Notes on a variable density sampling method for S3M surveys

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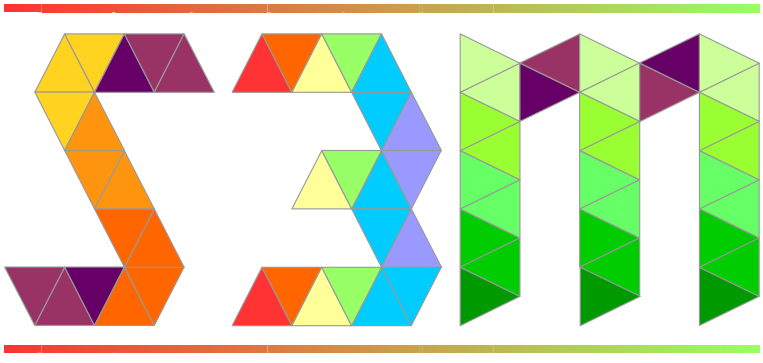
Simple Spatial Survey Method



Introduction

This guideline describes a variable density sampling approach that can be used for designing S3M survey samples.

A variable density sampling method can be useful for:

- Avoiding the difficulty of balancing the size of the sampling grid with the practicality of implementing a survey with too many sampling points. A variable density sampling design allows us to start with a large sampling grid that is suitable for the least densely settled areas and to increase the sampling density to match settlement density as needed.

- Achieving a sample that draws a minimum number of sampling points from administrative areas so that the survey can provide estimates for each administrative area with useful precision. Administrative areas tend to have similar population sizes. This means that a sample with a minimum number of sampling points per administrative area will also tend to match population density.

- Providing detailed mapping for areas of particular interest and areas in which we might expect considerable spatial heterogeneity (patchiness) at small scales as might be expected in urban and peri-urban areas or in areas containing a patchwork of different livelihood zones / agro-ecological zones.

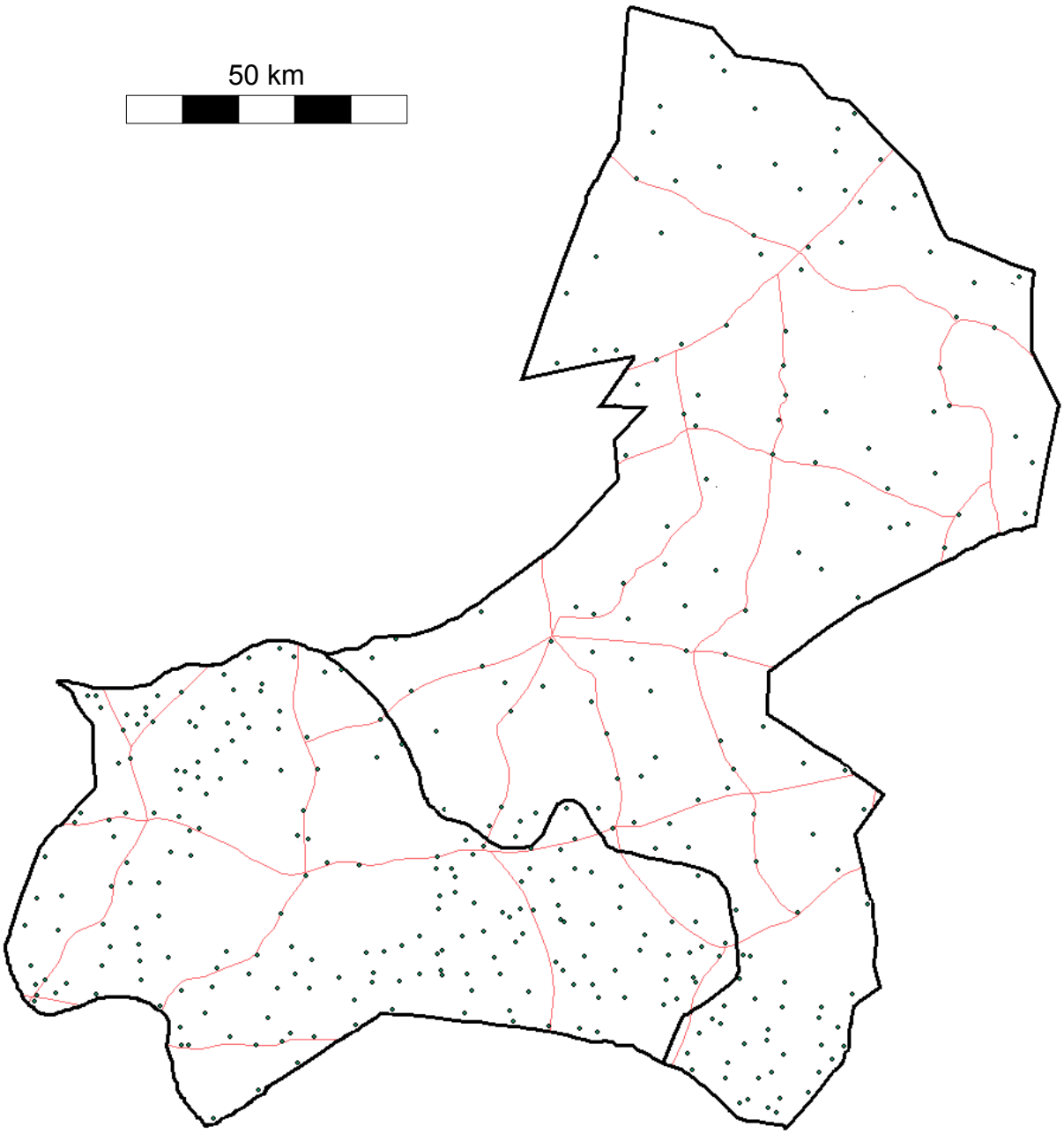
- Providing a sampling grid that maintains a similar sampling proportion or a similar number of communities within each triangular tile.

