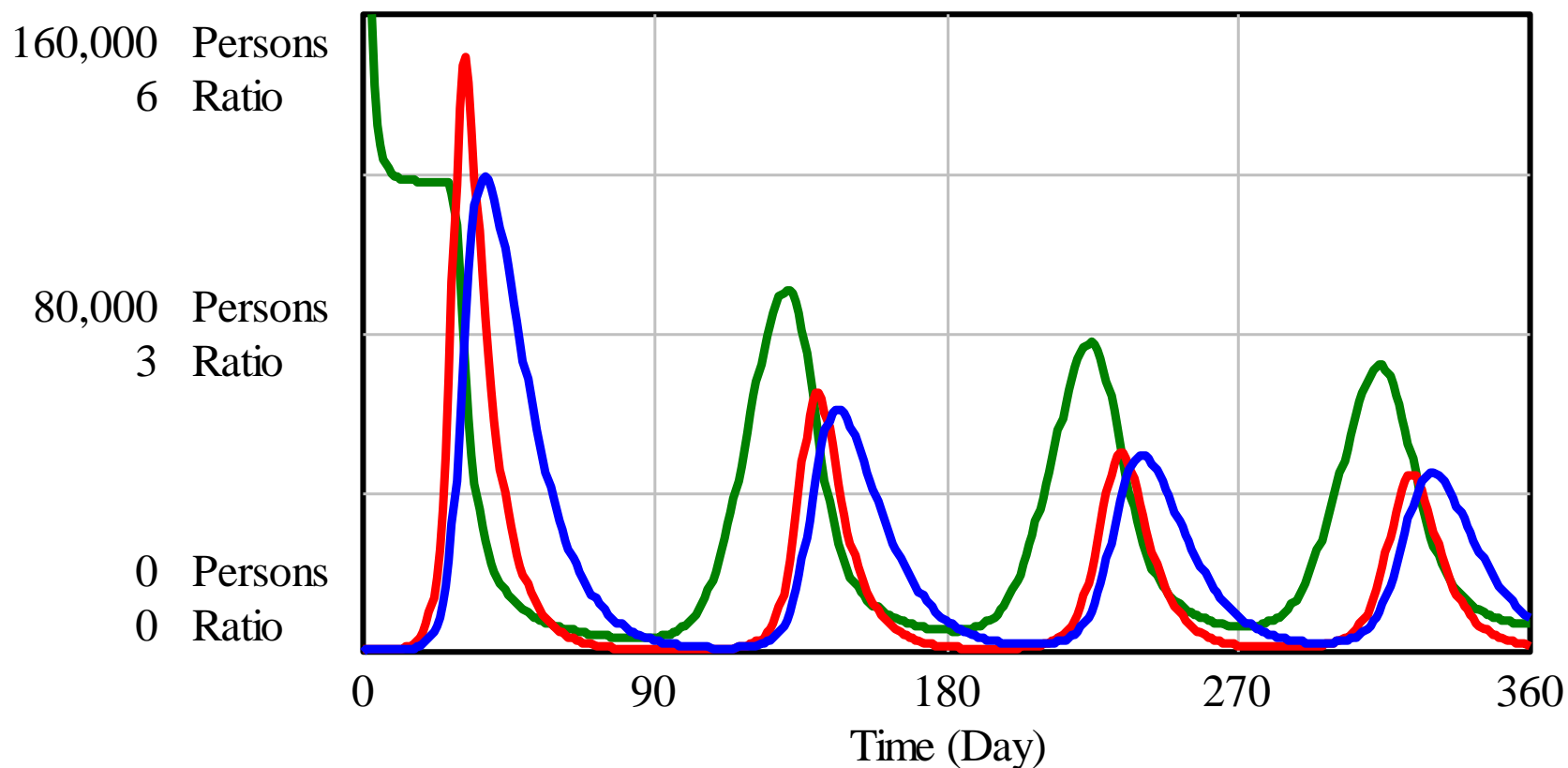
Introduction

- It is hypothesized that COVID-19 will reappear after the initial outbreak is controlled.
- To explore this, the model was run for a longer period of time under three scenarios.
 - Scenario 1: from the beginning of the epidemic both social distancing (reduced number of contacts per day) and infection protection (masks, hand washing, etc.) are carried out to a high degree.
 - Scenario 2: infection protection is high but social distancing is carried out to a lesser degree.
 - Scenario 3: both social distancing and infection protection are both carried out to a lesser degree.
- In these simulations two important assumptions are made:
 1. People who become infected and recover are immune and remain immune.
 2. No effective vaccine is available during the period of the simulation.
- All other assumptions are the same as originally described.

Summary Results

- Under all three scenarios waves of infection continue so long as a portion of the population remains susceptible. The amplitude of the waves decreases over time as the number of susceptible declines.
- After one epidemic wave passes, social distancing, infection control and quarantining are relaxed, but since some number infected people remain, the epidemic restarts.
- The simulations will show that first scenario is preferable, in that the peak and total number of infections persons and deaths is lower than other scenarios.

