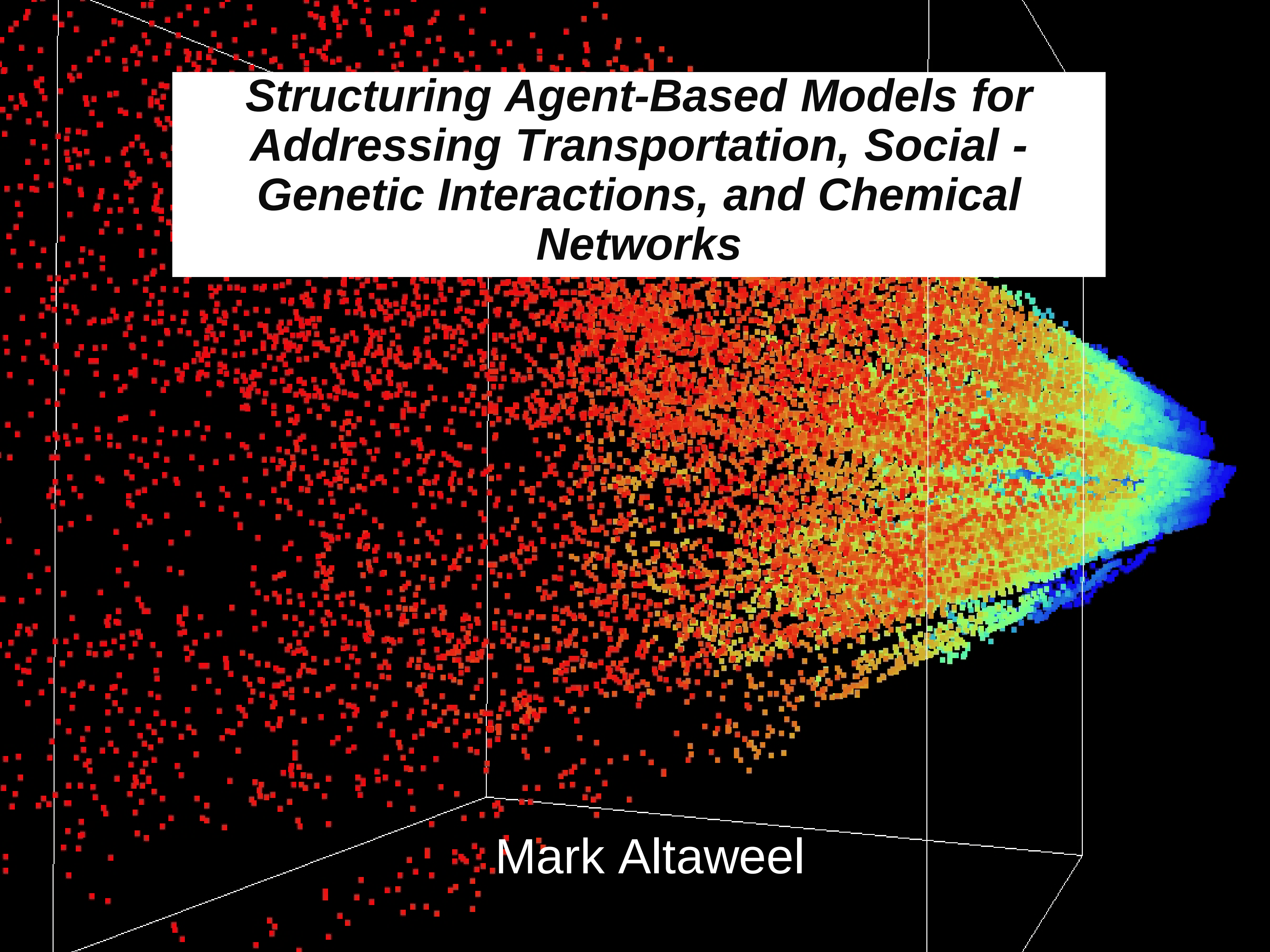
Structuring Agent-Based Models for Addressing Transportation, Social - Genetic Interactions, and Chemical Networks

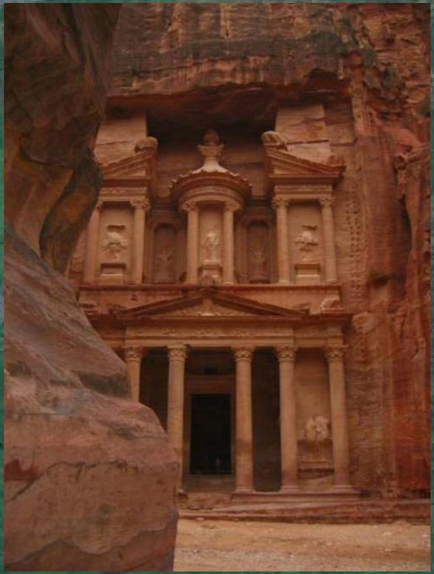


Mark Altaweel

Transportation: Kerkenes Dag Case

- Ancient cities were often divided into sectors and area of varying social significance and function. Finding these areas is difficult through expensive archaeological excavations. However, can limited excavations and survey along with agent-based models tell us something about the significance of social space?

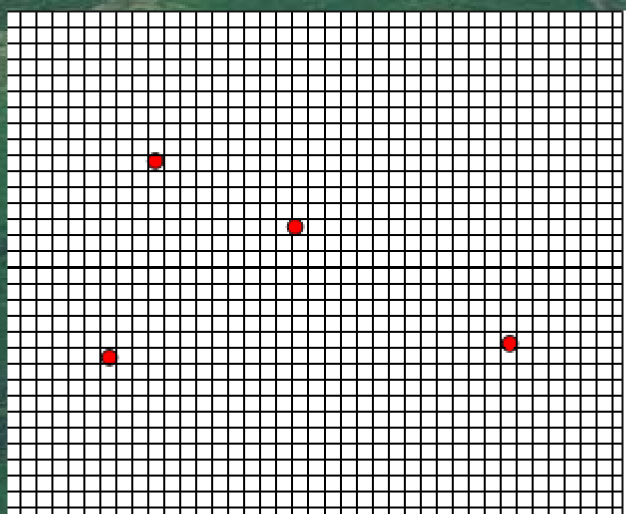
Rome



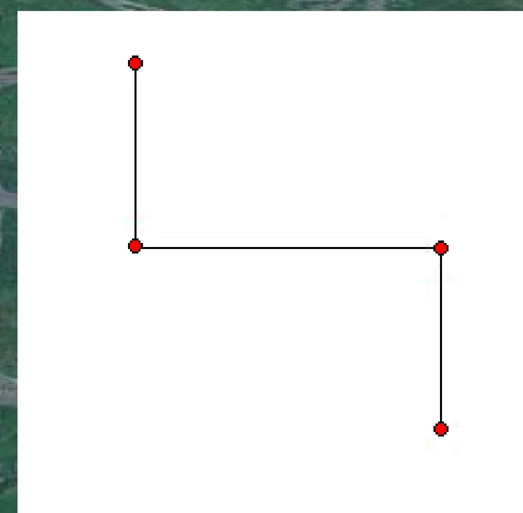
Petra

Network-Based Approach

- Movement can be modeled using vector networks or raster space. We have chosen a vector approach as movements in a urban environment are often restricted to specific spaces.