- Providing a sampling grid in which the area covered by each triangular tile does not violate assumptions of homogeneity (i.e. the assumption that the area of each triangular tiles is small enough such that a single per-tile classification or estimate is meaningful).

The guideline presents an extended practical example of a variable density sampling approach that can be used for designing S3M survey samples.

Example survey area

The example survey area is:



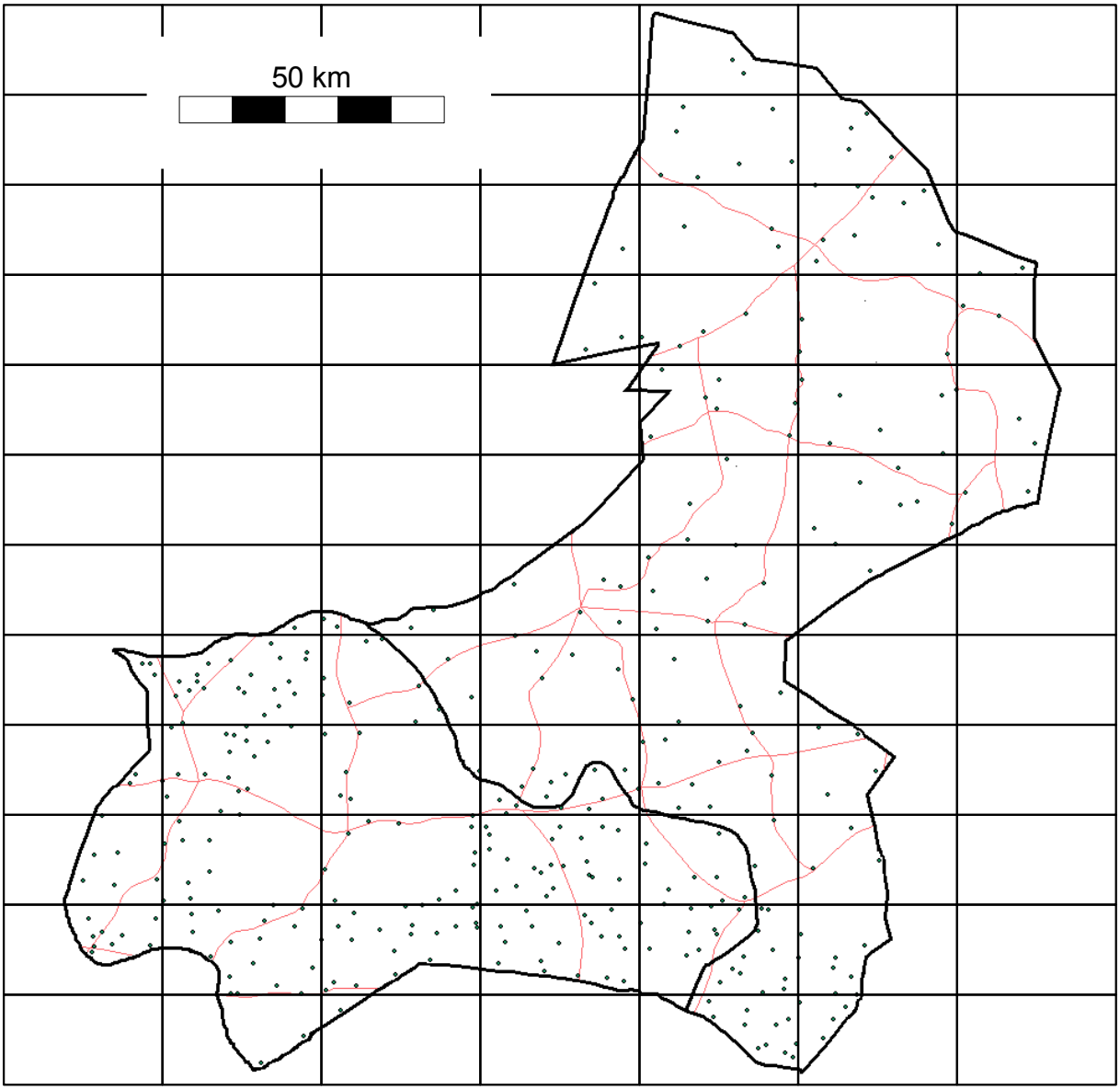
Note how the settlement density varies across the survey area (i.e. it is highest in the south and east of the survey area and relatively sparse elsewhere).

