Thesis Update

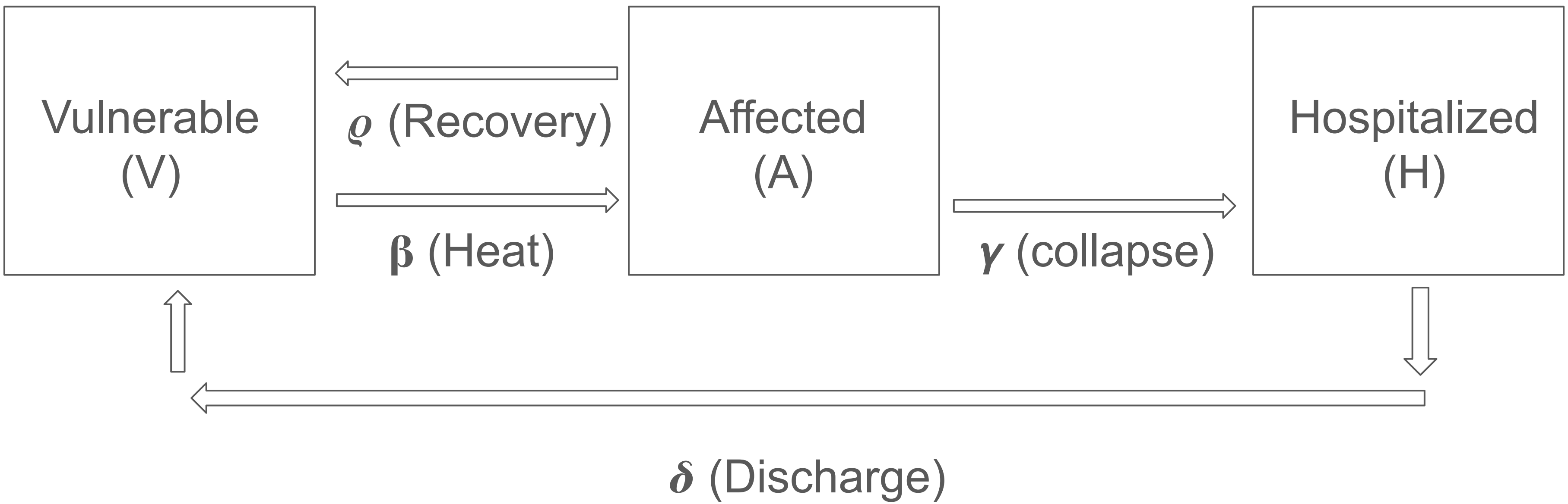
Short update of my thesis progress & next steps

