Supplementary Information: A gravity-based framework for the spatial allocation and distribution of storage capacity to facilitate reuse of construction and demolition waste

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1 Heterogeneous network comparison

To compare the homogeneous network to the heterogeneous network scenarios, Monte-Carlo (MC) simulations were conducted and included in the sensitivity analysis with randomised values for variables with the total sums of each variable in the system remaining the same as the homogeneous network. In Figure 1, the flows of $w_{i,t}$ and $a_{i,t}$ at each node, which vary at each time step except for $c_{max,i}$, were sampled from a uniform distribution $U(0,1)$, while the total sums remained constant, with both ϕ_M and λ_i set to 0.5.

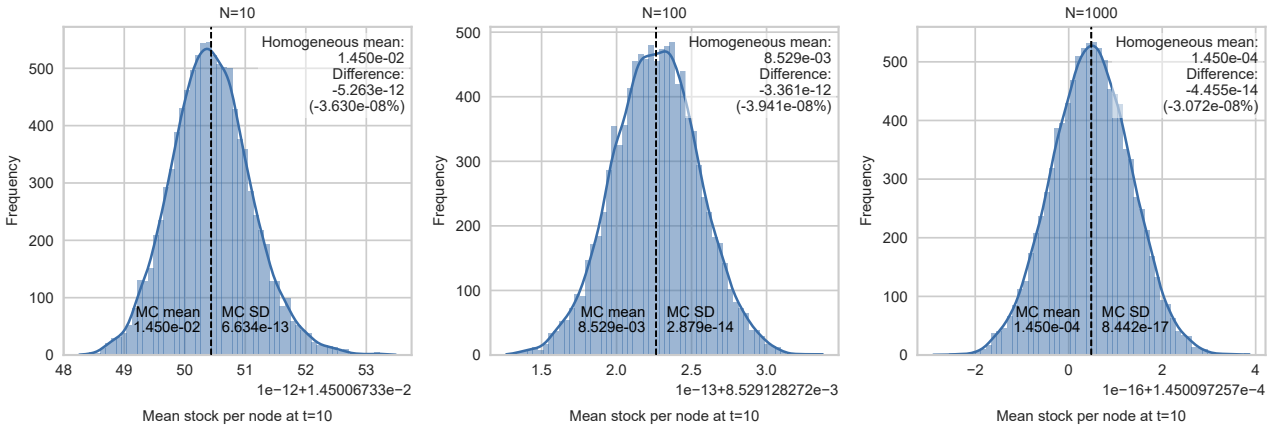


Figure 1: The mean stock per node after a fixed time, $t = 10$, generated from 10,000 MC simulations for varying N, indicating the difference between heterogenous and homogeneous network.

Then, Figure 2 compares the results of MC mean values against the results generated from a homogenous network, where all variables $w_{i,t}$, $a_{i,t}$, $c_{max,i}$, ϕ_M, and λ_i, were randomised at each iteration.

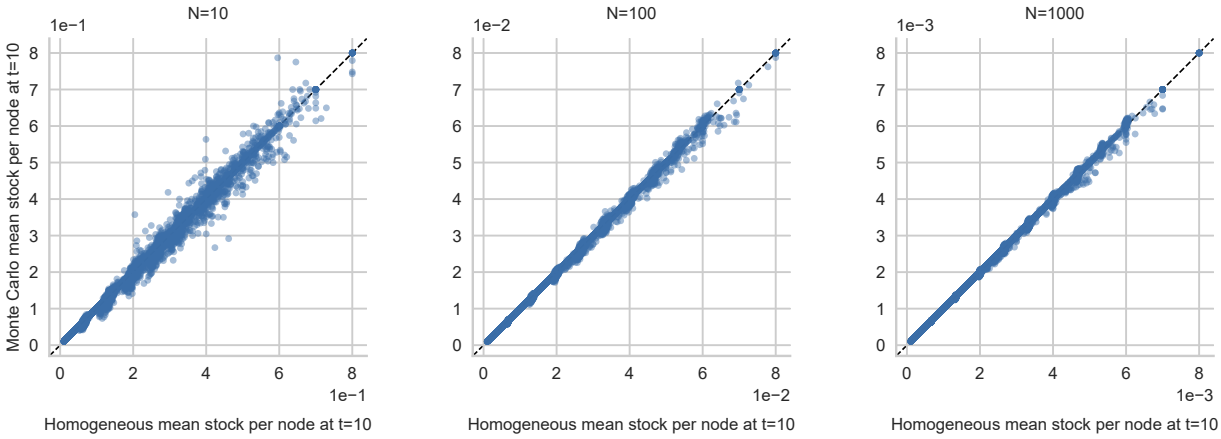


Figure 2: MC output 2.