Waves of number of infected patients in scenario 1



Infected symptomatic ————— Persons
 Infected asymptomatic ————— Persons
 Ratio of symptoms appearance to recovery rate ————— Ratio

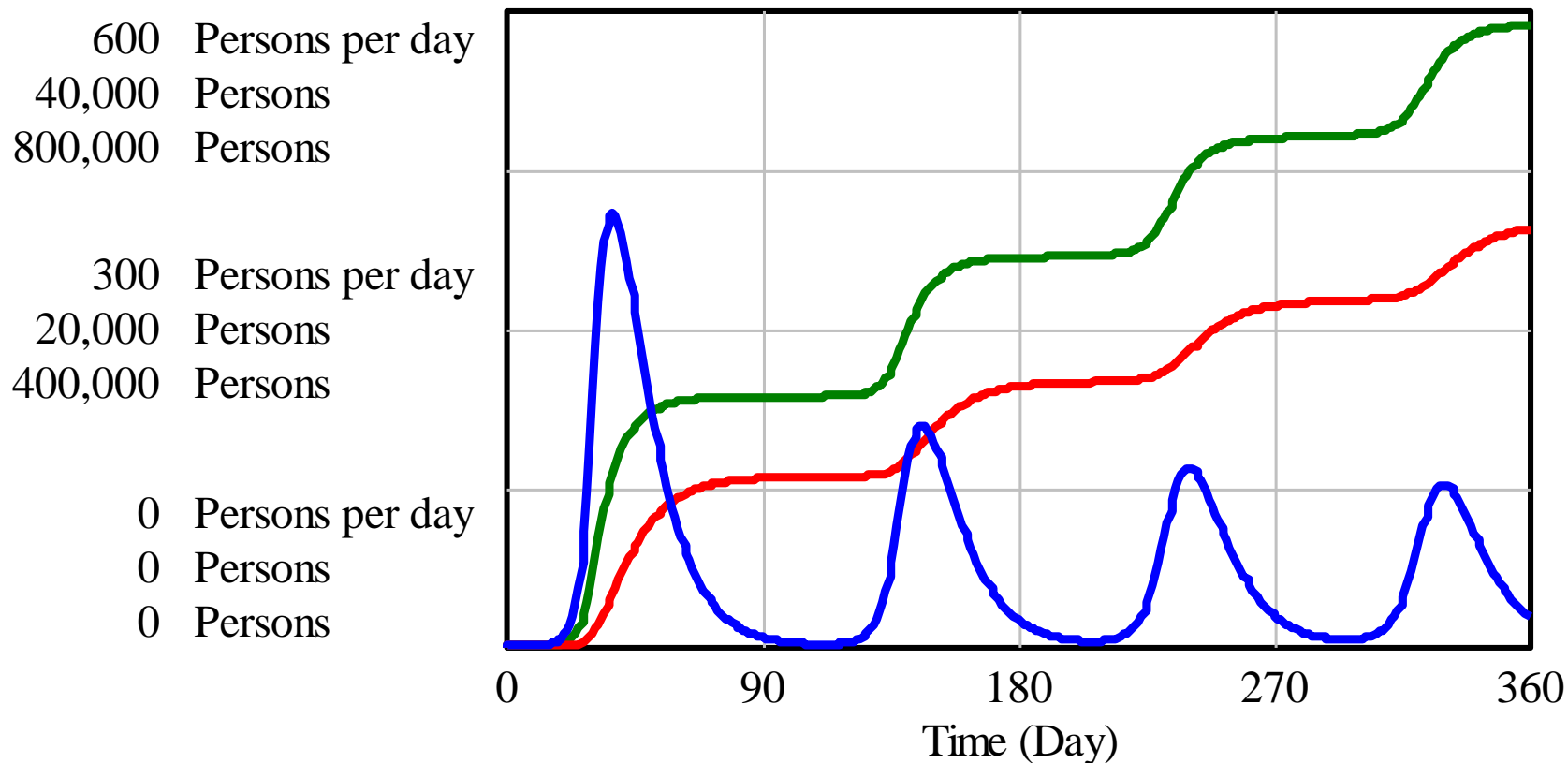
In Scenario 1 there are successive outbreaks (“waves”) of disease.

A proportion of the population remains susceptible after the quick suppression of the initial outbreak persons. Since the number of infected (contagious) persons never falls all the way to 0, the epidemic keeps restarting.

The the following waves are successively smaller, since the number of susceptible persons decreases over time.