Rationale

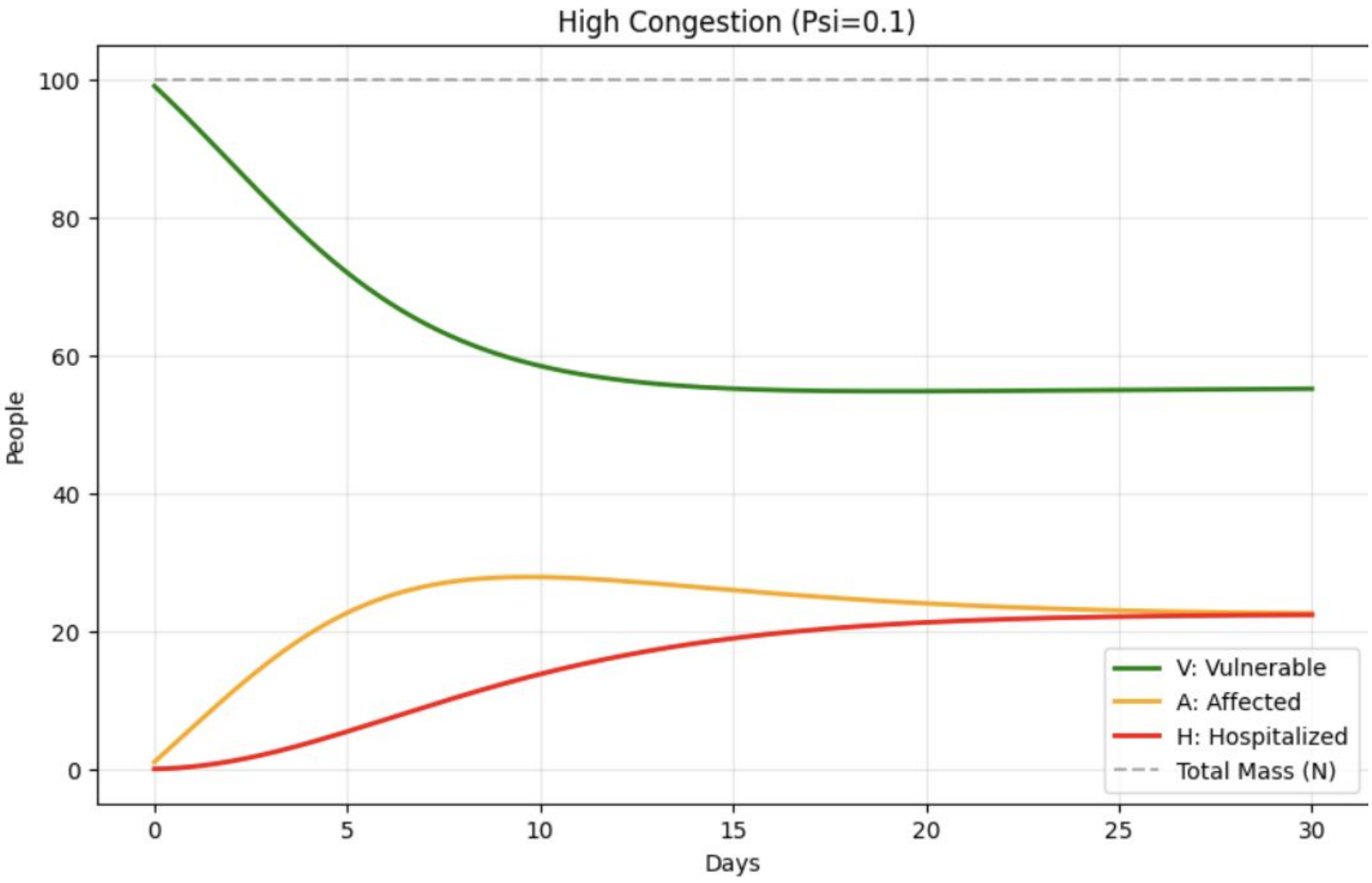
- I did a deep dive on the papers you sent (Gasparrini, Masselot, Cheung) as well as the literature.
  - Two-stage designs, time-series, BART, regression.
  - Current methods excel at associating risk factors with past mortality
- Regression describes what happened, struggles to simulate system collapse.
- Selected System Dynamics (ODEs) to model tipping points of hospital capacity (rather than just quantifying mortality).

