Summary of Results

0.1 Isolation-only (no importations)

$$\frac{dS}{dt} = -\beta SI \tag{1}$$

$$\frac{dI}{dt} = \beta SI - (\mu + u_i)I \tag{2}$$

$$\frac{dw}{dt} = u_i I \tag{3}$$

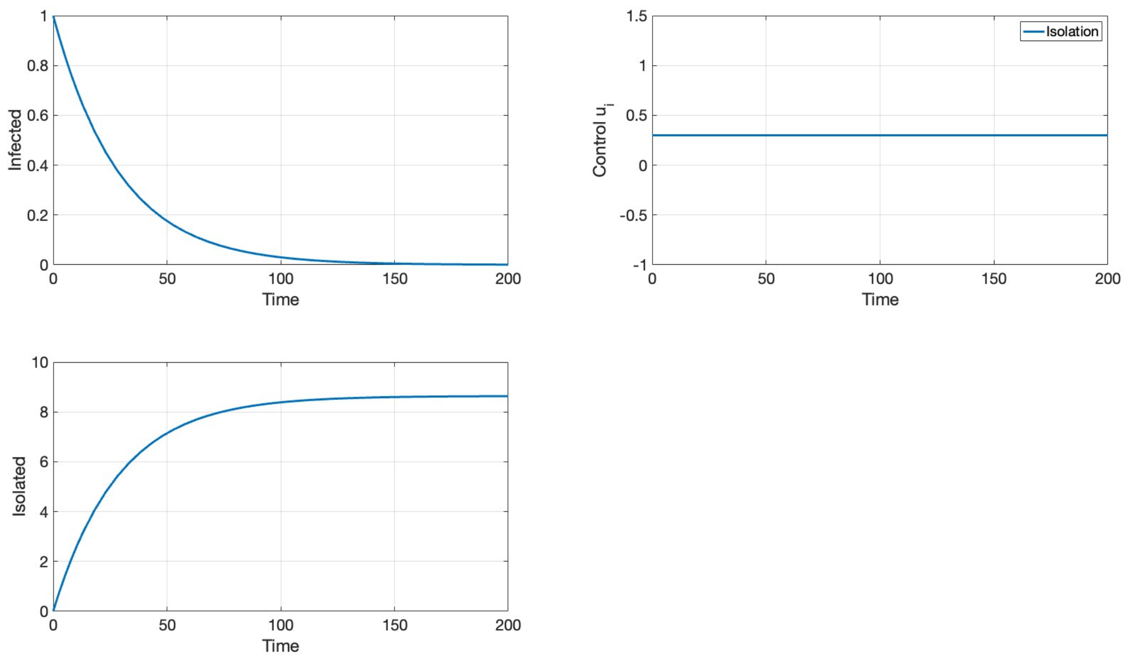

Figure 1: Dynamics of the isolation-only model for $w_{max} = 500$, starting at $t = 0$