Initial S3M sample

The initial sample is a standard S3M sample.

The value of the distance parameter (d) can be set large. In this example, a value of d = 20 km was used for the initial sample. This value of d is well suited to sampling from the least densely settled areas.

Here is the initial sample grid for d = 20 km drawn over the example survey area:



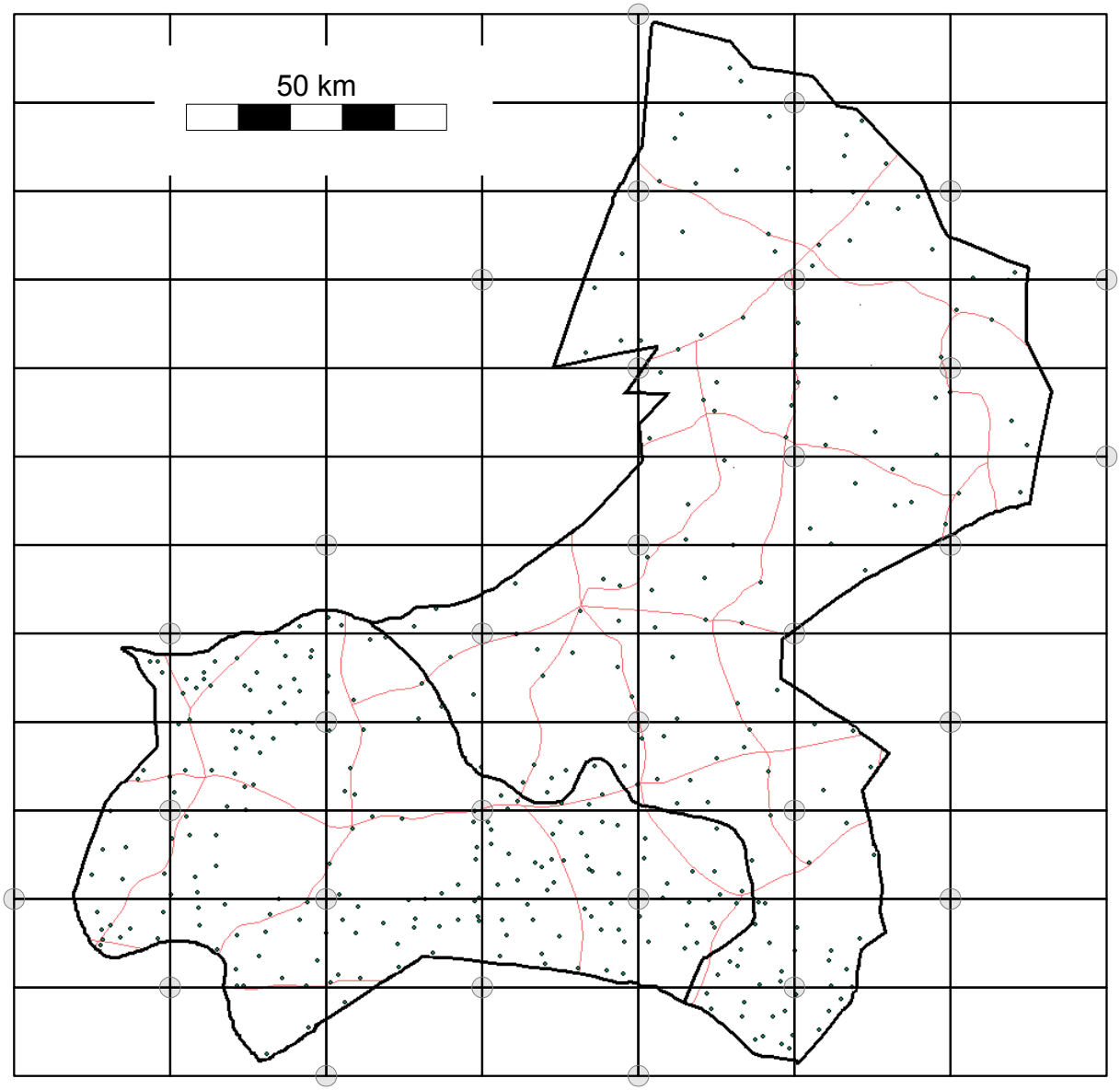
Note that we start with a quite a large value for d. This is chosen to suit the least densely settled areas.