2 Numerical modelling results with varying constraints

Based on a homogeneous network with fixed size of 10 nodes that are identical and equal distance between all the nodes, different constraint conditions were modelled by adjusting the supply, demand and capacity. Figure 2 shows the behaviours of the system under the following conditions:

1. Supply and stock constraints
2. Supply and demand constraints
3. Capacity and stock constraints
4. Capacity and demand constraints

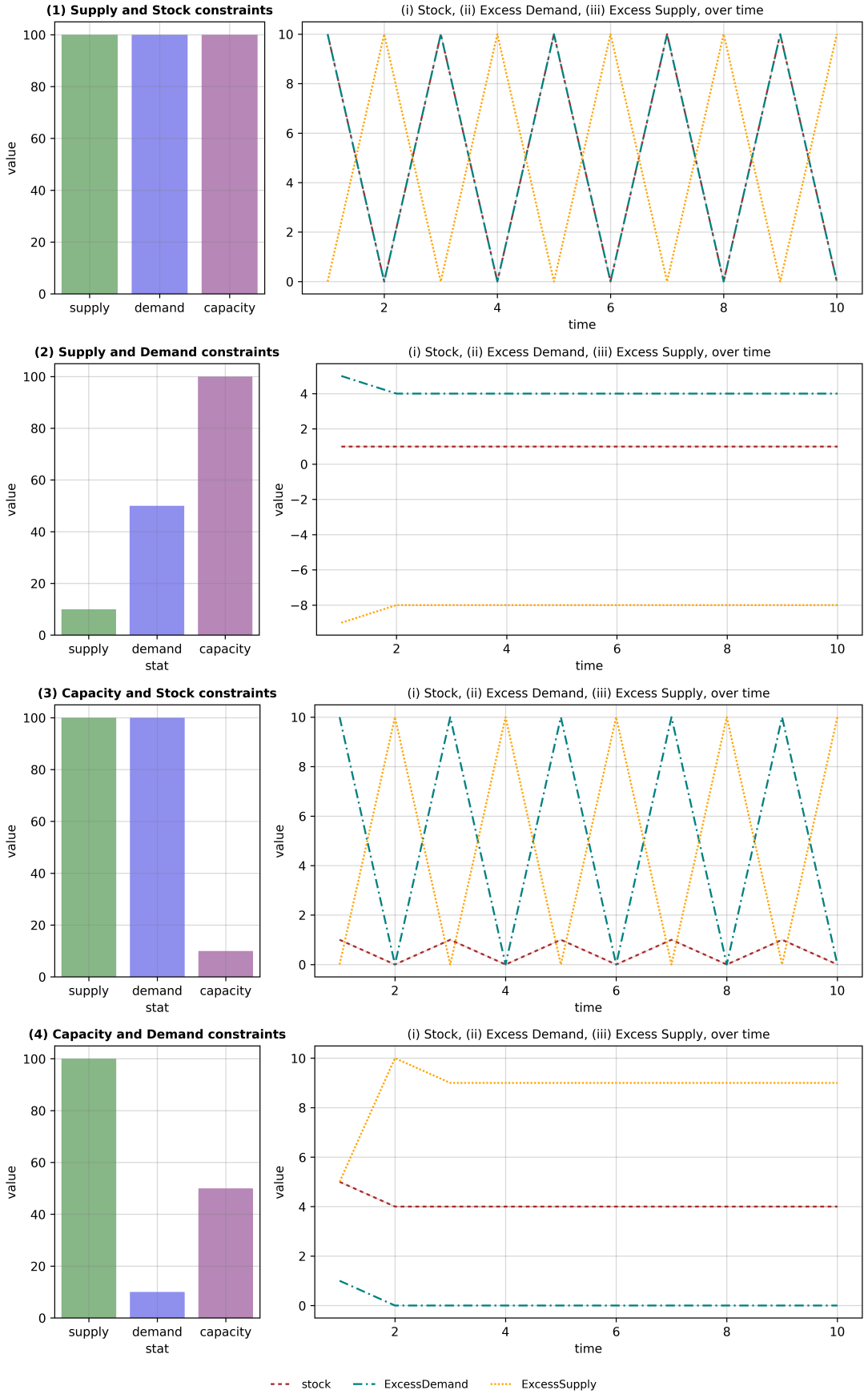


Figure 3: Stock, Excess Demand, and Excess Supply, over time, under varying constraint conditions.