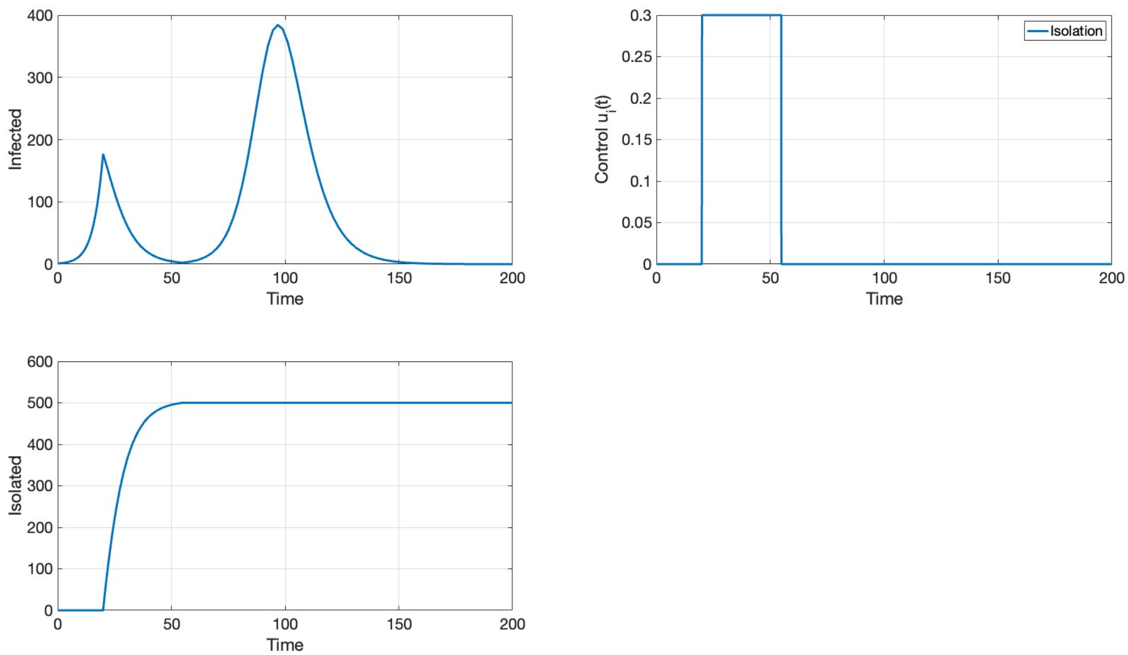

Figure 2: Dynamics of the isolation-only model for $w_{max} = 500$, starting at $t = 20$

Our model indicates that the most effective approach for managing an outbreak depends on the availability of isolation resources. When resources are abundant, we recommend putting in the highest level of effort to quarantine infected individuals throughout the entire outbreak. Conversely, when resources are scarce, it's critical to employ a strategy that optimizes all available resources for isolation. This adaptable strategy guarantees the best possible outcome under resource-constrained conditions. For optimal results, we recommend initiating isolation efforts at the highest level of effort as soon as an epidemic begins and maintaining this stringent level until all resources are fully expended.

0.2 Isolation-only (importations)

$$\frac{dS}{dt} = -\beta S(I_1 + I_2) \tag{4}$$
$$\frac{dI_1}{dt} = \beta S(I_1 + I_2) - (\mu + u_i)I_1 \tag{5}$$
$$\frac{dI_2}{dt} = \theta - \gamma I_2 \tag{6}$$
$$\frac{dw}{dt} = u_i I_1 \tag{7}$$