Raster movement

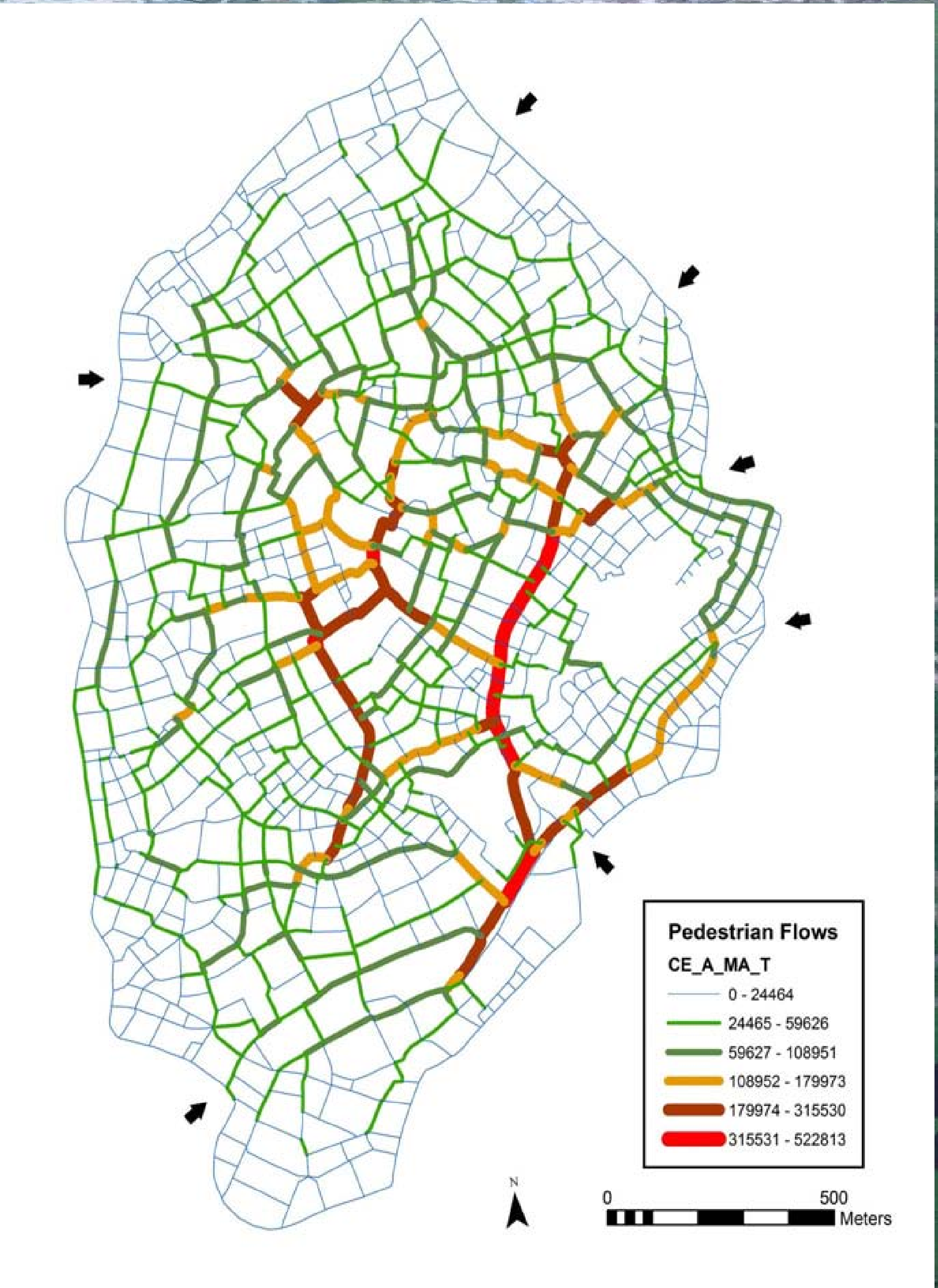


Vector movement

Models Applied in Scenario

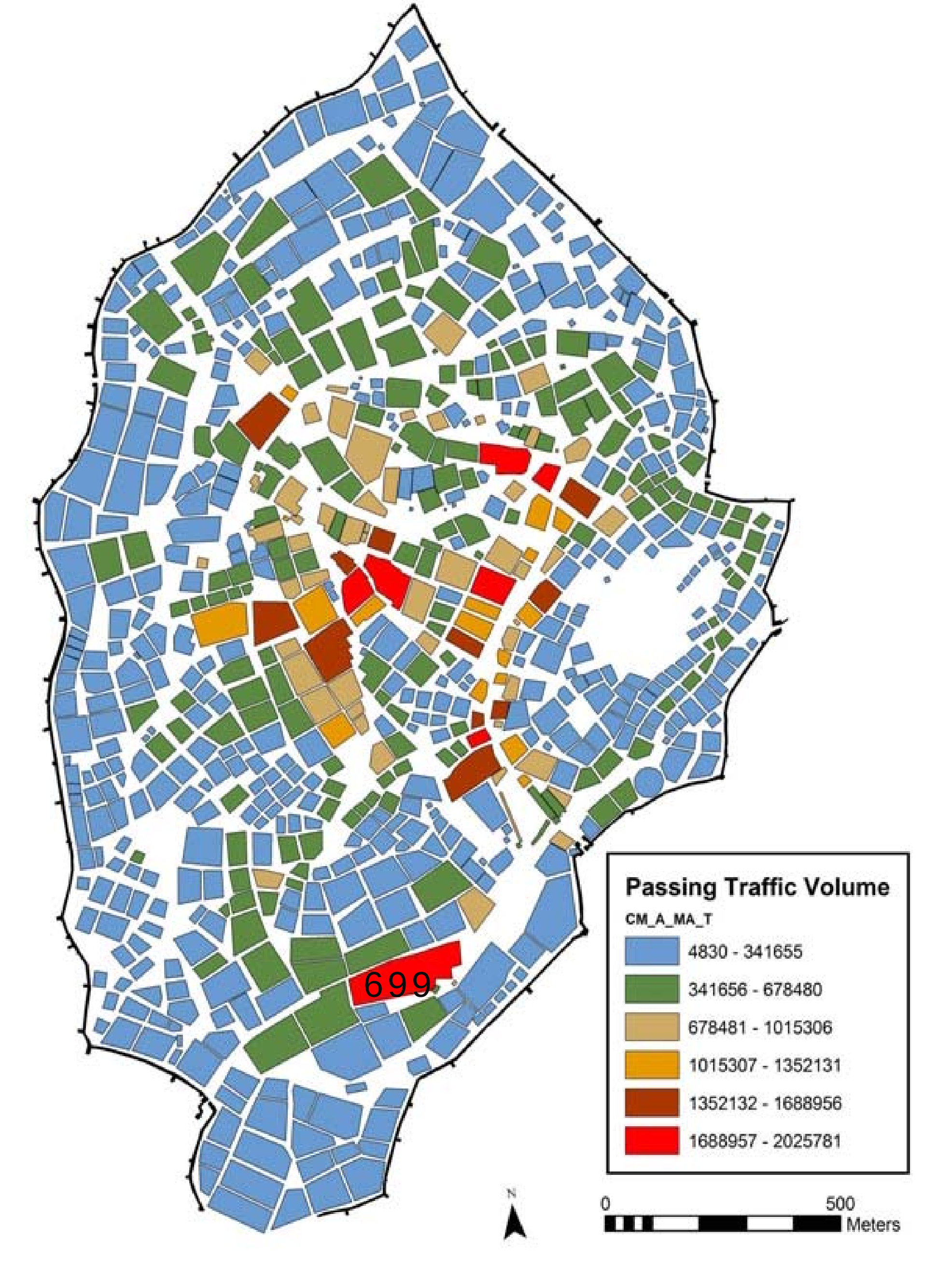
- Models/Algorithms Used
  - McDonald and Pandolf Metabolism Models
  - Decision Model for human movement
  - Least cost/search algorithms (Dijkstra and A*)
- Data Used
  - Spatial Datasets (e.g. GPS points, street networks, mapped structures)
  - Physical data collected from human movement

GIS-T Kerkenes Dag Street Traffic Volume



Applying multiple modeling approaches is one way to strengthen the case for your overall results.

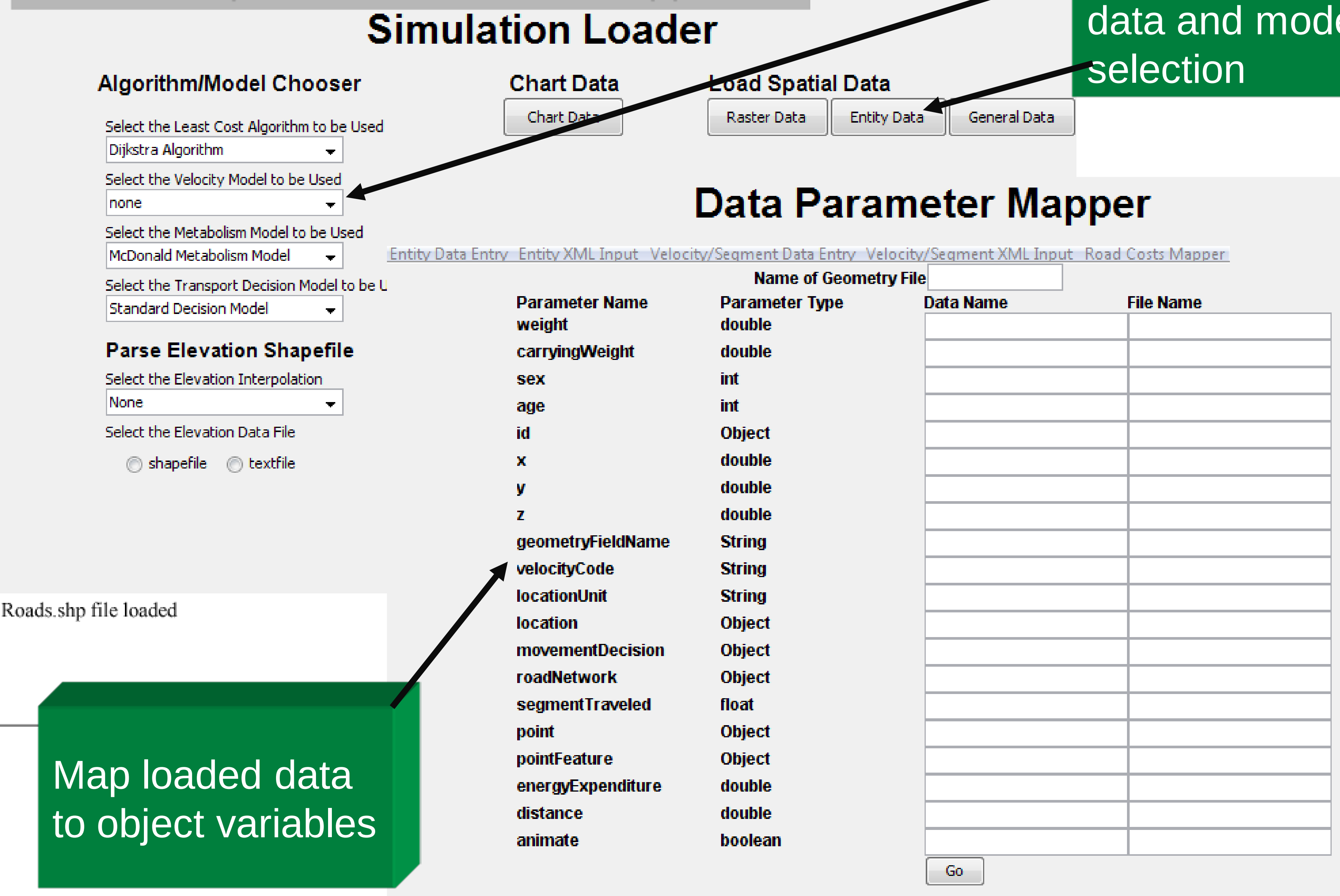
GIS-T Kerkenes Dag Passing Building Volume



Heaviest volume of traffic is expected to be near the palace area based on GIS-T model.

Integrating Data-Point and Click Philosophy

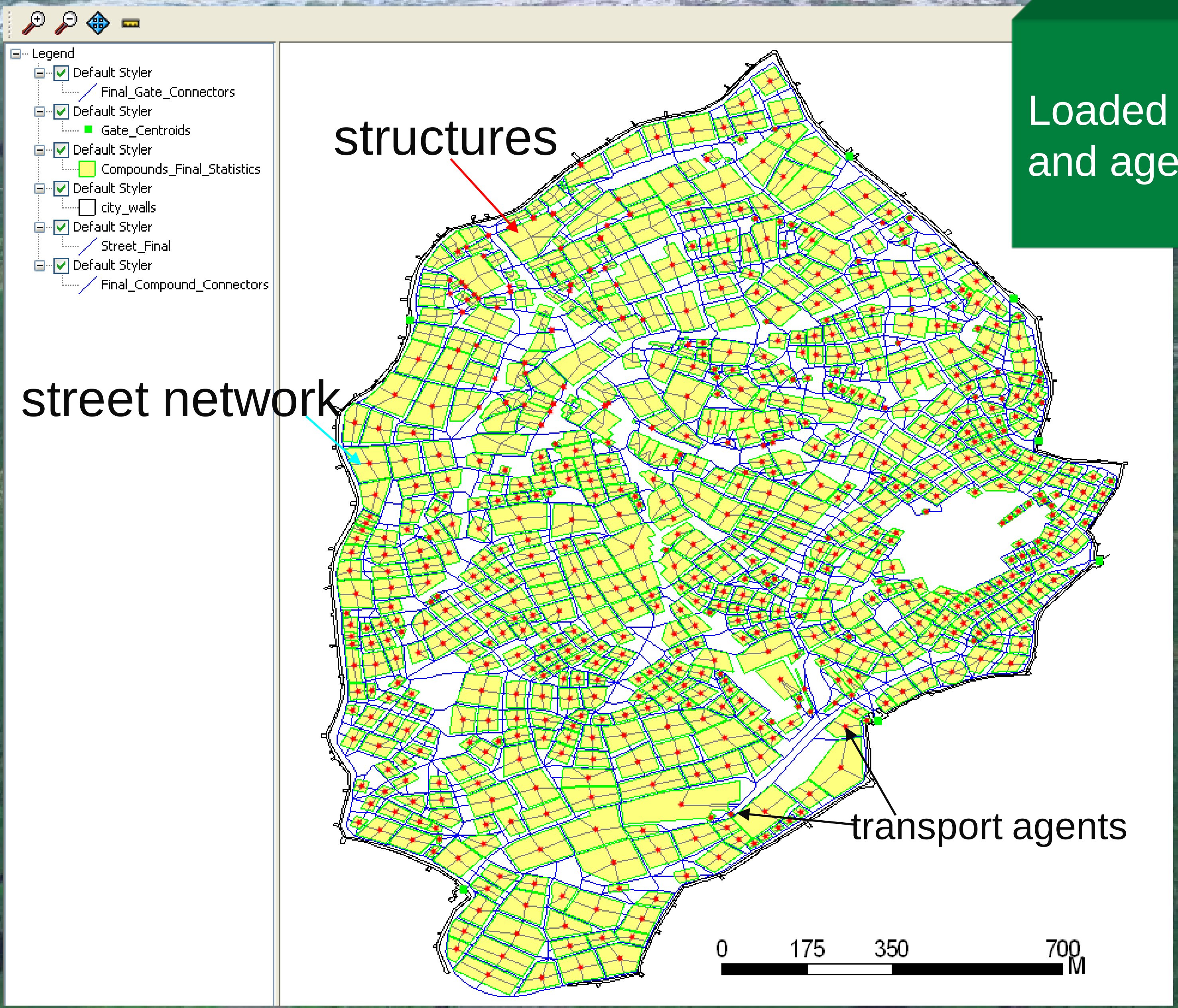
Address impracticalities of GIS-T approach