When d = 20 (as used here) the average area of each triangular tile will be about 520 km^2. The next level of the sample will give triangular tiles with an average area that is about one quarter of this (i.e. about 130 km^2). The next level of the sample will give triangular tiles with an average area that is about also a quarter of this (i.e. 32 km^2).

Initial S3M sample

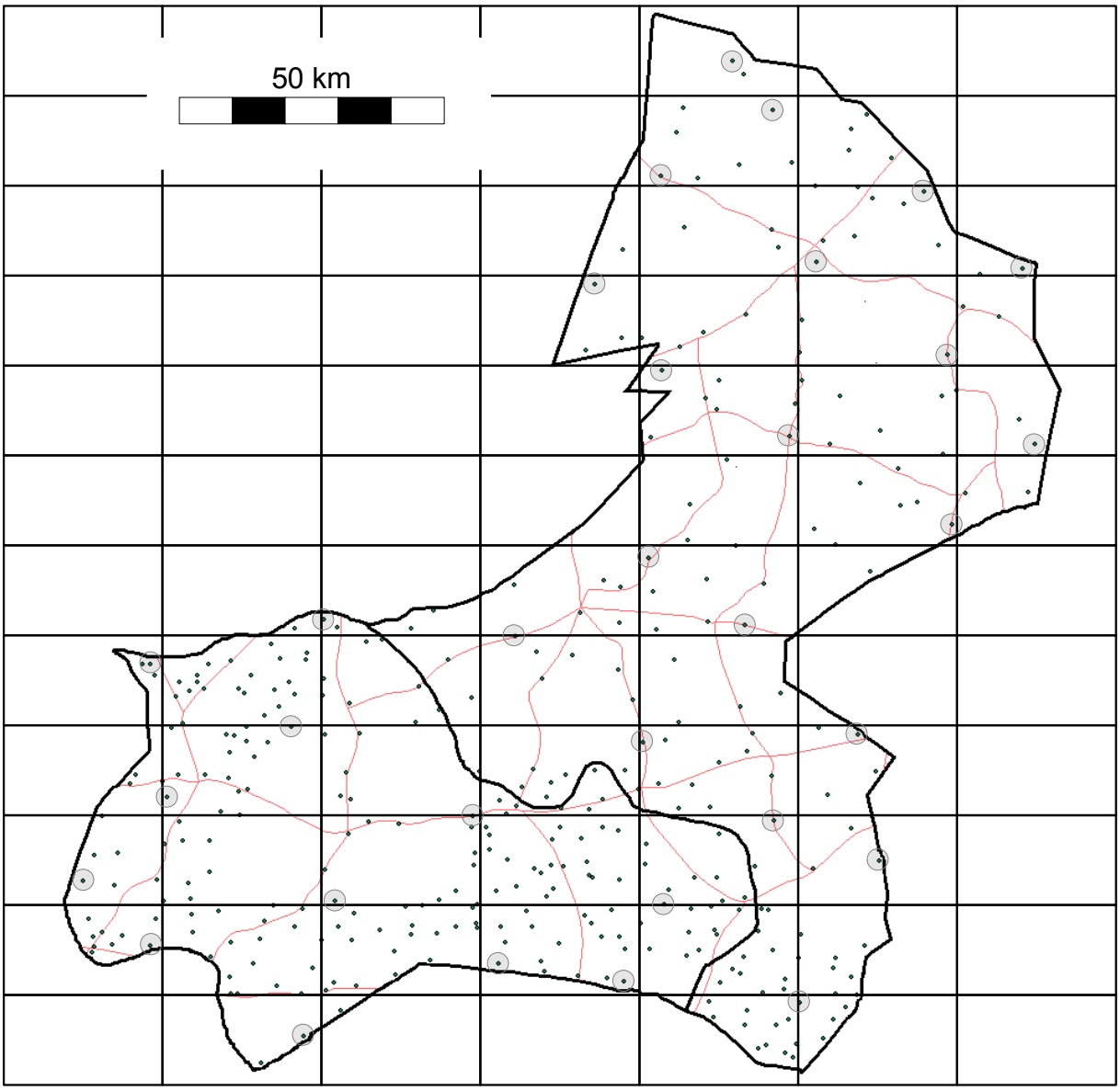
The initial S3M sample is taken in the usual manner.

