How network structure affect the spread of diseases between farms

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Introduction

The spread of diseases between farms can be graphically illustrated in networks.

Farms in Sweden have different level of aggregation. In this study we have created fictive networks depending on the level of aggregation.

Different network measures are calculated and compared to simulations of disease transmission between farms.
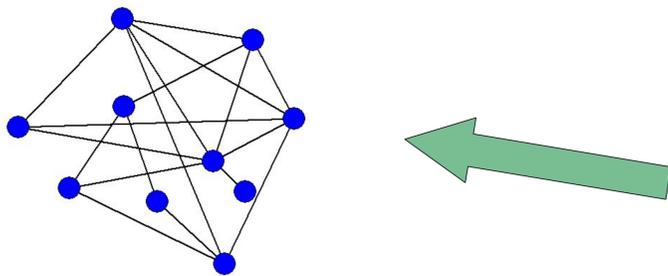
Generating Networks

Fictive networks, along a gradient from a random structure to a highly aggregated structure, are created:
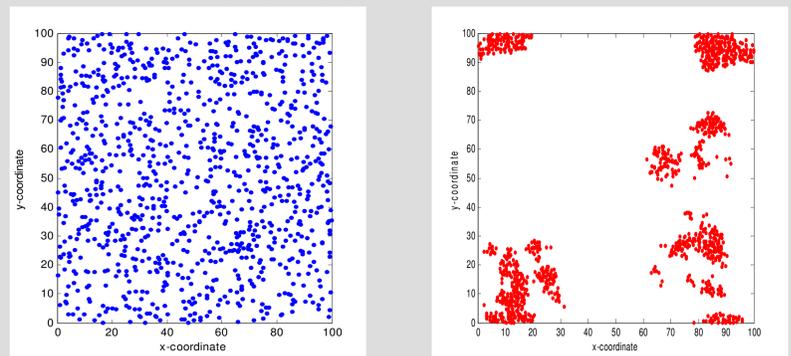
Random   Aggregated

We use a Gaussian probability function, based on distances, to decide if a pair of farms should be connected to each other or not. Then we have our network!

Network measures and simulations

Four network measures are calculated. The figures show how these measures are associated with the level of aggregation of farms in the landscape.

Median values (100 replications) increase with the level of aggregation. There are large variations around the median, which increases with higher levels of aggregation.

Diameter and closeness have a lower degree of association with the level of aggregation. Therefore these two measures are not able to capture the full range of landscape structure.

Boxplot explanation

Each box contains the middle half of the data. The box has lines at the lower quartile, median (red line) and the upper quartile values. The upper horizontal line is the maximum non-outlier value and the lower horizontal line is the minimum non-outlier value. The red plus sign indicates potential outliers.

In landscapes with higher level of aggregation more farms are infected (2000 farms, 100 replications, 10 time steps). Variation increases with increased level of aggregation.

The clustering coefficient and number of infected farms show the same pattern with different levels of aggregation. This indicates that the clustering coefficient may be useful as an indicator of the risk of disease transmission.
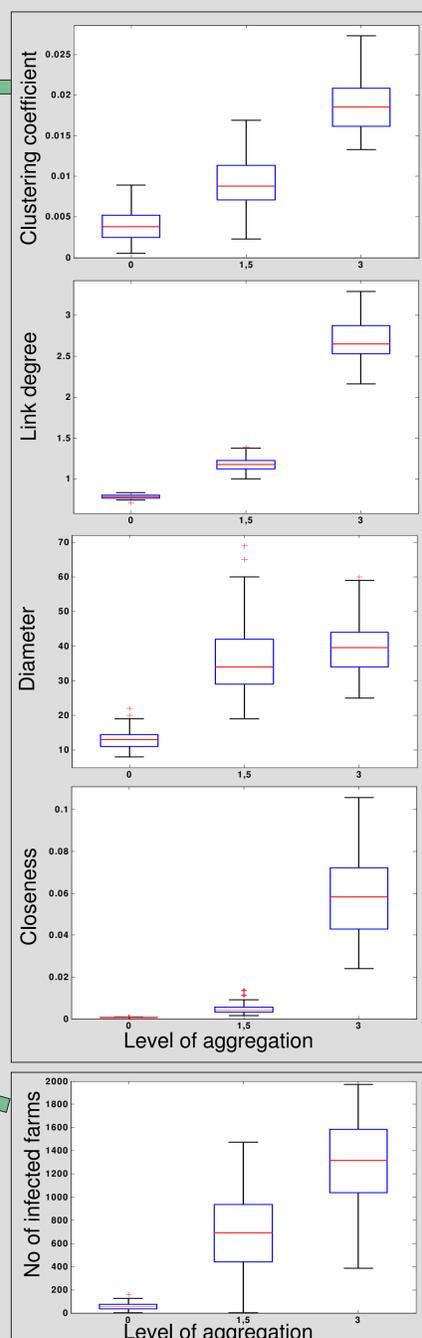
Conclusions

- The level of aggregation has impact both on the network measures and on the transmission of diseases between farms.

- Increased aggregation in landscape structure leads to more infected farms.

- Some of the network measures may be able to capture landscape structure and indicate risk disease transmission.

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