With the onset of the next wave of disease, the number of patients and deaths increases. This increase continues until all susceptible populations are affected

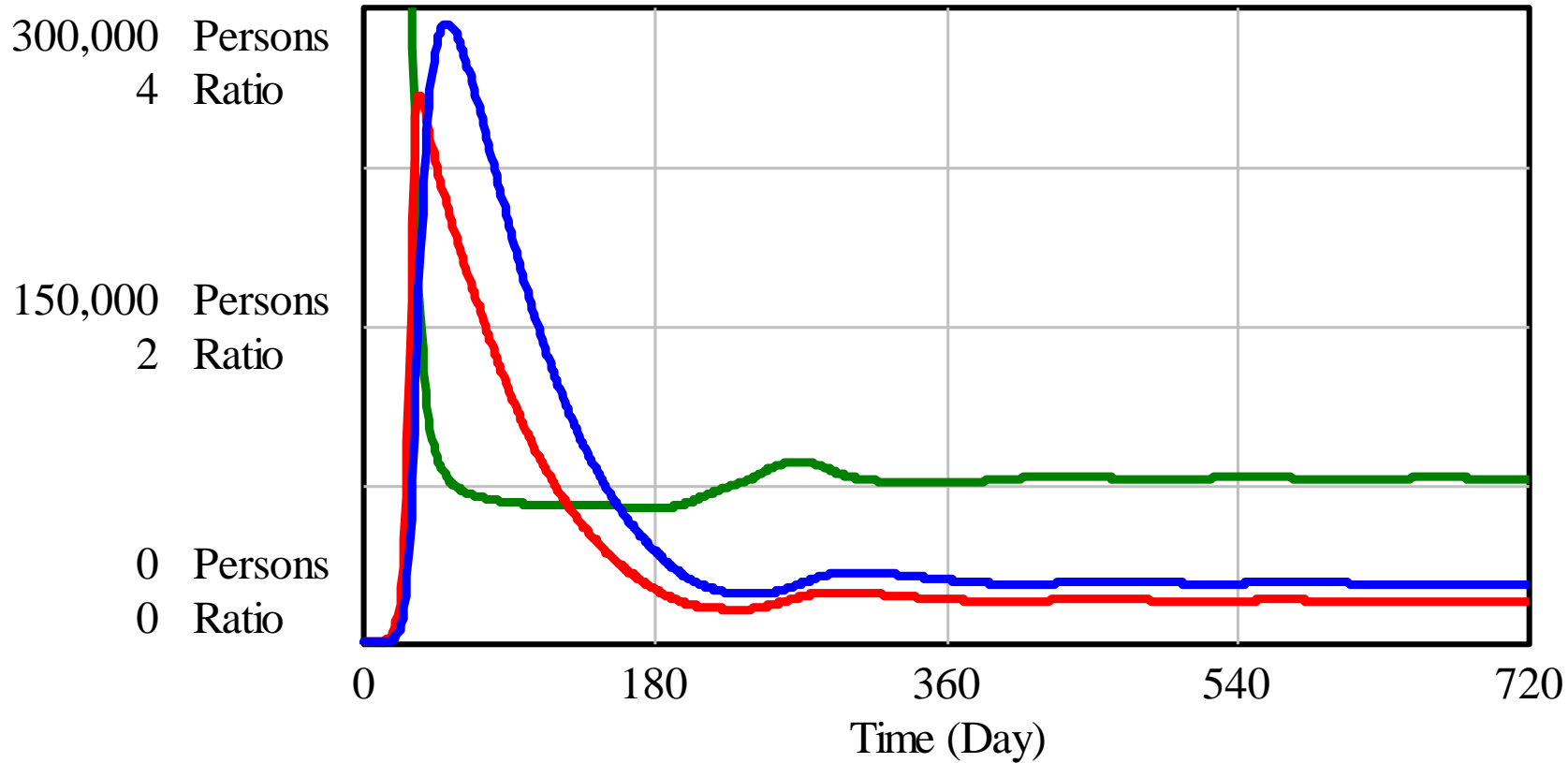
Waves in cumulative number of deaths and infected in Scenario 1



In each wave the number of cumulative patients and cumulative infected people increase until all susceptible population get infected.

Death rate ————— Persons per day
 Cumulative deaths ————— Persons
 Cumulative Cumulative infected symptomatics ————— Persons