Load GIS/chart data and model selection

Map loaded data to object variables

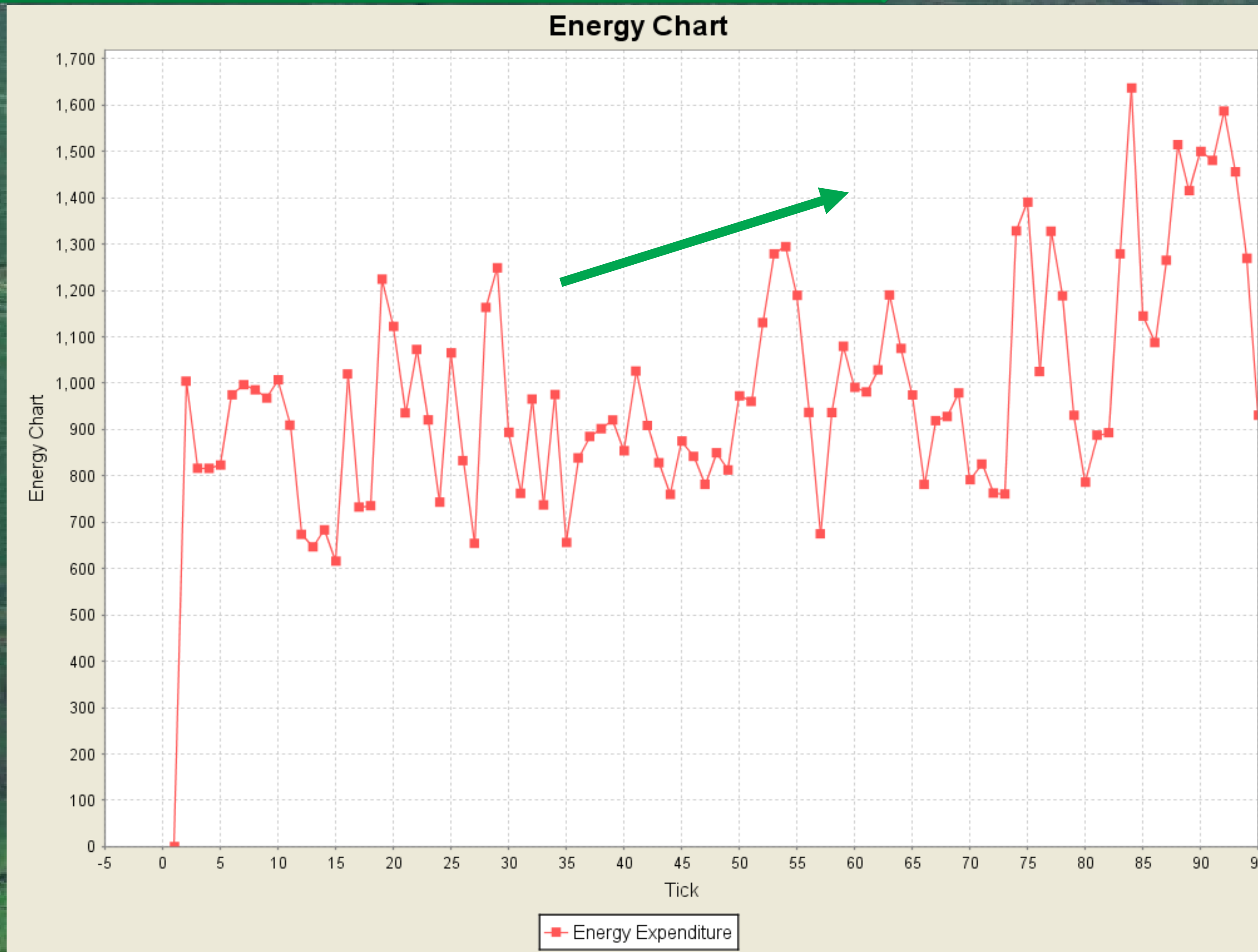
Kerkenes Dag Agent-Based Approach



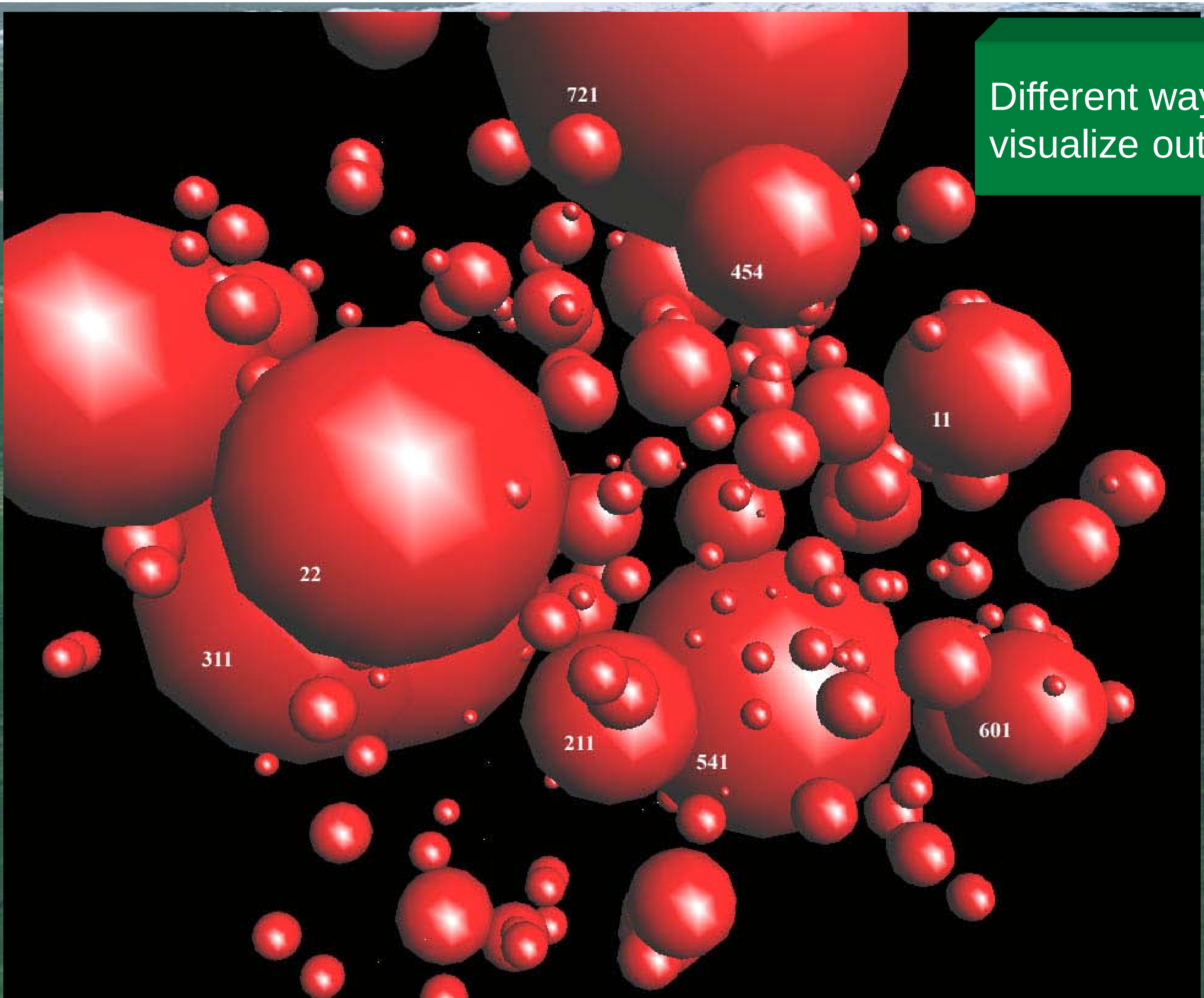
Loaded shapefiles and agents

Energy Expenditure by Agents

During the simulation, sometimes there is a benefit to validation by tracking some key statistics. In this case, energy used increases as agents choose more distant locations to visit.