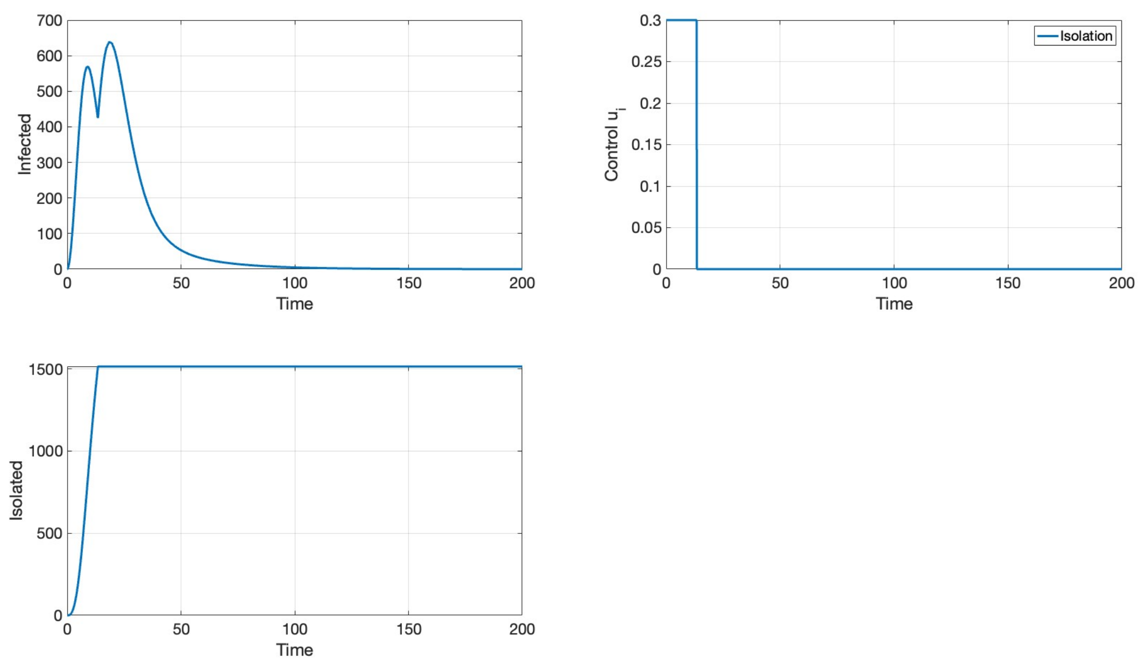

Figure 3: Dynamics of the isolation-only model for $w_{max} = 1500, \quad$ starting at $t = 0$

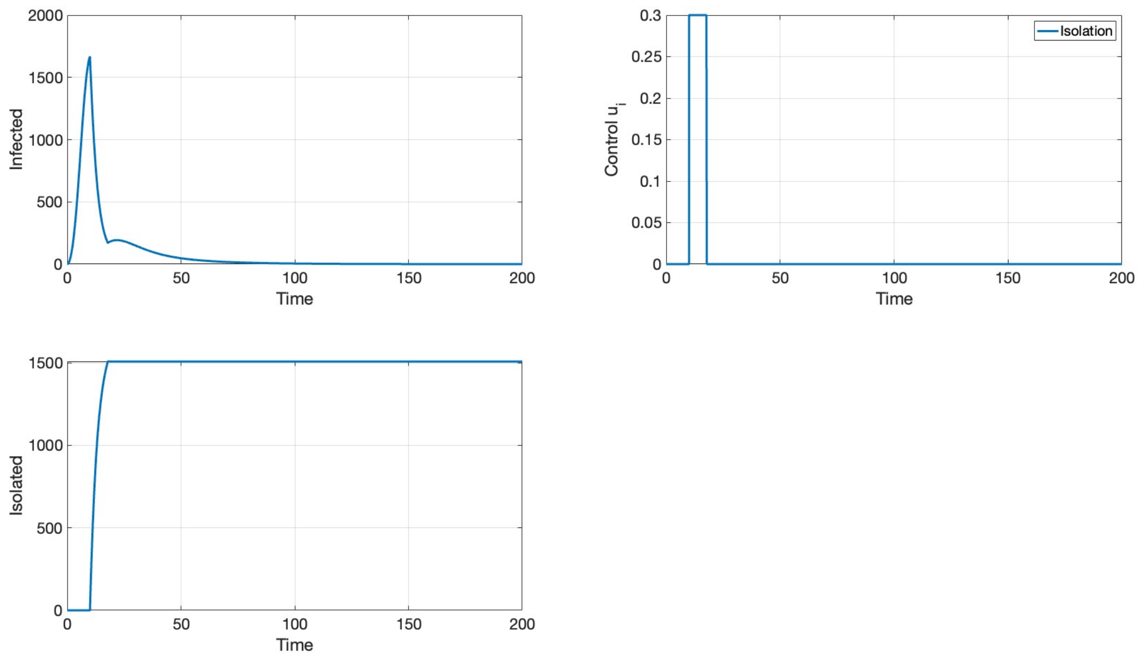

Figure 4: Dynamics of the isolation-only model for for $w_{max} = 1500, \quad$ starting at $t = 10$

Given the uncontrolled influx of infected travellers, the imposition of isolation just before or right after the peak of infections results in a minimum objective function value. This value, a key indicator of the effectiveness of our control measures, is significantly reduced when we intensify these measures during this critical period. This aligns with our objective of reducing the incidence of new cases. However, it's important to note that implementing these controls too early can lead to premature depletion of our available resources, rendering us unable to sustain isolation. This, in turn, can lead to multiple peaks of infections and a higher number of new infections.