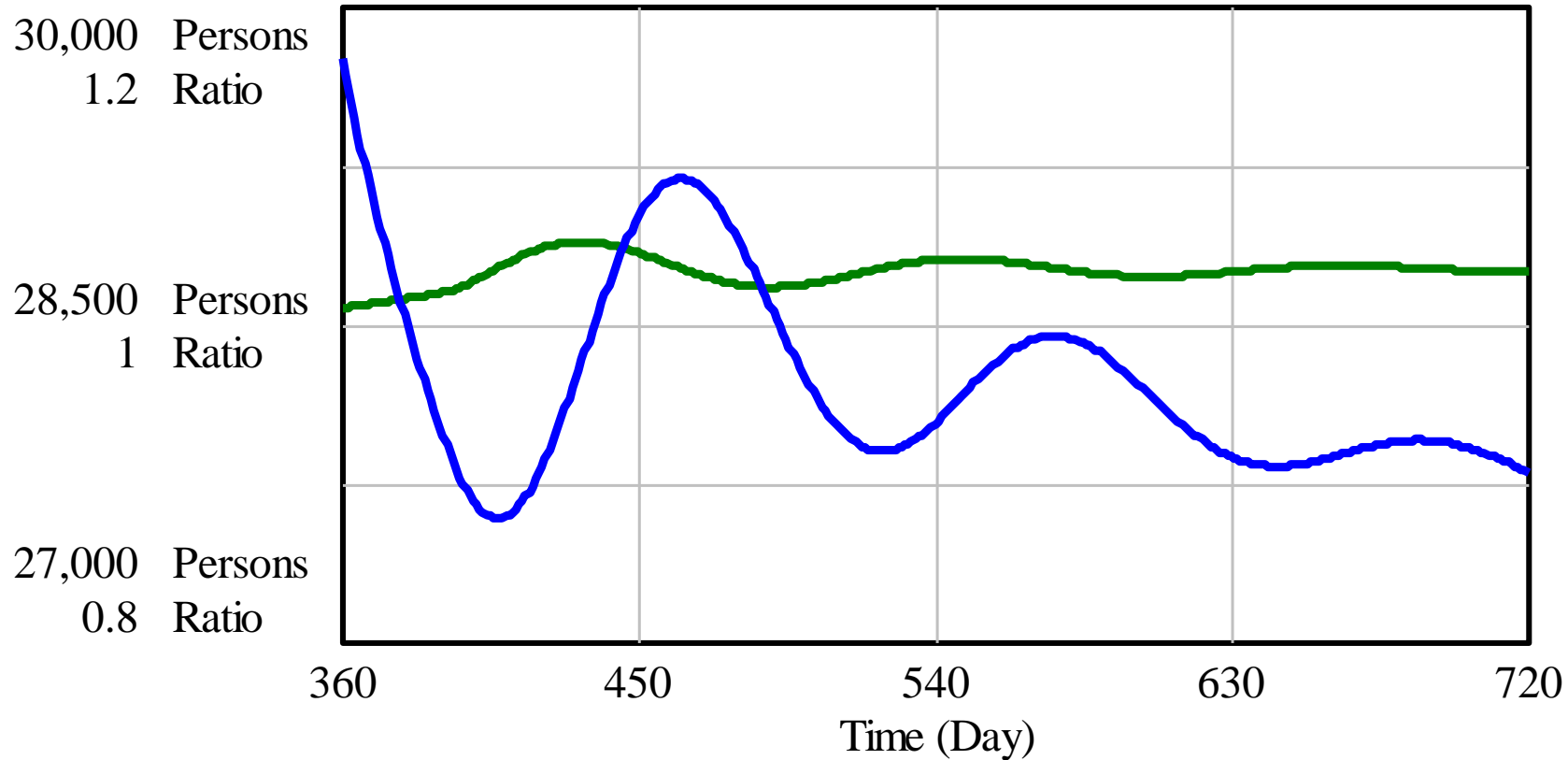
Waves of number of infected patients in scenario 2



Infected symptomatic ————— Persons
 Infected asymptomatic ————— Persons
 Ratio of symptoms appearance to recovery rate ————— Ratio

In scenario 2 the return of disease happens but in waves with lower peaks. As the ratio of symptoms appearance to recovery rate is always larger than 1, symptomatic patients always exist and move on waves with lower peaks. In the next slide the number patients are shown on a smaller scale to depict the wave.