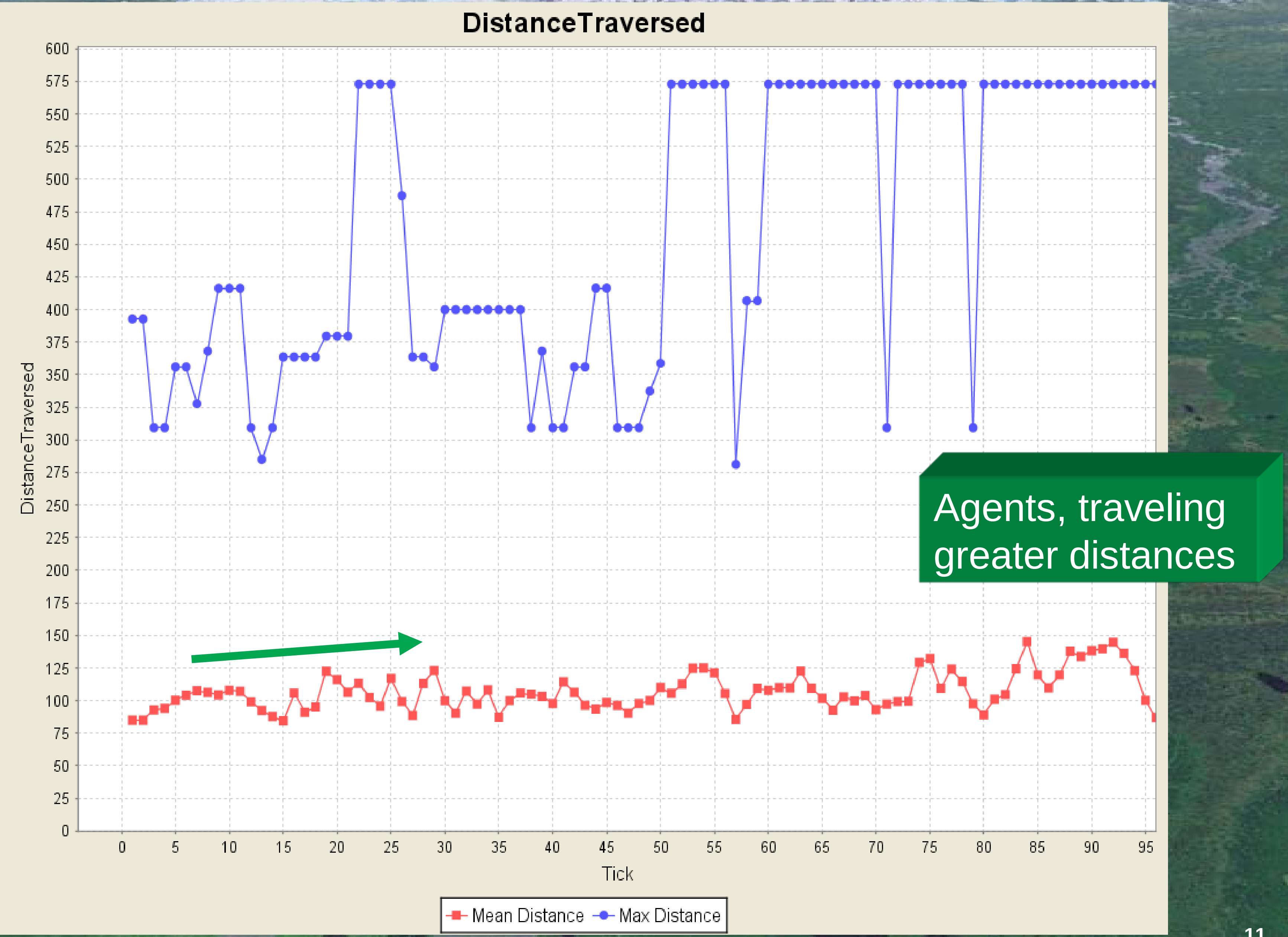


Individual Results

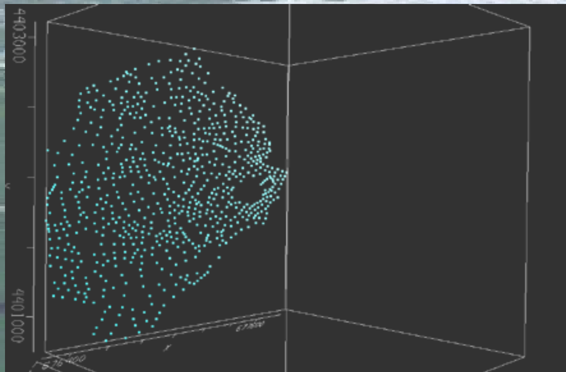


Different ways to visualize output

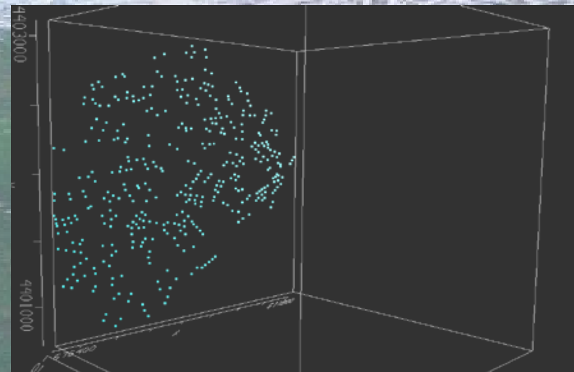
Monitoring Distance Traveled



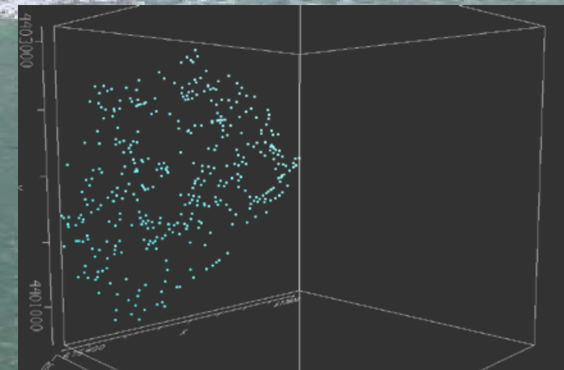
Location of Agents at Time Steps



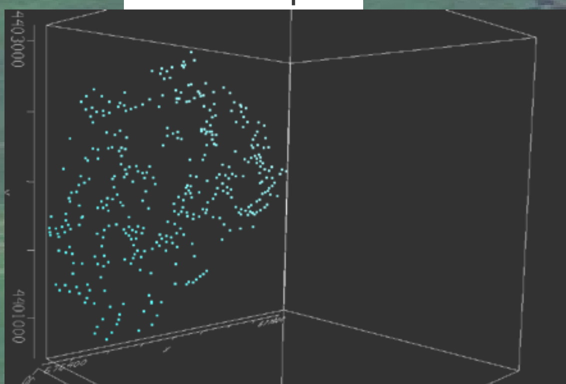
Time Step 0



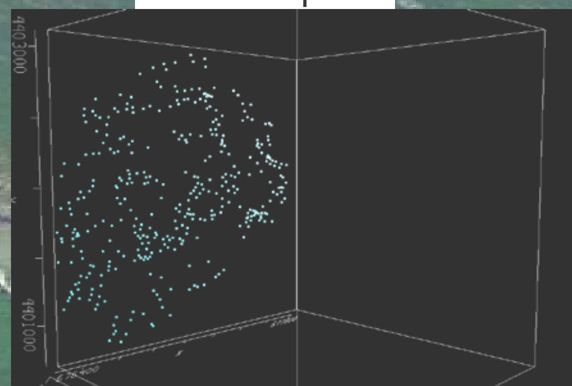
Time Step 10



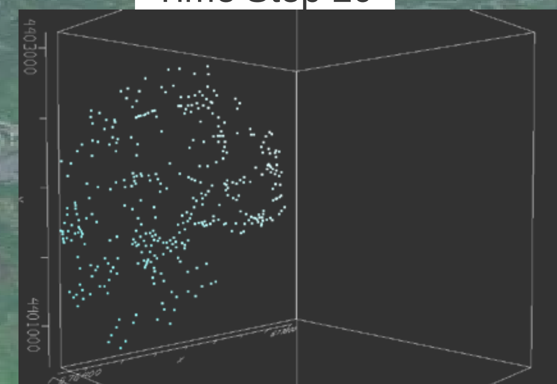
Time Step 20



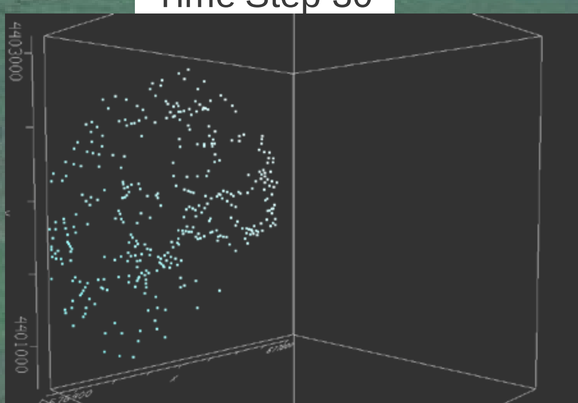
Time Step 30



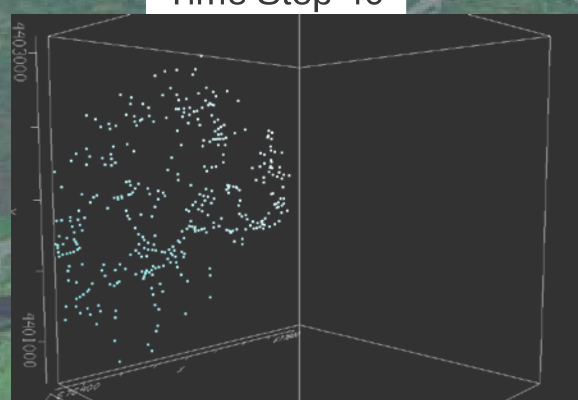
Time Step 40



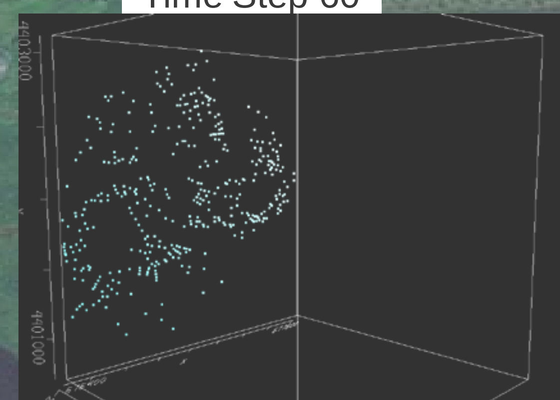
Time Step 60



Time Step 70

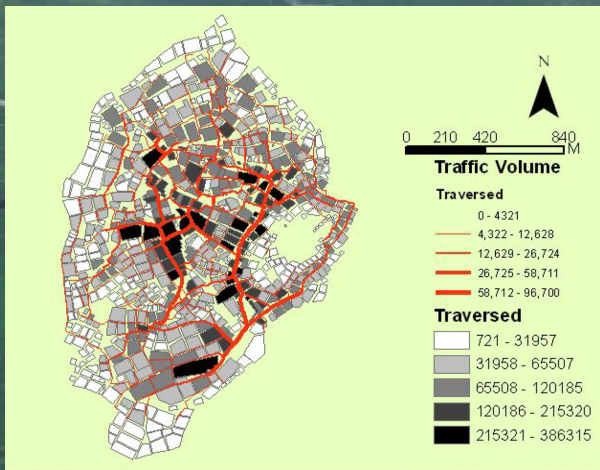


Time Step 80

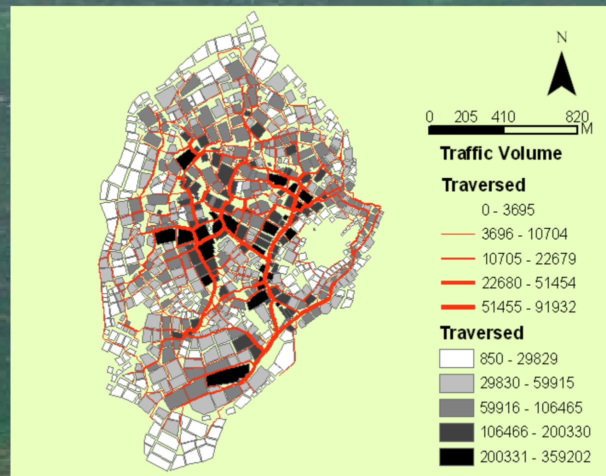


Time Step 100

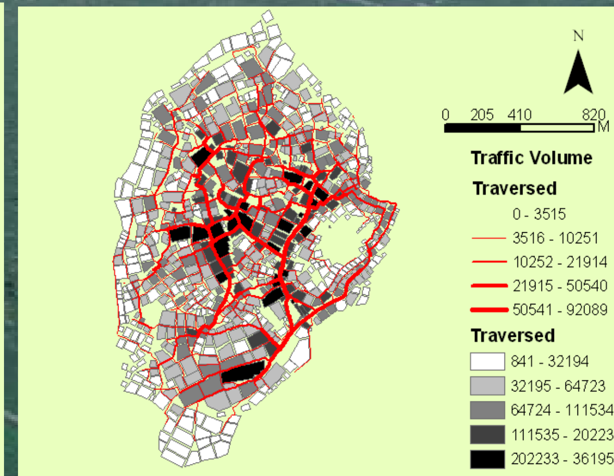
SHULGI Output – Broken Down by Agent Categories