3 Network typology arrangement

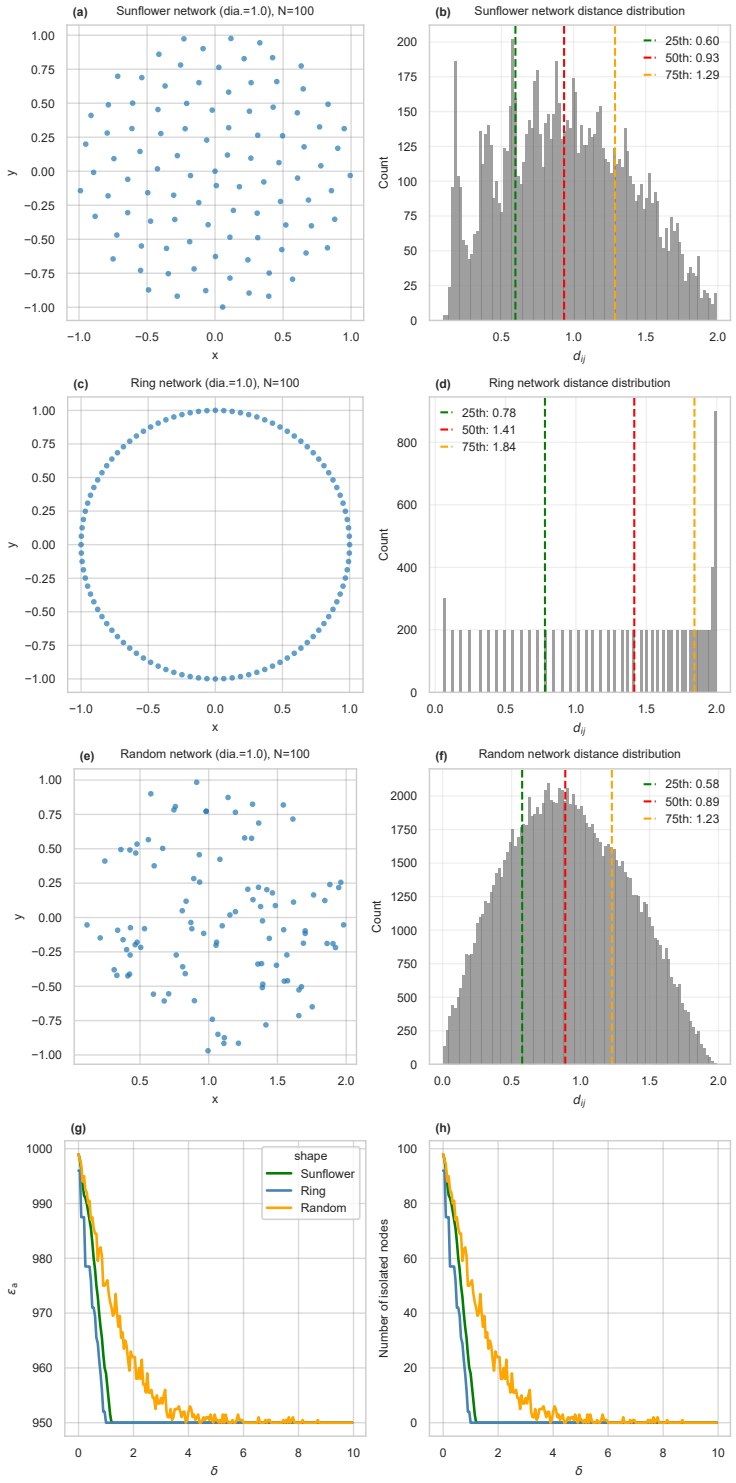


Figure 4: Spatial distribution of node locations in the (a) sunflower, (b) ring, and (c) random networks for $N = 100$, with the corresponding pairwise-distance distributions for the (e) sunflower, (f) ring, and (g) random networks, where dashed lines indicate the 25th, 50th, and 75th percentiles. For each network topology arrangement, results of (d) excess supply (ε_p), and (h) number of isolated nodes, against the distance cut-off threshold (δ).

4 Material properties

To compare transport emissions with embodied carbon emissions across different types of material, the framework estimates the maximum transport distance for each material given its embodied carbon value, with the option of varying loading conditions.

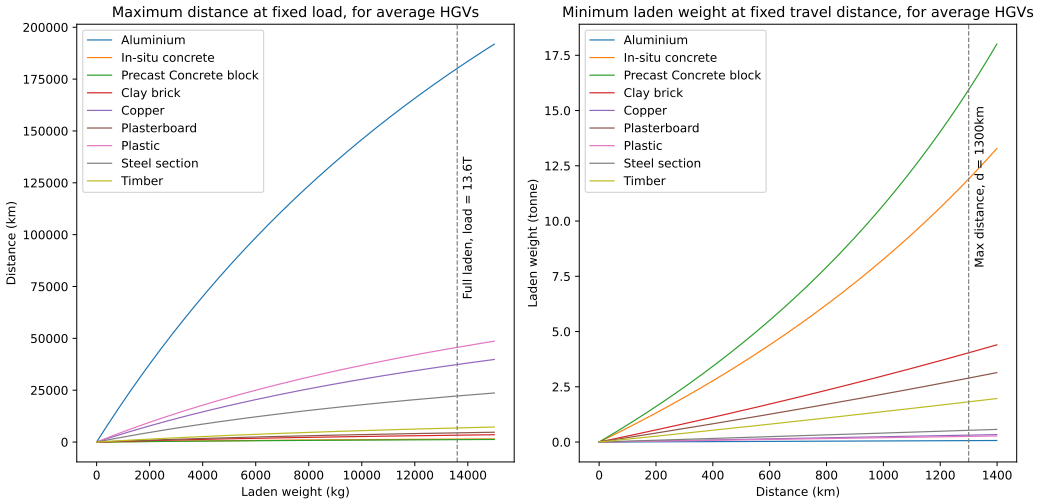


Figure 5: Maximum distance at fixed load and the minimum laden weight at fixed travel distance for selected materials, transported in an avaerage HGV.