Waves of number of infected patients in scenario 2 - Year 2

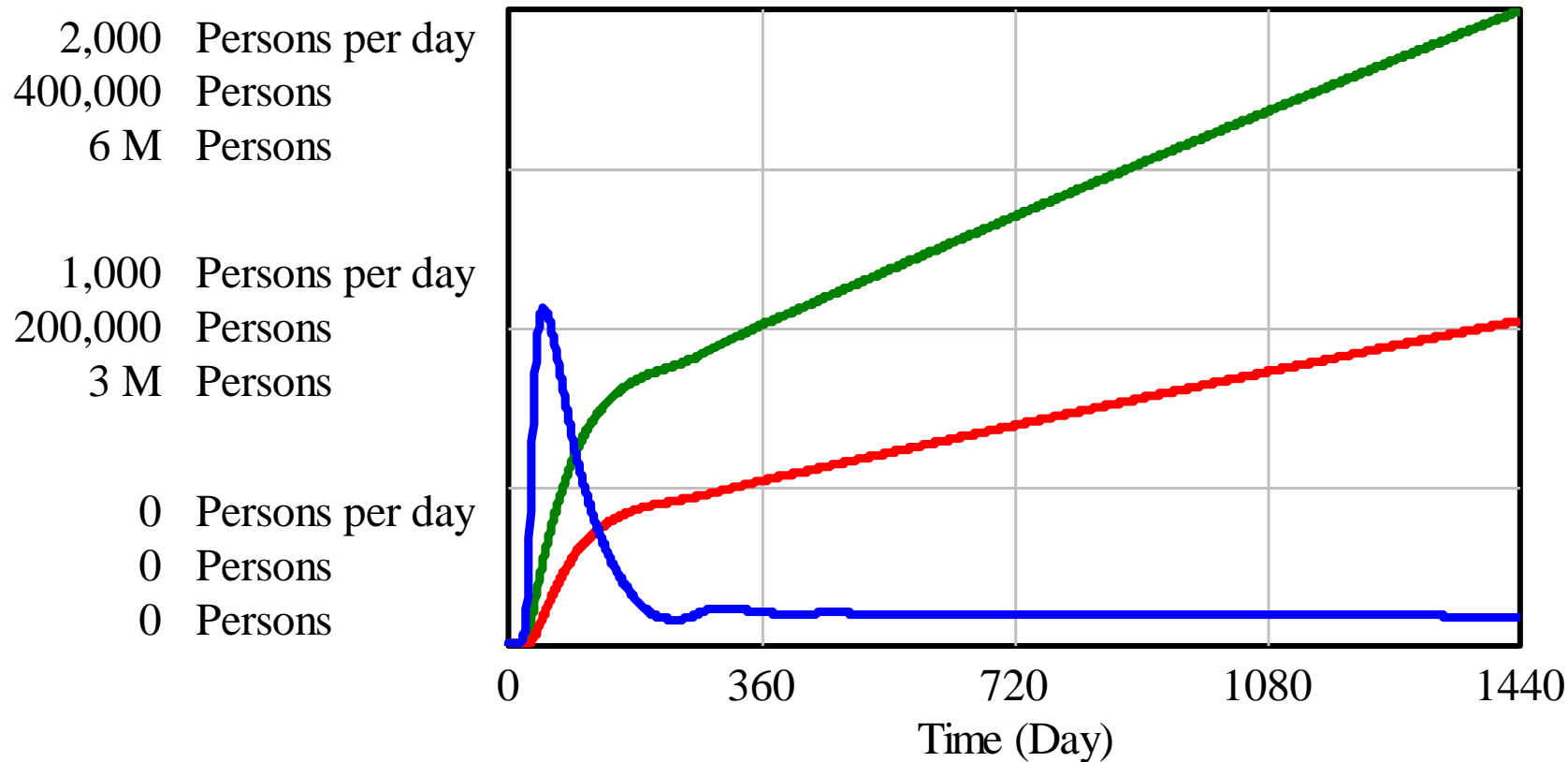


Infected symptomatic  Persons

Ratio of symptoms appearance to recovery rate  Ratio

In year 2 the waves are quite small. However, the ratio of new infections to recoveries remains above 1, indicating that the epidemic is not winding down at this time – it is just stabilizing

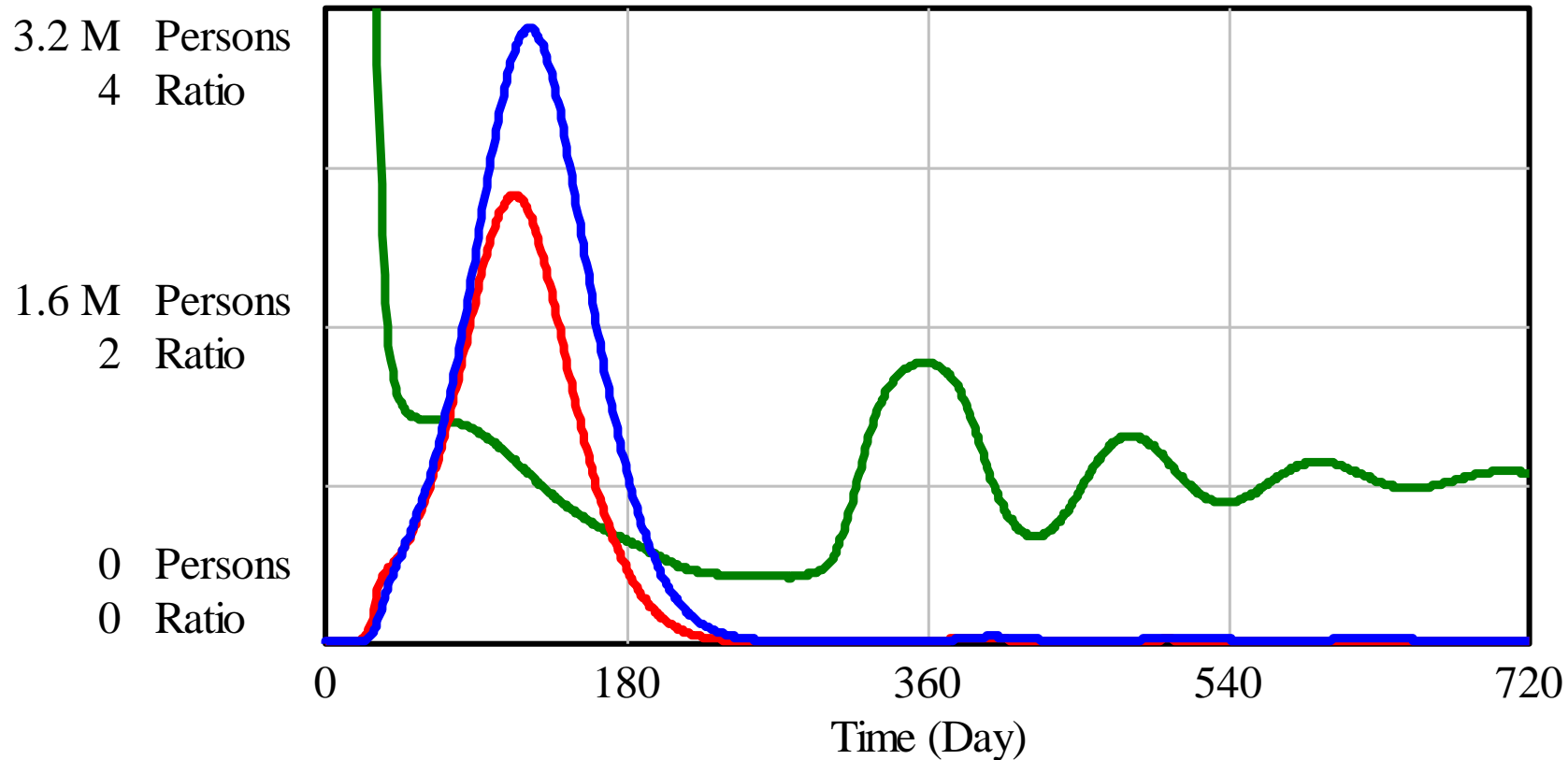
Waves in cumulative number of deaths and infected in Scenario 2