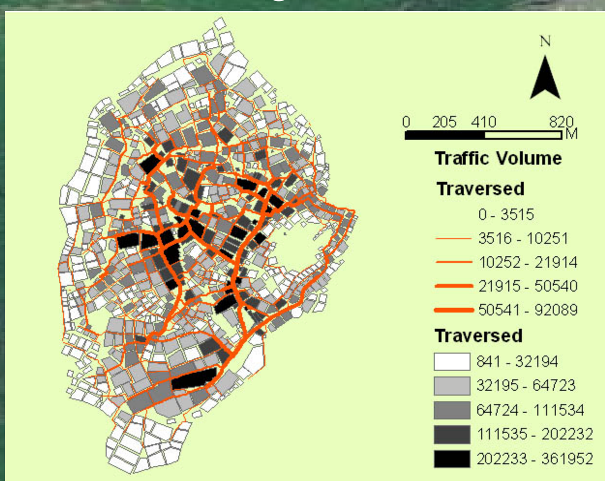
Middle Age Males



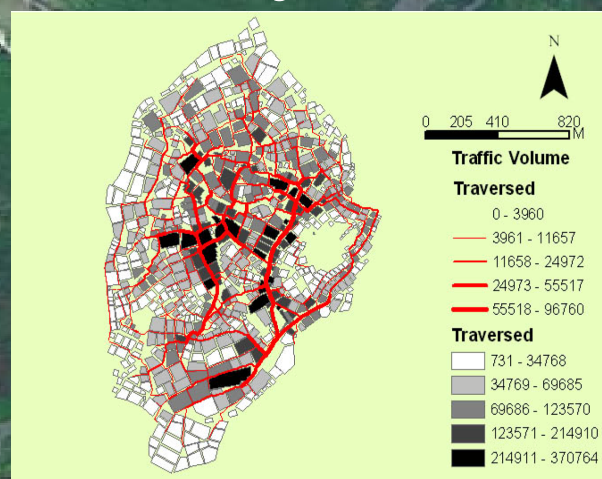
Middle Age Females



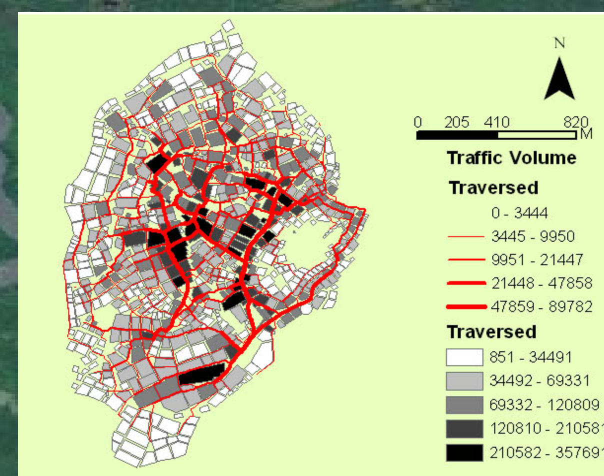
Old Males



Old Women

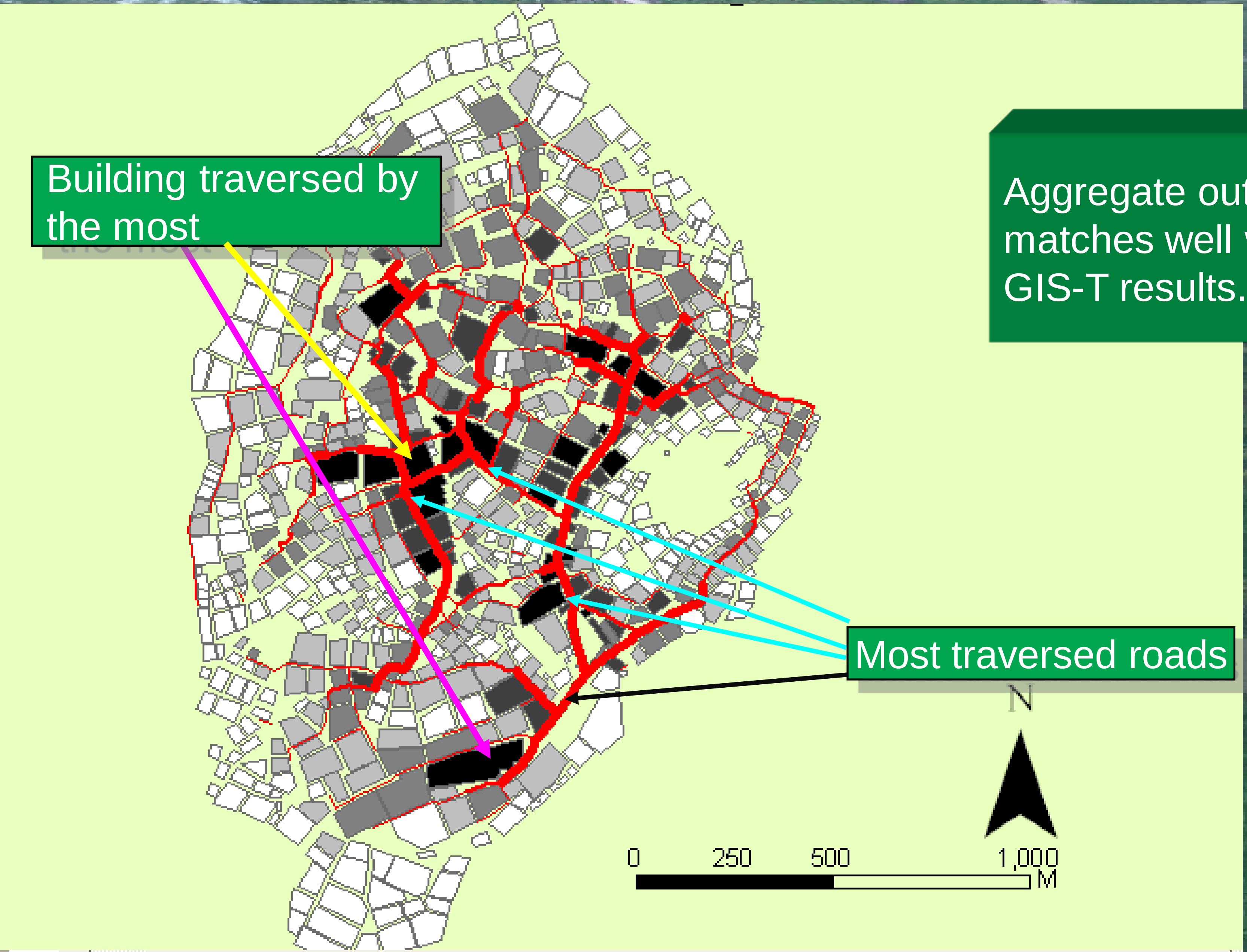


Young Males



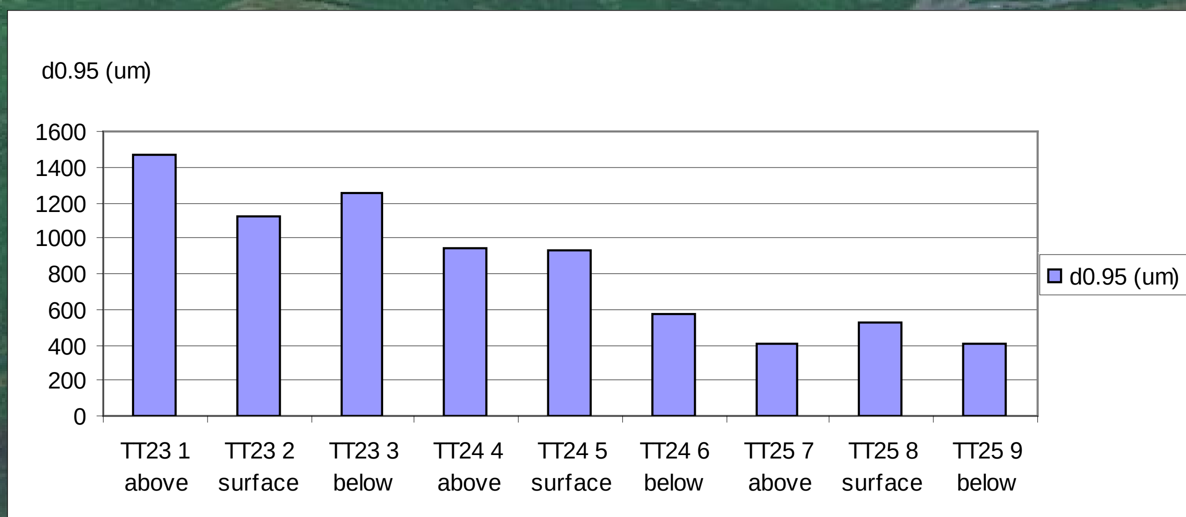
Young Females

Aggregate Output



Aggregate output matches well with GIS-T results.

Validation – Linking Fieldwork and Modeling

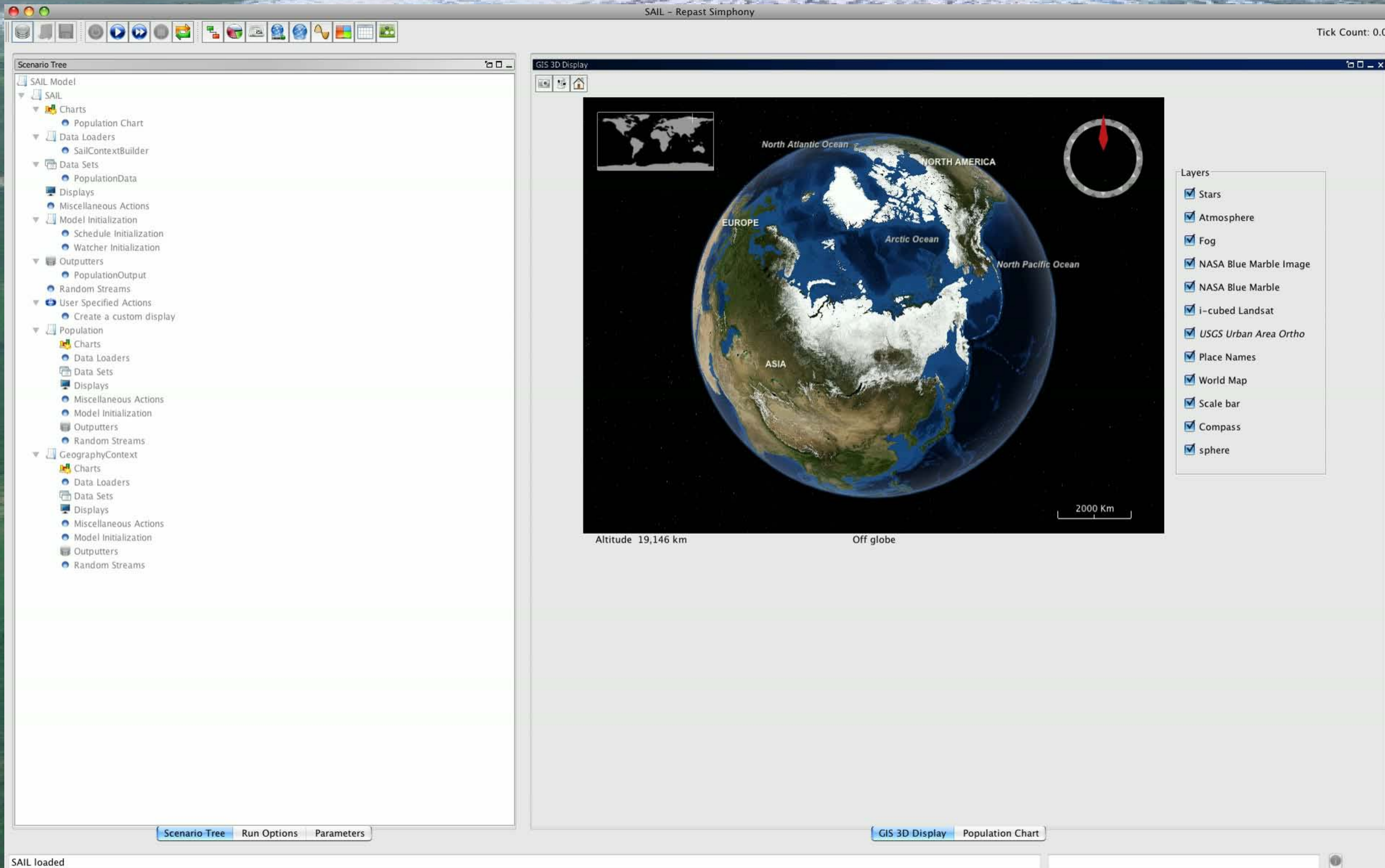


d0.95 (95 percentile) Particle size (μm) from the three transportation trenches

Modeling Social Behavior and Genetic Changes

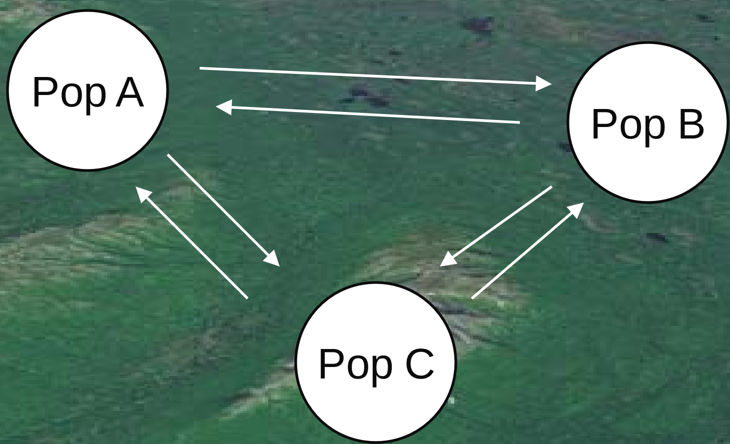
- In Indonesia, people have made choices in recent and past periods that have affected genetic makeup of individuals. Can the underlying mechanisms of genetic change and cultural processes be understood?