0.3 Travel Restrictions - only

$$\frac{dS_1}{dt} = -\beta S_1(I_1 + I_2) \tag{8}$$
$$\frac{dI_1}{dt} = \beta S_1(I_1 + I_2) - \mu I_1 \tag{9}$$
$$\frac{dI_2}{dt} = \theta - u_\tau I_2 - \gamma I_2 \tag{10}$$
$$\frac{dz}{dt} = u_\tau I_2 \tag{11}$$

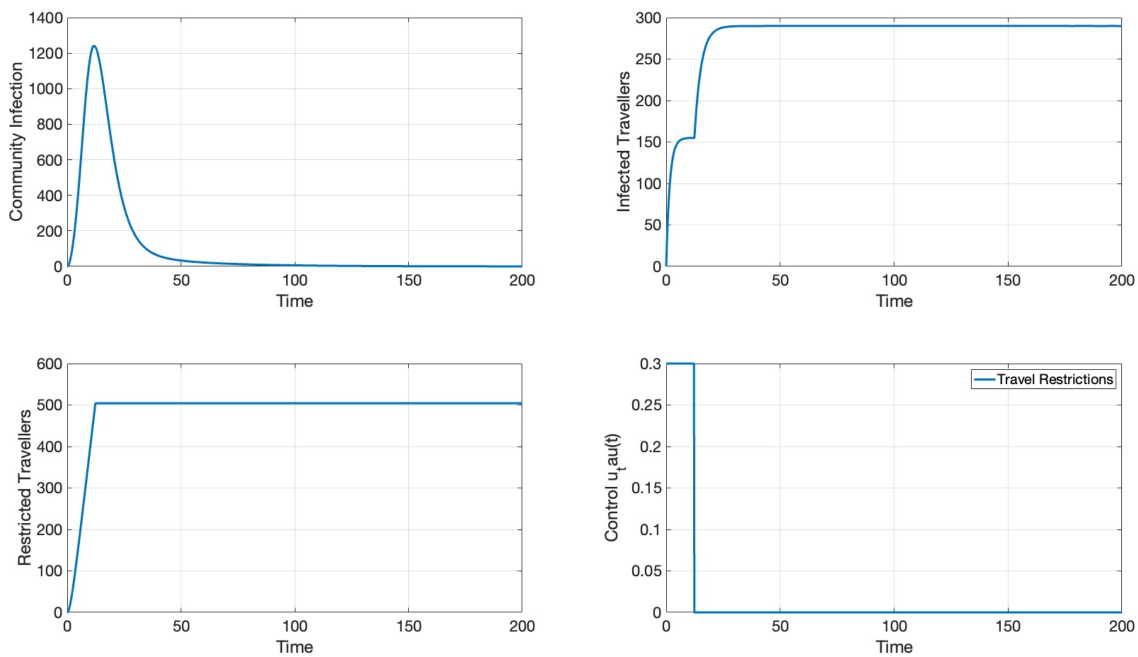

Figure 5: Dynamics of the travel restrictions-only model for $z_{max} = 500$, starting at $t = 0$