Death rate ————— Persons per day
 Cumulative deaths ————— Persons
 Cumulative infected symptomatics ————— Persons

As noted in the previous slide, the epidemic continues at a relatively low level for several years after the first wave. The magnitude of the subsequent waves in the death rate is small, but infections and deaths do continue.

Waves of number of infected patients in scenario 3



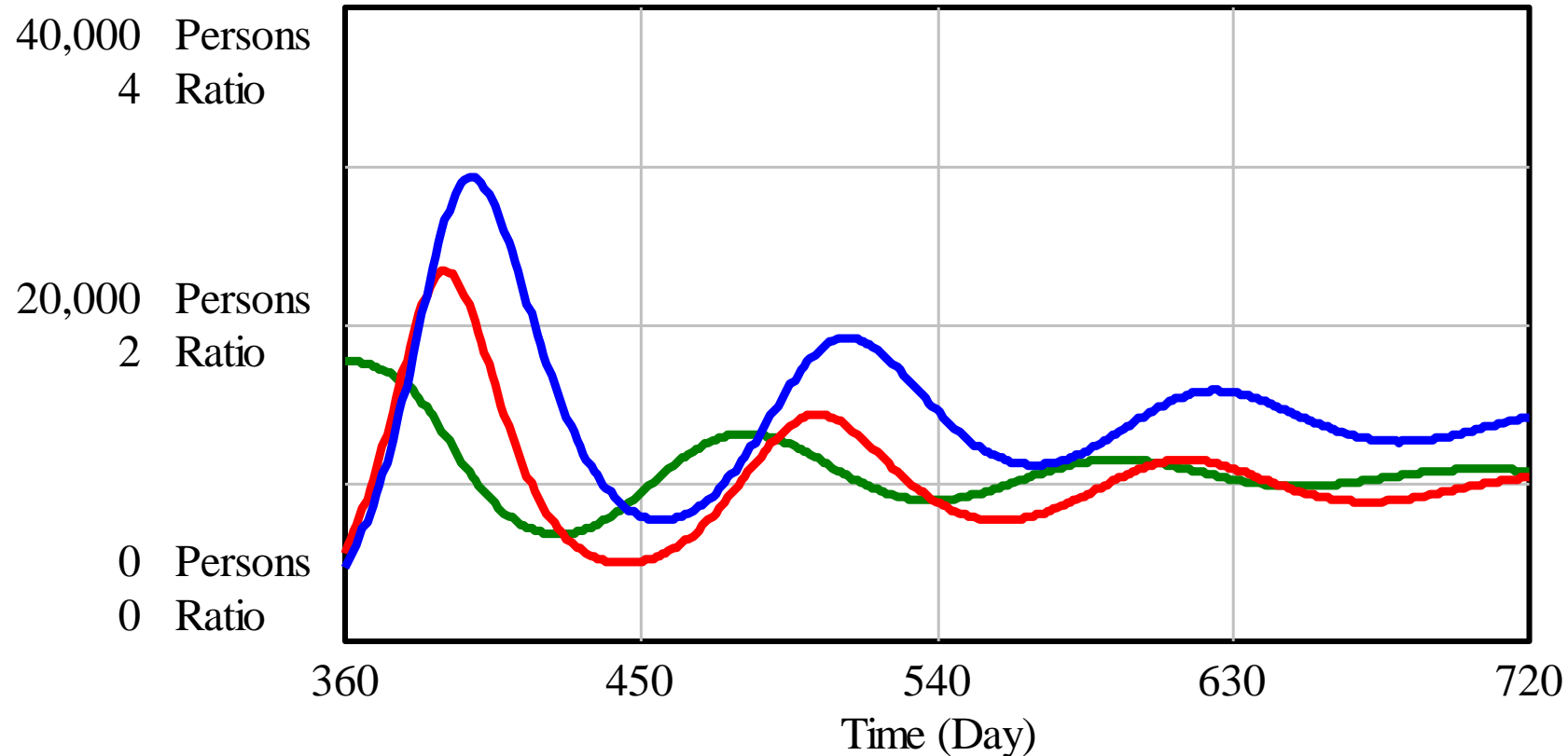
Infected symptomatic ————— Persons
 Infected asymptomatic ————— Persons
 Ratio of symptoms appearance to recovery rate ————— Ratio

In scenario 3, the epidemic returns, but the following waves are small.