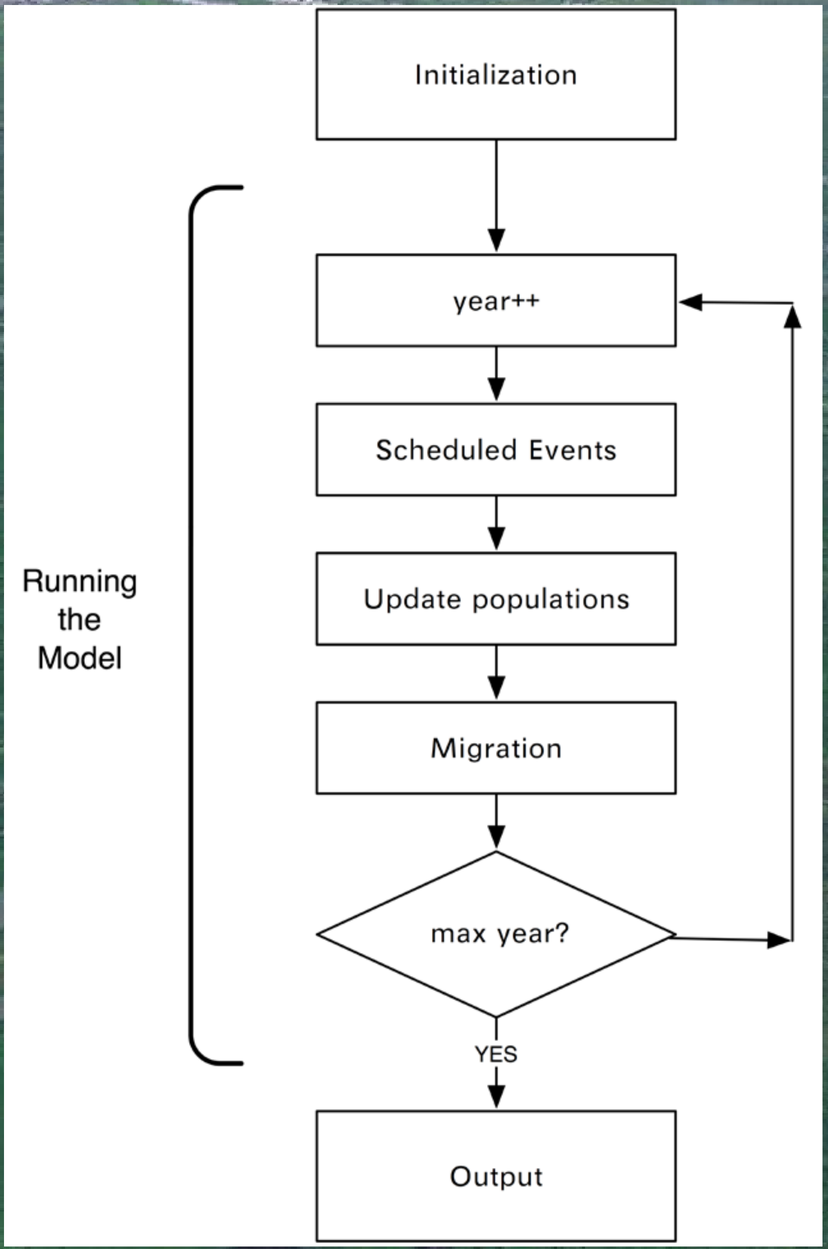
SAIL-Demo



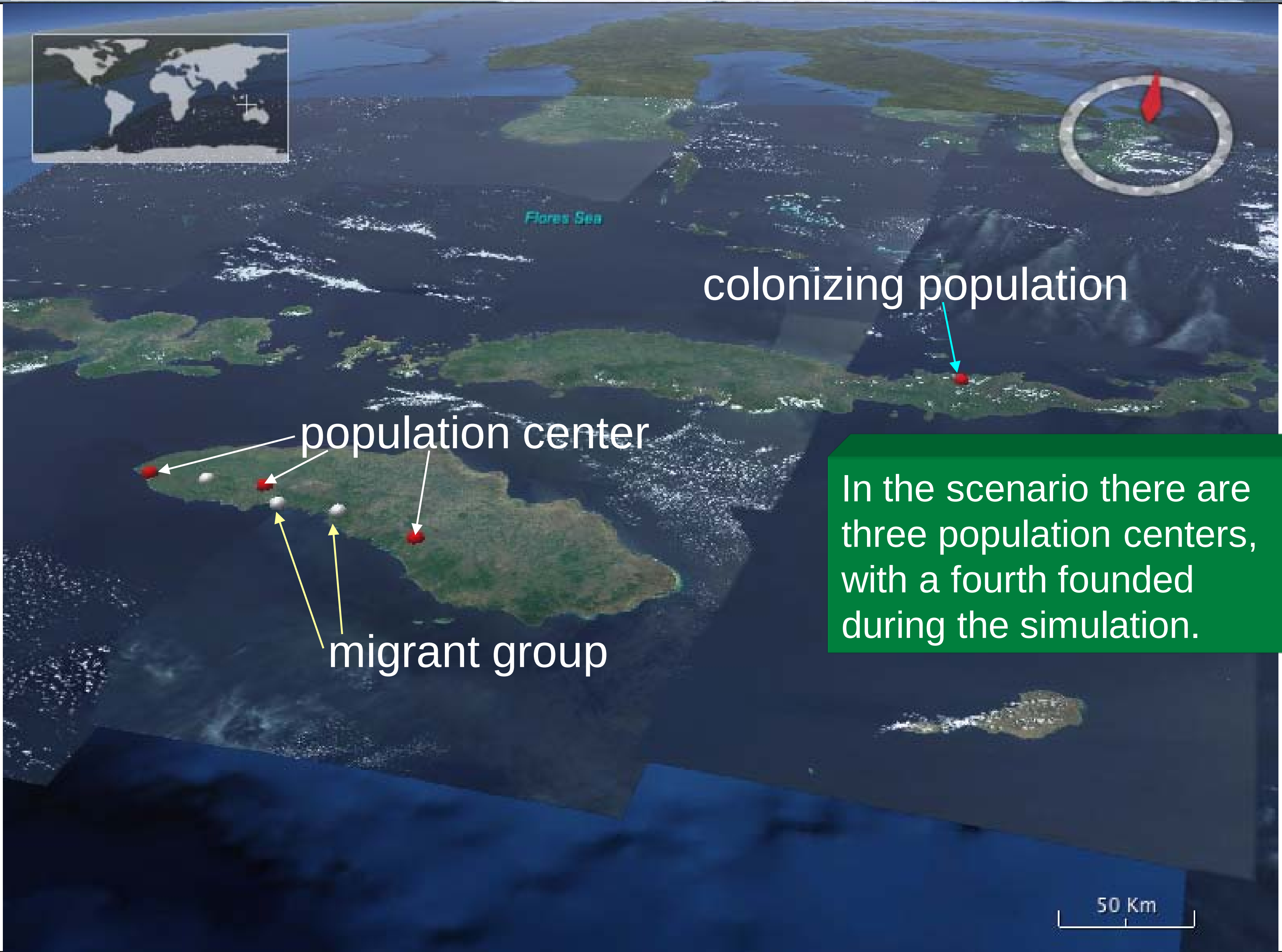
Genetic and cultural interactions are measured over multiple generations.

SAIL Model- Details



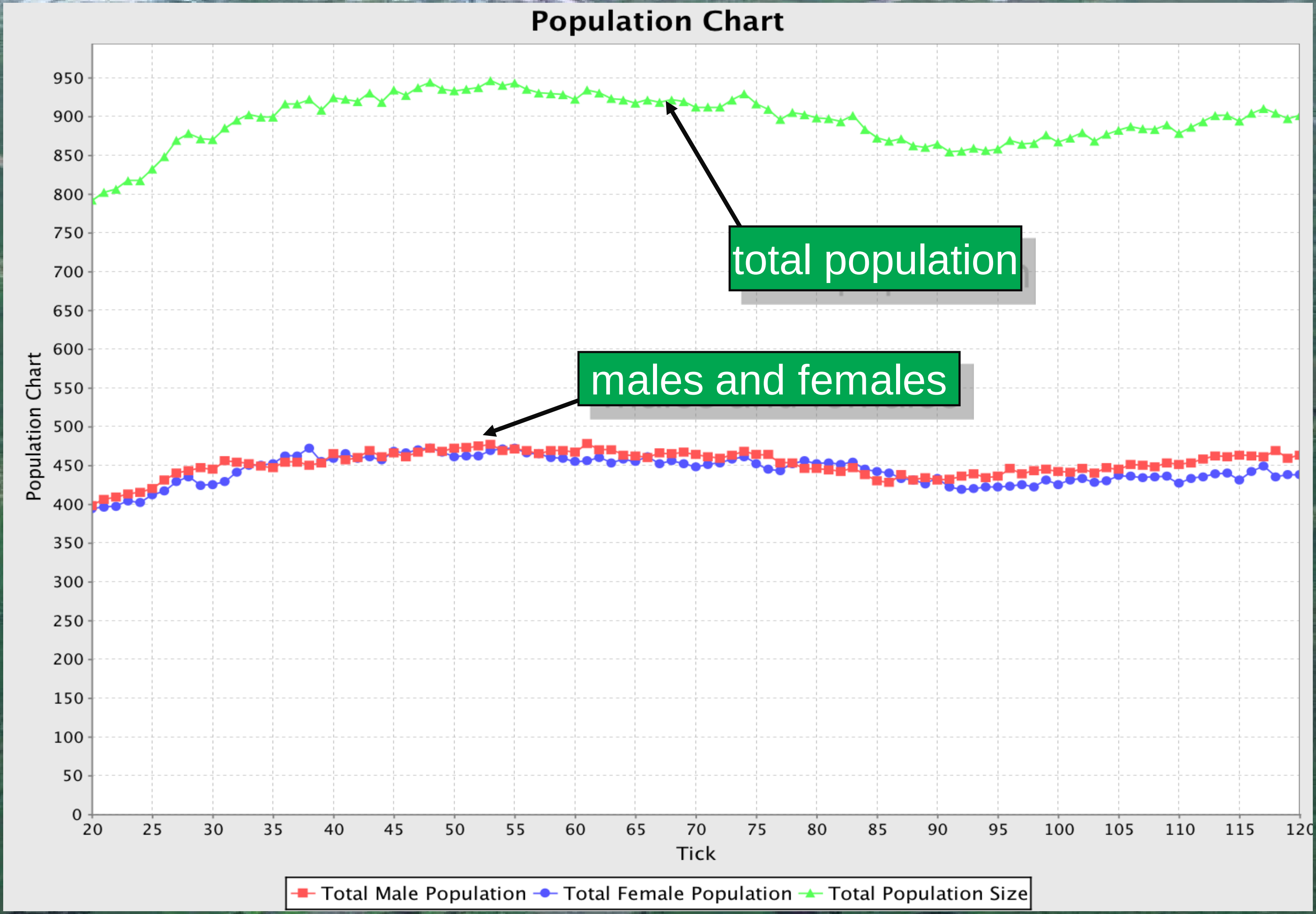


Simulation Setting

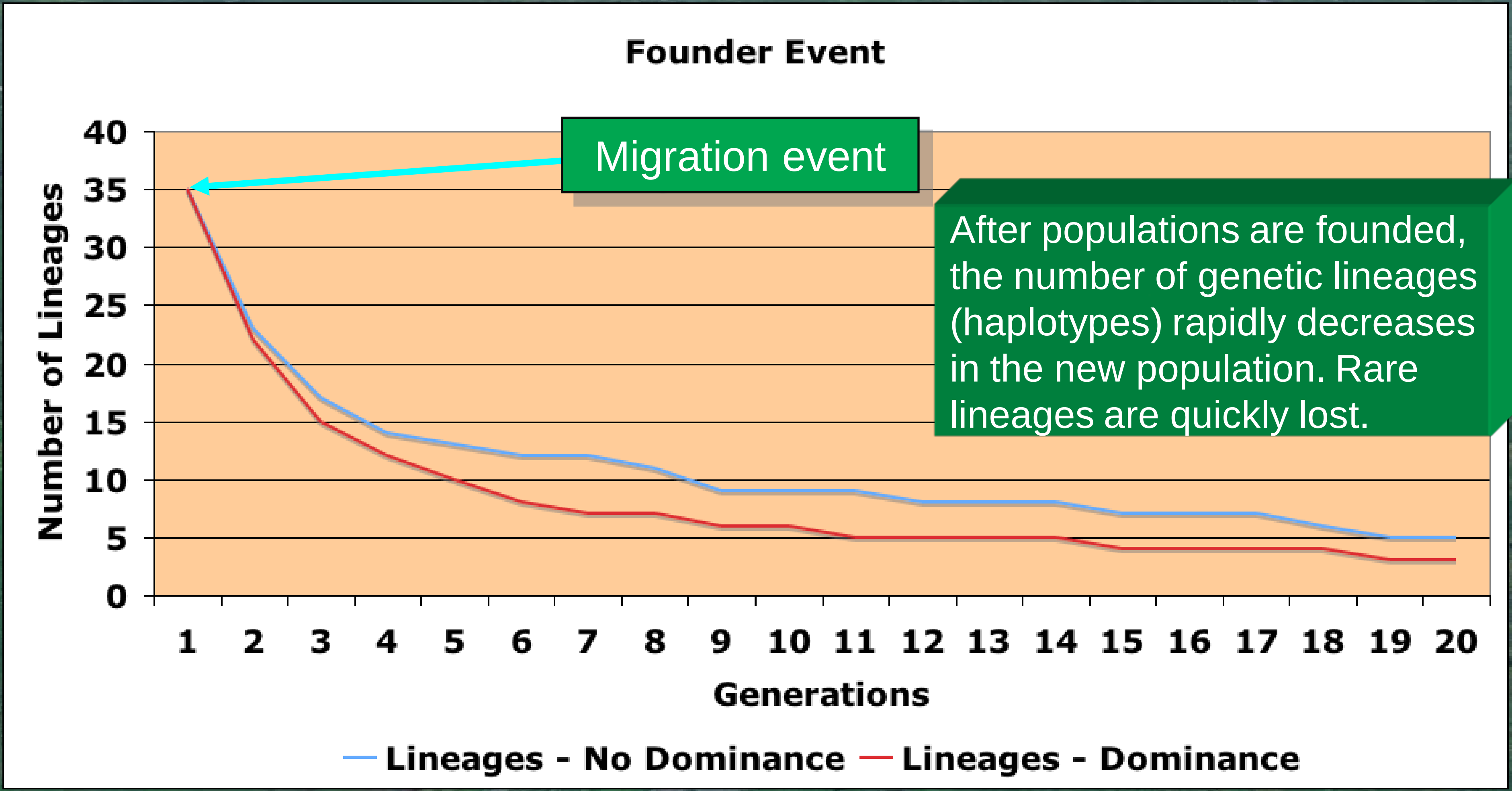


In the scenario there are three population centers, with a fourth founded during the simulation.