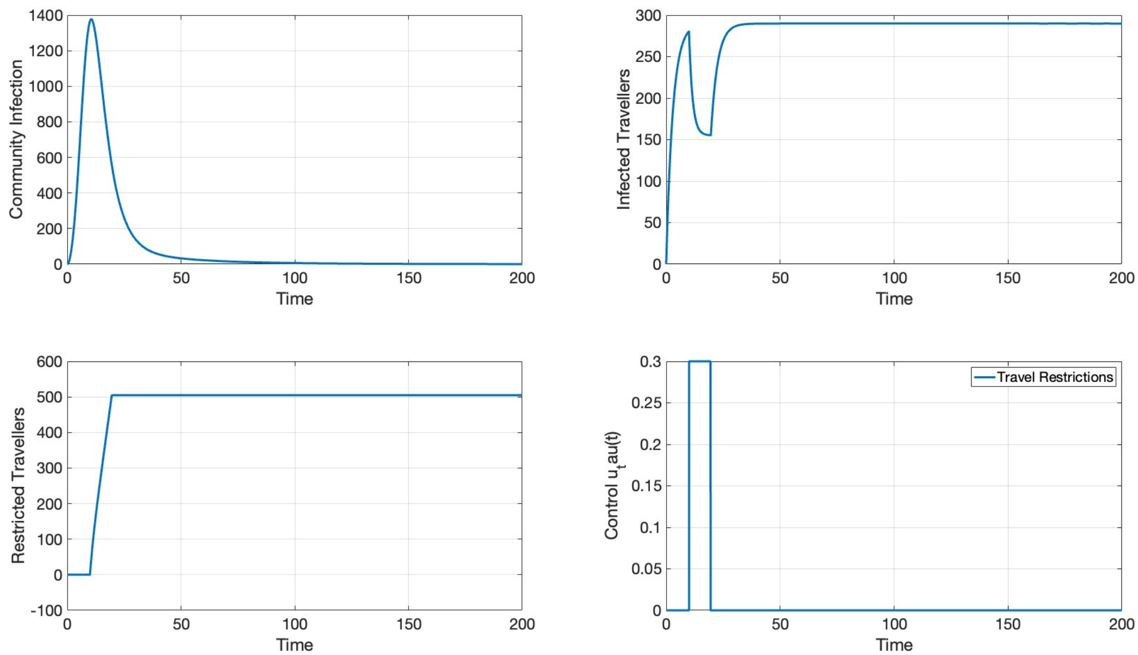

Figure 6: Dynamics of the travel restrictions-only model for $z_{max} = 500$, starting at $t = 10$

Imposing travel restrictions just before or right after the peak of infections results in a minimum value of the objective function. This is because fewer susceptible individuals remain at the infection's peak. By intensifying control measures during this time, we can significantly decrease the emergence of new infections, aligning with our objective of reducing the incidence of new cases. However, implementing these controls too early can lead to premature depletion of our available resources, rendering us unable to sustain travel restrictions. Many individuals would still be vulnerable at this juncture, and introducing new infections by arriving travellers could raise the number of new cases.

0.4 Mixed Policy

$$\frac{dS}{dt} = -\beta S(I_1 + I_2) \tag{12}$$
$$\frac{dI_1}{dt} = \beta S(I_1 + I_2) - (\mu + u_i)I_1 \tag{13}$$
$$\frac{dI_2}{dt} = \theta - u_\tau I_2 - \gamma I_2 \tag{14}$$
$$\frac{dw}{dt} = u_i I_1 \tag{15}$$
$$\frac{dz}{dt} = u_\tau I_2 \tag{16}$$