Starting with the second wave, the ratio of symptoms appearance to recovery rate hovers around 1, meaning that the epidemic does not wind down over this period but rather continues at a low level.

The next slide shows the waves in year 2, at a smaller scale.

Waves of number of infected patients in scenario 3 - Year 2

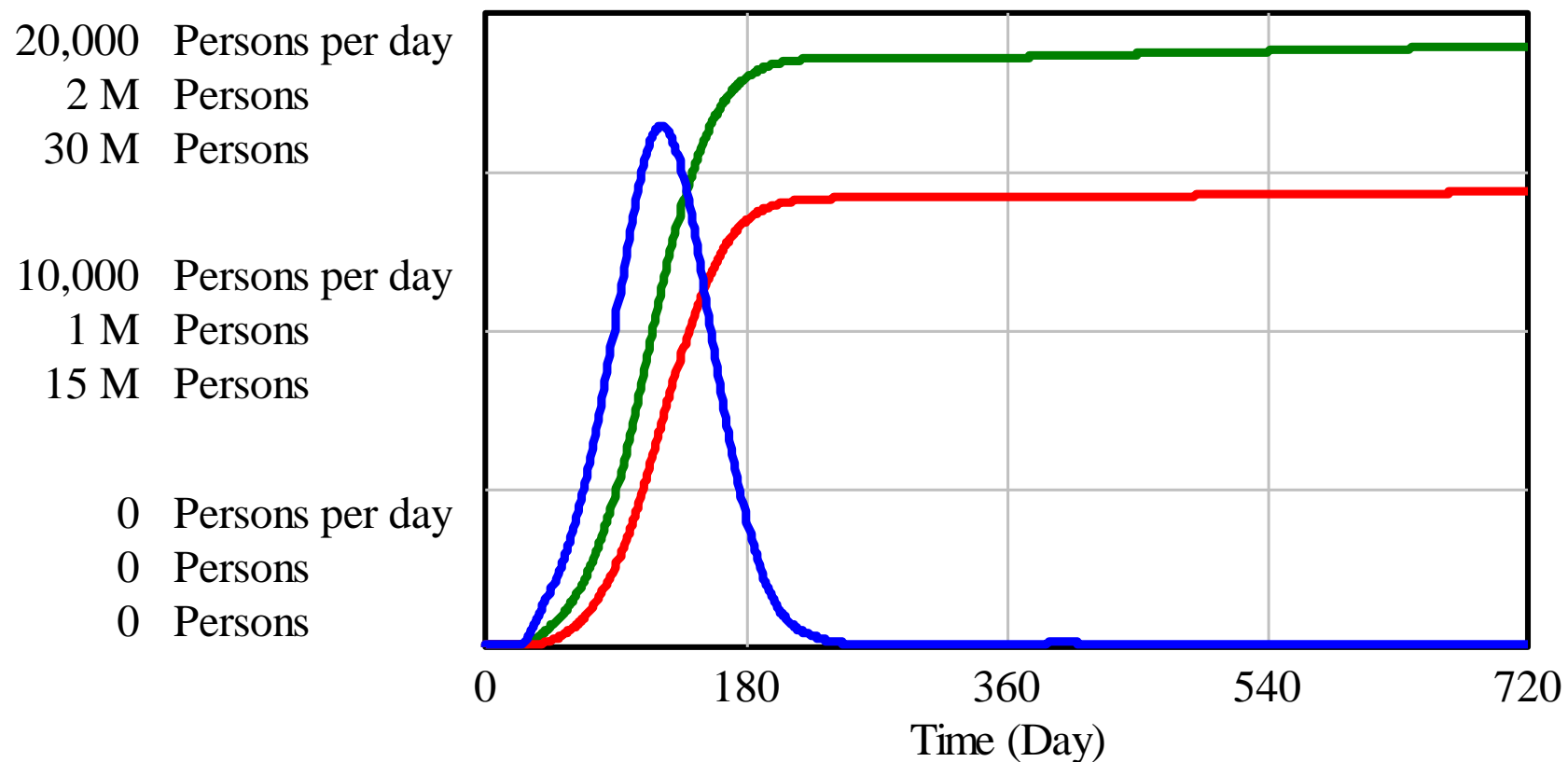


Infected symptomatic ————— Persons
Infected asymptomatic ————— Persons
Ratio of symptoms appearance to recovery rate ————— Ratio

In the second year, after the first wave has passed, we see damped oscillation of both asymptomatic and symptomatic patients.

The number of active cases settles down to around 24,000 persons.