SAIL Population – Relatively Stable Population

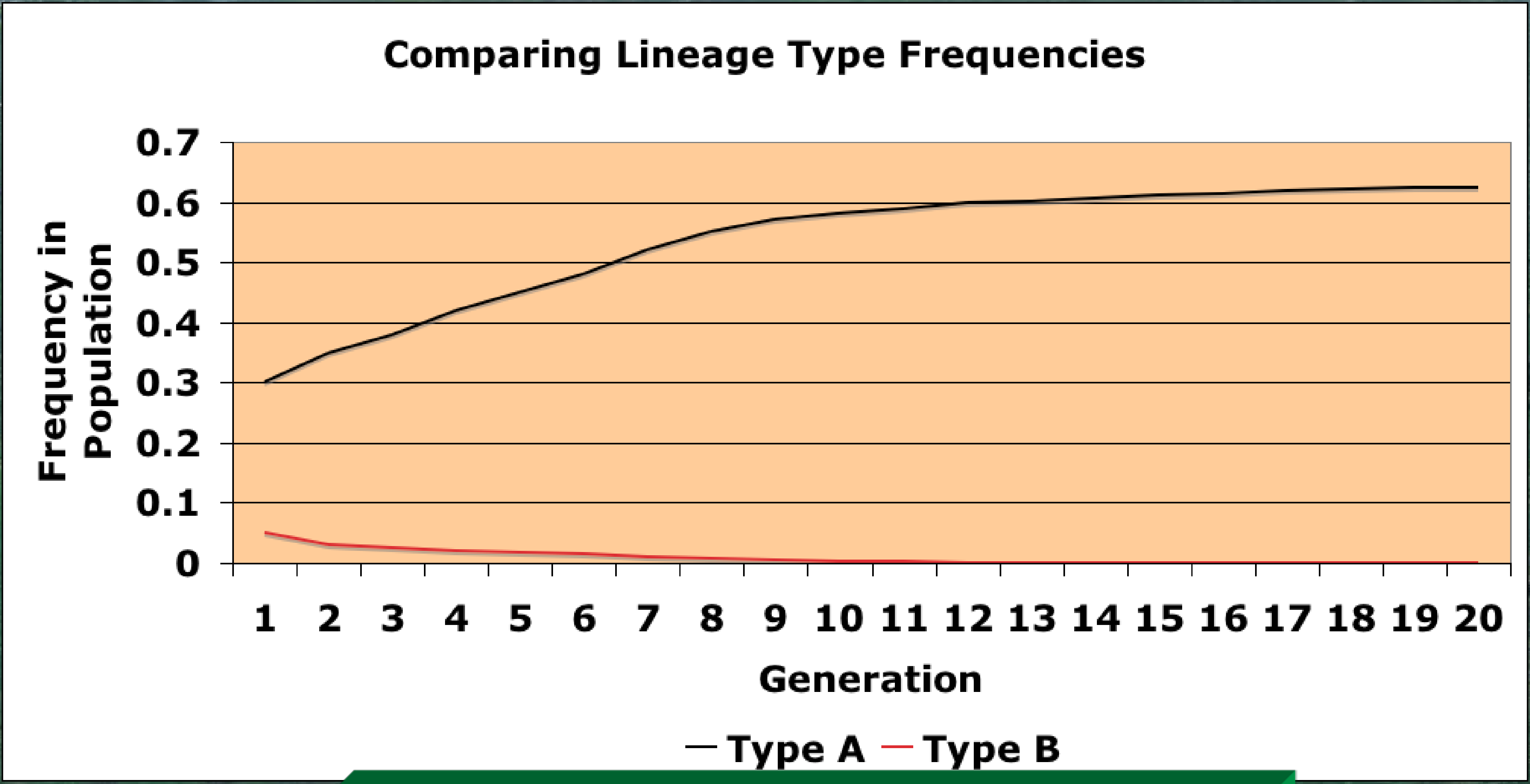


Lineage Reduction – Dominant Reproduction



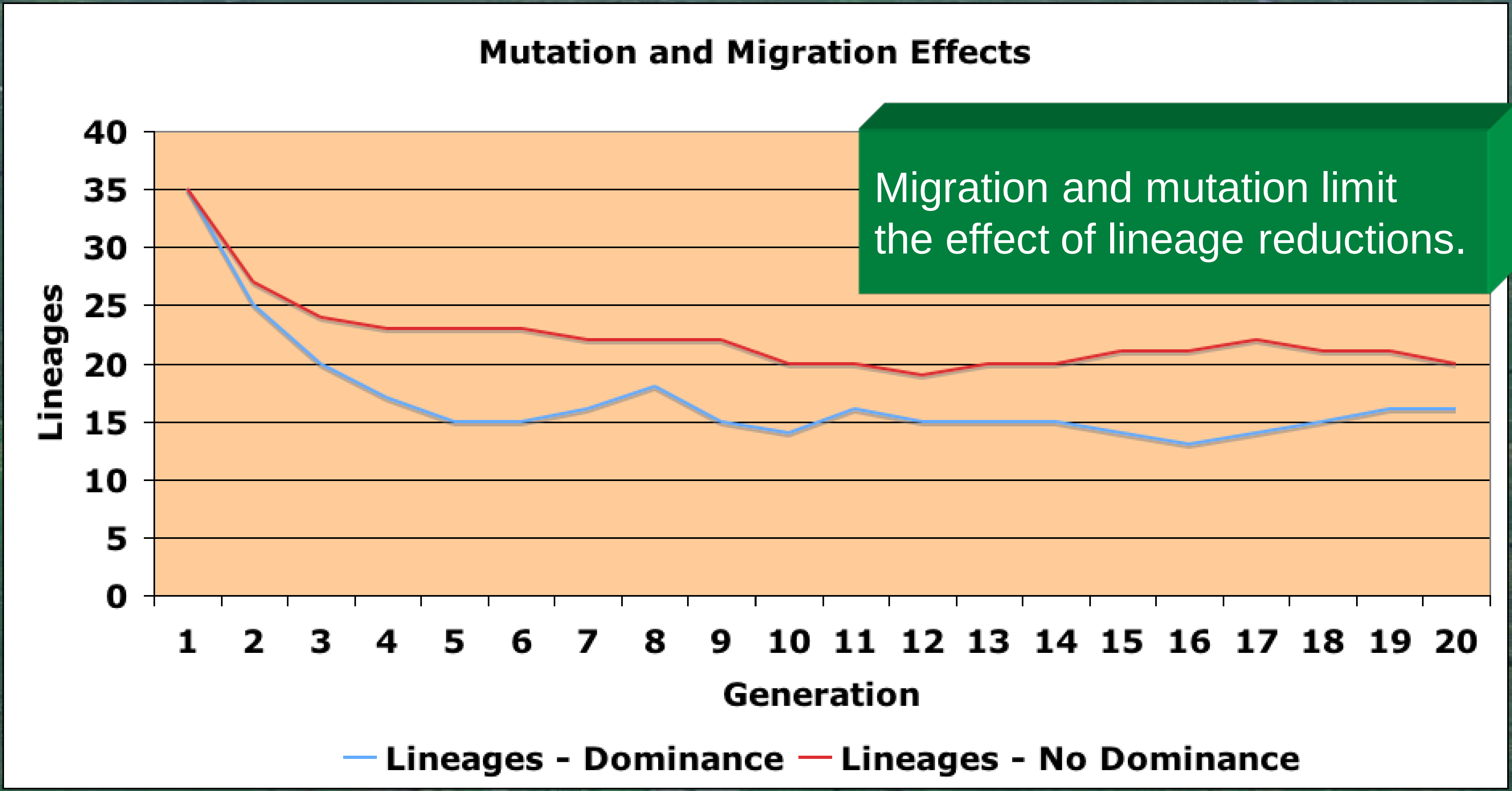
Generation=20 years; Simulations are run 1000+

Changes in Lineages



More common lineages becomes dominant, while low frequency alleles diminish.

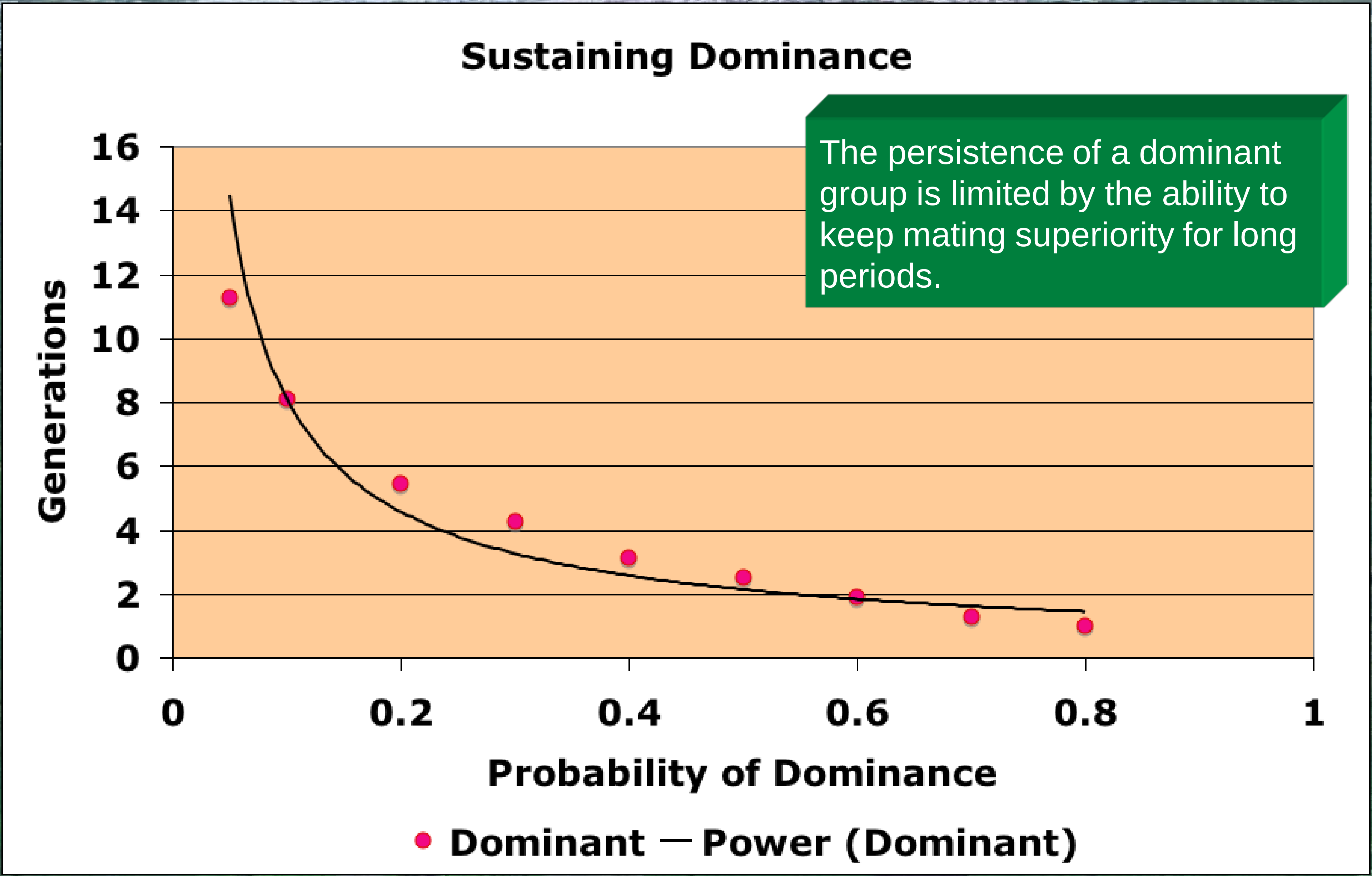
Migration and Mutation Limit Lineage Reduction



Migration and mutation limit the effect of lineage reductions.