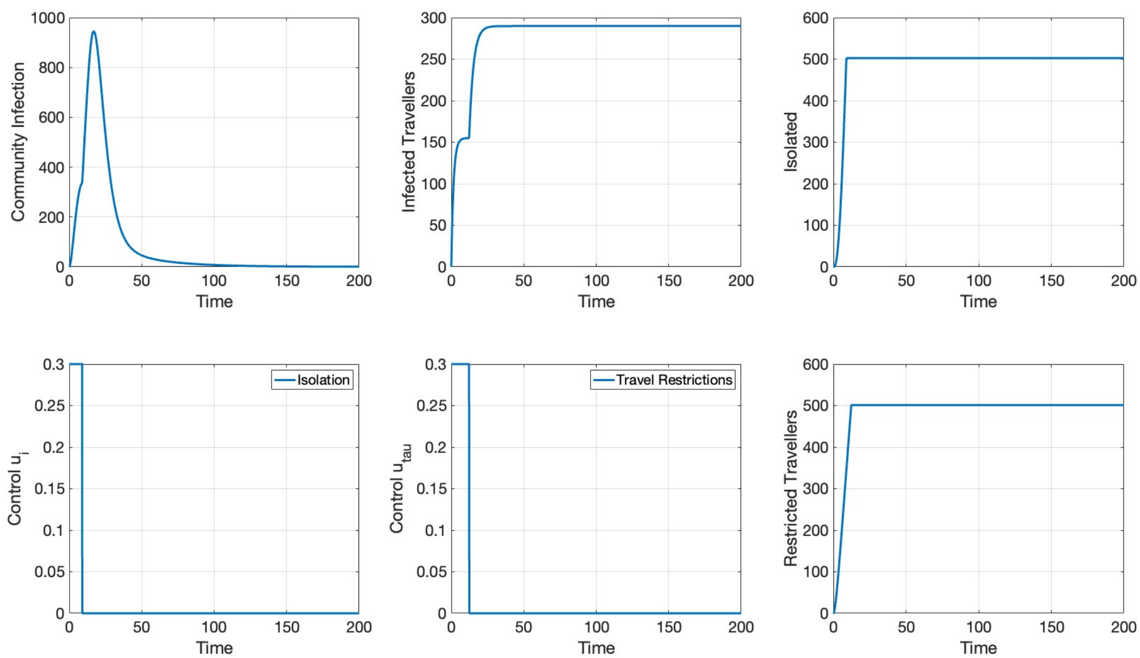

Figure 7: Dynamics of the mixed model when the controls are initiated at the start of the epidemic for $w_{max} = 500,\ z_{max} = 500$ (both immediately until all available resources used up)

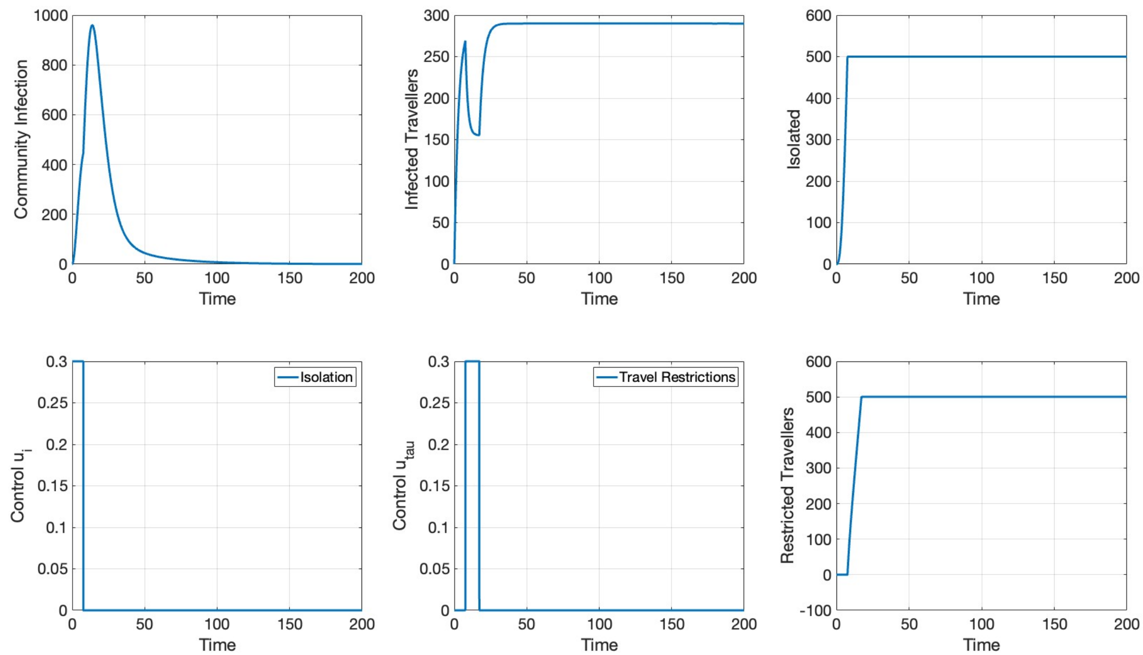

Figure 8: Isolation-only first starting at $t = 0$ until all resources used up, then travel-restrictions only; for $w_{max} = 500, \ z_{max} = 500$

The mixed policy model, a significant finding of our research, indicates that initiating both controls at the outset can effectively minimize the infection peak. Notably, isolation is more effective than travel restrictions. The model suggests that the optimal isolation–travel restrictions strategy is to isolate with maximal effort until the isolation or travel restrictions resources are depleted. The mixed policy model demonstrates its adaptability in scenarios where isolation resources are depleted first. In such cases, the optimal travel restrictions strategy remains the most effective. This adaptability is what makes the mixed policy particularly interesting, as it is not simply a combination of the optimal isolation and vaccination policies, but a dynamic strategy.