Waves in cumulative number of deaths and infected in Scenario 3

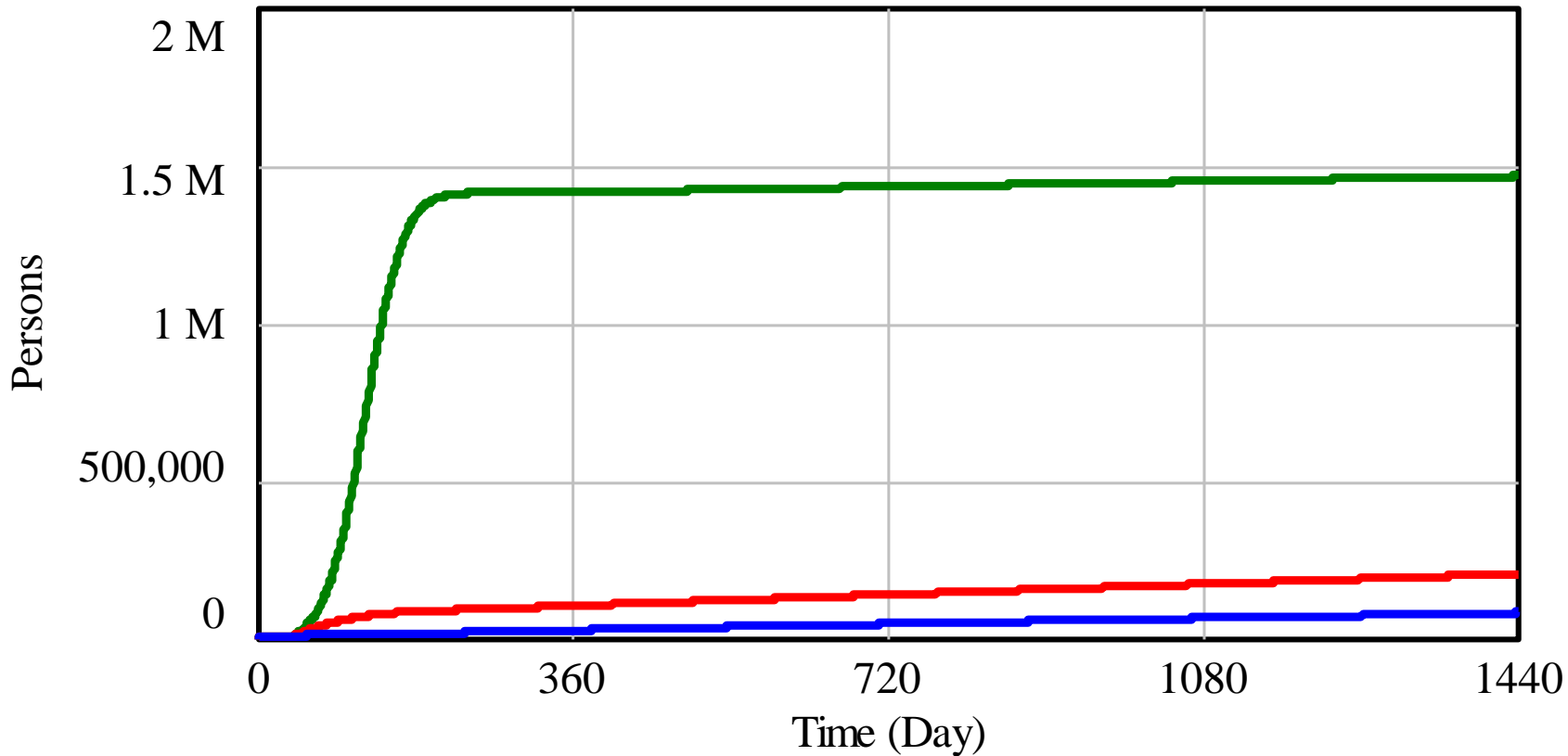


Death rate ————— Persons per day
 Cumulative deaths ————— Persons
 Cumulative infected symptomatics ————— Persons

In scenario 3 the number of cases and deaths in the first wave is very high.

Consequently, the susceptible population that remains after the first wave is small, and subsequent waves of infection do not add much to the total.

Longer Term Cumulative Deaths in the 3 Scenarios



Cummulative deaths in scenario 1 —————

Cummulative deaths in scenario 2 —————

Cummulative deaths in scenario 3 —————

Clearly scenario 1 with much lower cumulative death is preferred to the other two scenarios. In scenario 1 because the medical system's capacity is enough to treat the critical patients, the number of deaths is lower, whereas in scenario 3 the society faces a major crisis due to a high number of patients who cannot be treated well, consequently the number of death is very high.

Discussion

- Scenario 1 appears preferable to the other two scenarios because its first wave is far smaller:
 - The peak infection rate, number of cases and total cases are far smaller.
 - The death rate and total number of deaths are far smaller, because of the number of cases is smaller and because the medical system is not overburdened.
 - The overall degree of social disruption, at least in the short term, is far smaller.
- On the other hand, in scenarios 2 and 3 after the disastrous first wave passes, subsequent reappearances of the epidemic are relatively mild.
- In all three scenarios:
 - After the first wave passes some infected persons remain, and the disease becomes endemic in the population.
 - Succeeding waves become smaller because the proportion of the population who are susceptible decreases over time.
- Societies that quickly and strongly begin promoting and observing social distancing and infection control at each appearance of the disease will fare better than those whose response is slower and weaker.

Thank you for your attention

Take care and stay safe