migration prob.=.05 (males)
mutation prob. =.025 pat. alleles

Sustaining Dominance of Lineages for Generations

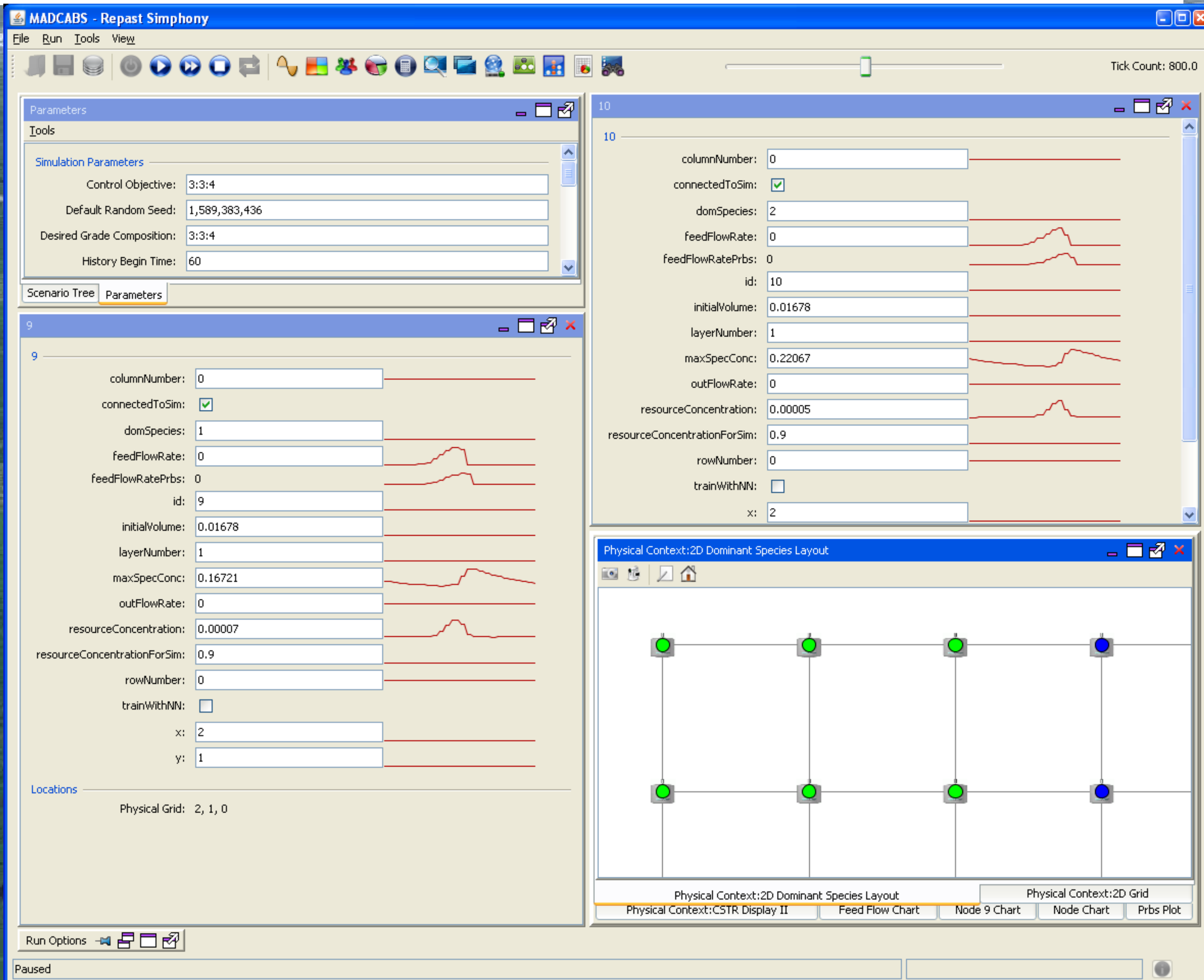


Observed Results- What the Data Suggest

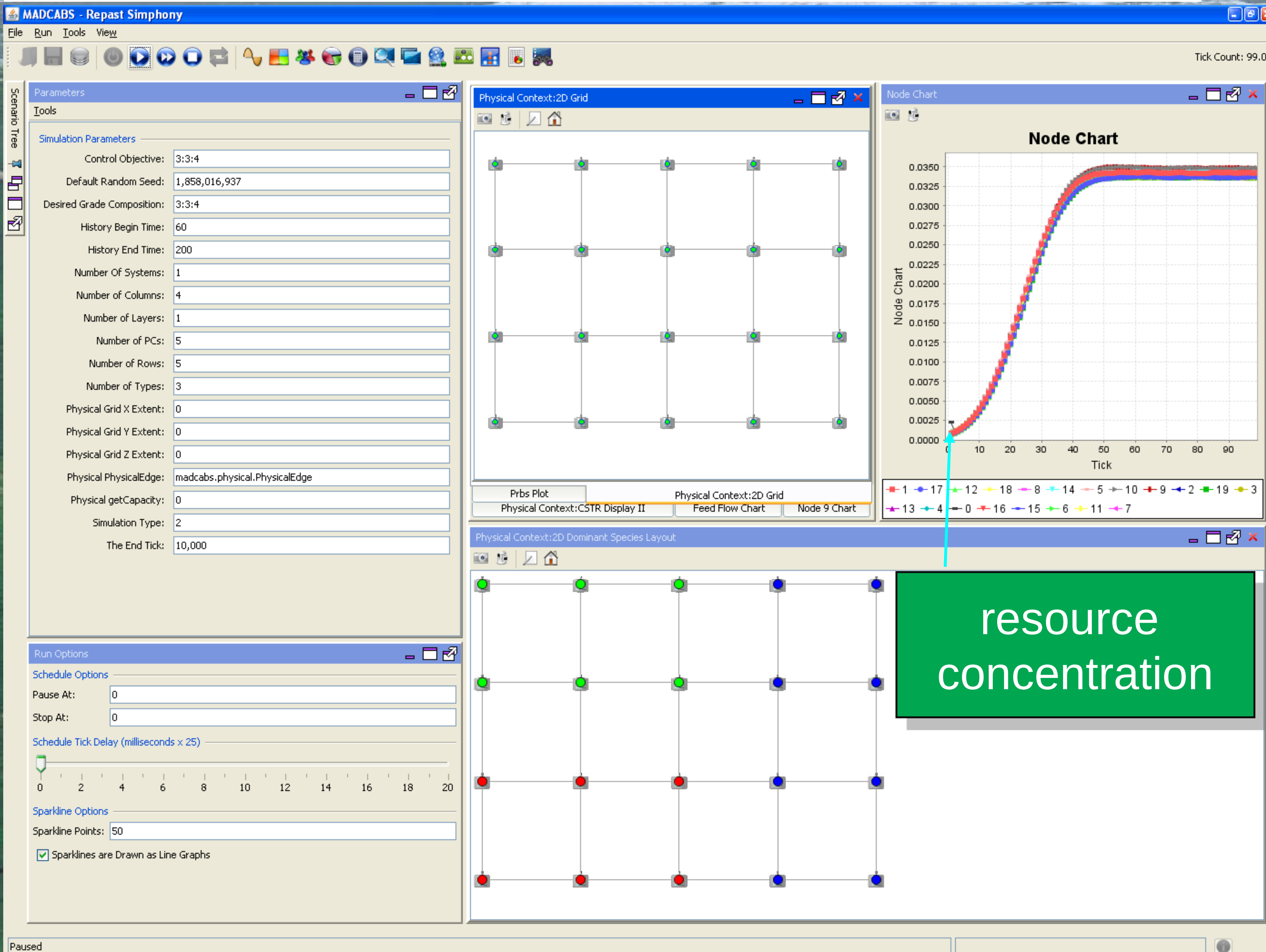
- Collected data from Indonesia suggest that although there appears to be evidence for selection in the short-term for cultural traits, in the long-term there is no evidence of specific genetic markers or lineages biased for.

- We suspect that lineage dominance are not maintained culturally. Data collection and tests need to validate this theory. Where dominance might be present in a population group at a given instance, the influence of genetic dominance tend to be transient.

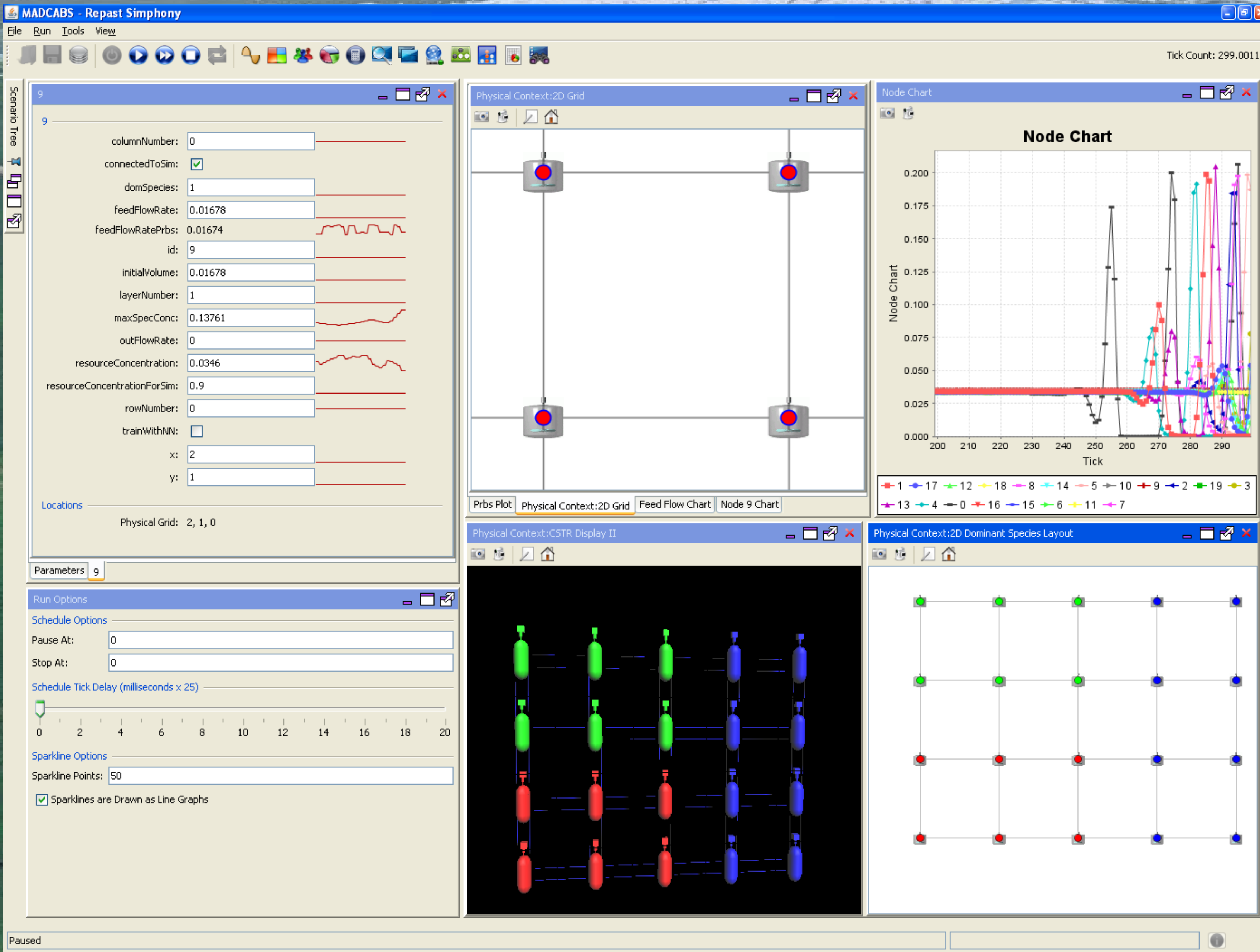
Monitoring Chemical Reaction Networks



Reaction Stability and Content Balance



Monitoring Specific Nodes or Total Network



Conclusion- Transportation, Genetics, and Chemical Processes Scenarios

- Transportation Modeling
  - For past systems, we can assist fieldwork efforts and determine relative importance of certain locations by projecting areas of heaviest traffic.
  - Modeling results match well with GIS approaches, but with far less cost and with greater agent-level flexibility.
- Genetics and Culture
  - We can study current populations and experiment with models to see how populations evolved.
  - Agent-based modeling allows a platform to test ideas over multiple generations with relative ease.
- Chemical Network Reactions
  - Agent modeling enables analysts to monitor the flow and reaction within chemical mixers in a network of reactors.