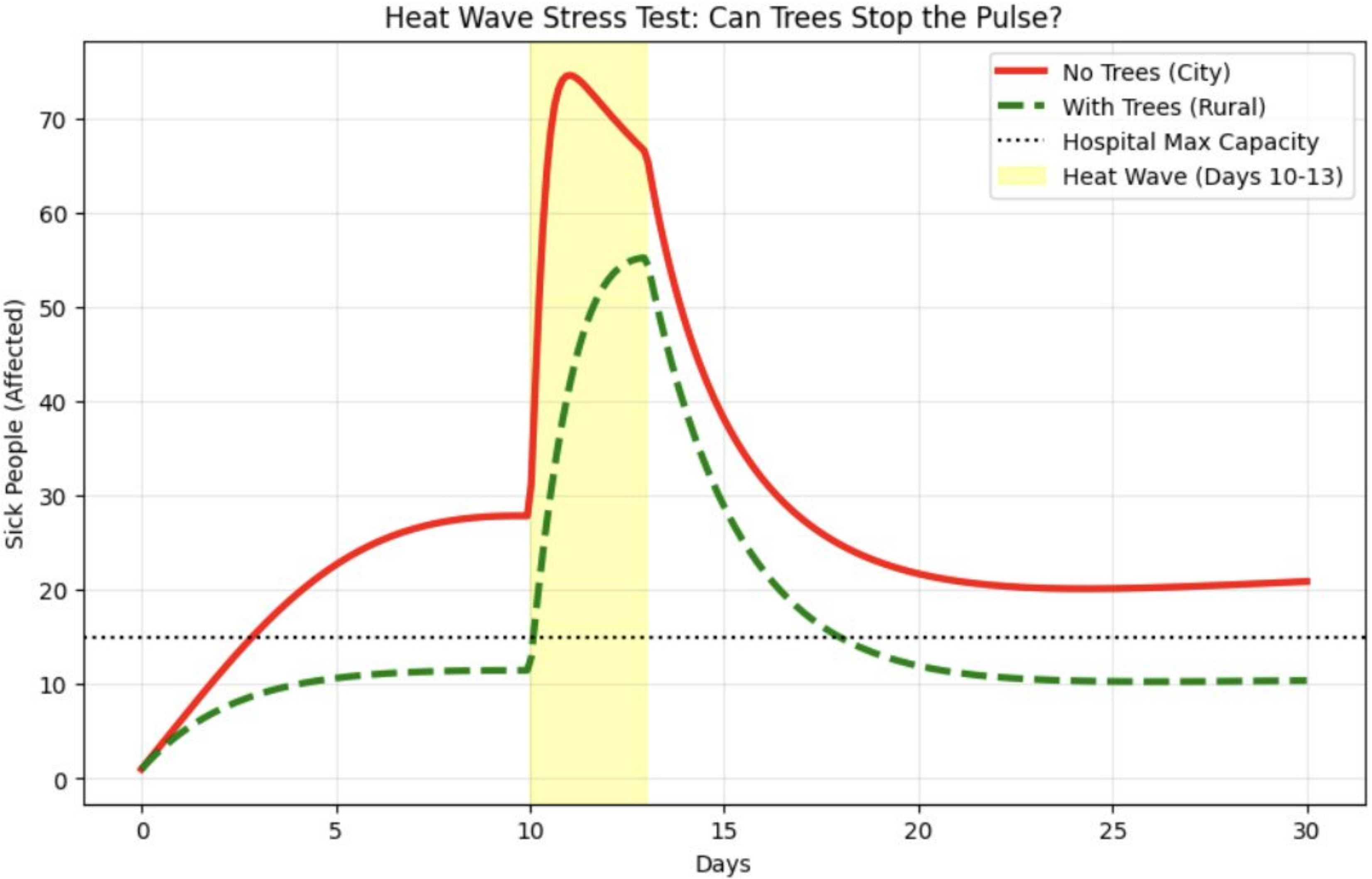
Background

- Differential equations quantify the rate of change rather than the static state.
- Gold standard in infectious disease epidemiology (SIR models).
- I treated Heat Stress similar to a contagion that overwhelms system buffers.
- Whereas regression fits data to find correlations, ODEs simulate mechanisms to find limits.



$$\frac{dV}{dt} = -\beta V(1+\psi A) + \rho A + \delta H$$
$$\frac{dA}{dt} = \beta V(1+\psi A) - \rho A - \gamma A$$
$$\frac{dH}{dt} = \gamma A - \delta H$$


High Congestion (Psi=0.1)
People
Days
0
20
40
60
80
100
0
5
10
15
20
25
30
V: Vulnerable
A: Affected
H: Hospitalized
Total Mass (N)


Heat Wave Stress Test: Can Trees Stop the Pulse?
No Trees (City)
With Trees (Rural)
Hospital Max Capacity
Heat Wave (Days 10-13)
Sick People (Affected)
Days
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30

Dashboard

Insights

- Prevention > Cure
- Mathematically, blocking the sun with trees (reducing β) is more effective than increasing Hospital Capacity.
- The system remains in failure long after temperature drops in concrete scenario
- There is a specific threshold of heat where the system doesn't degrade linearly, but crashes vertically. We can identify this temperature

Limitations

- This is a model, not reality
- We treat the whole population as one bucket - in reality, seniors and children flow at different rates
- We are assuming the city in one big mixing pot. We ignore specific neighbourhoods (though we can add that later)
- The model is deterministic. Real life has randomness.

Implications and Next Steps

- Next Steps
  - Draft Abstract and send it for review
  - Calibrate β and ρ using 2021 BC Heat Dome empirical data
  - Schedule TAC meeting and write paper