Here is the initial location of the S3M sampling points:



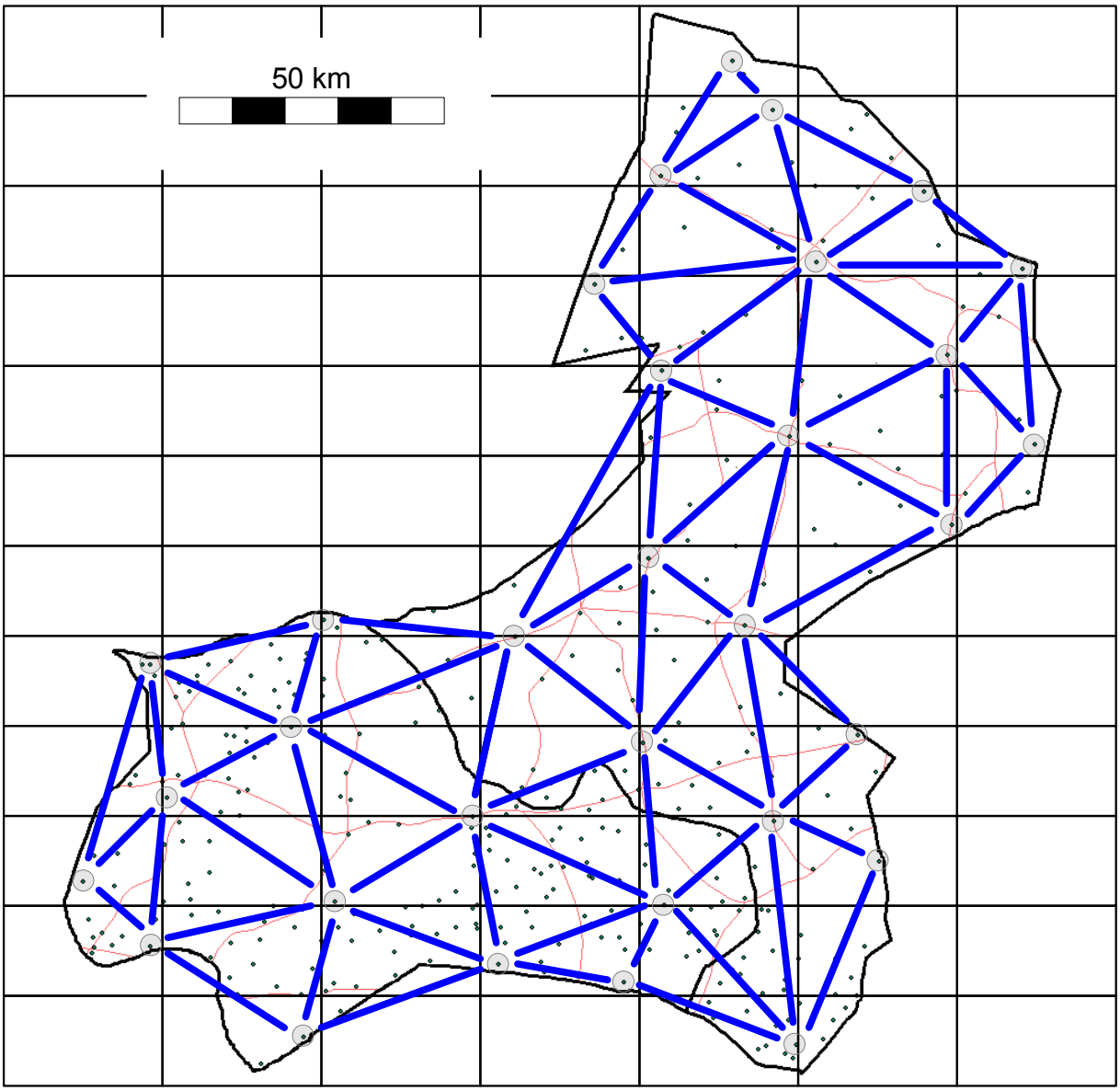
Initial S3M sample

These points are moved to their nearest communities:



Initial S3M sample

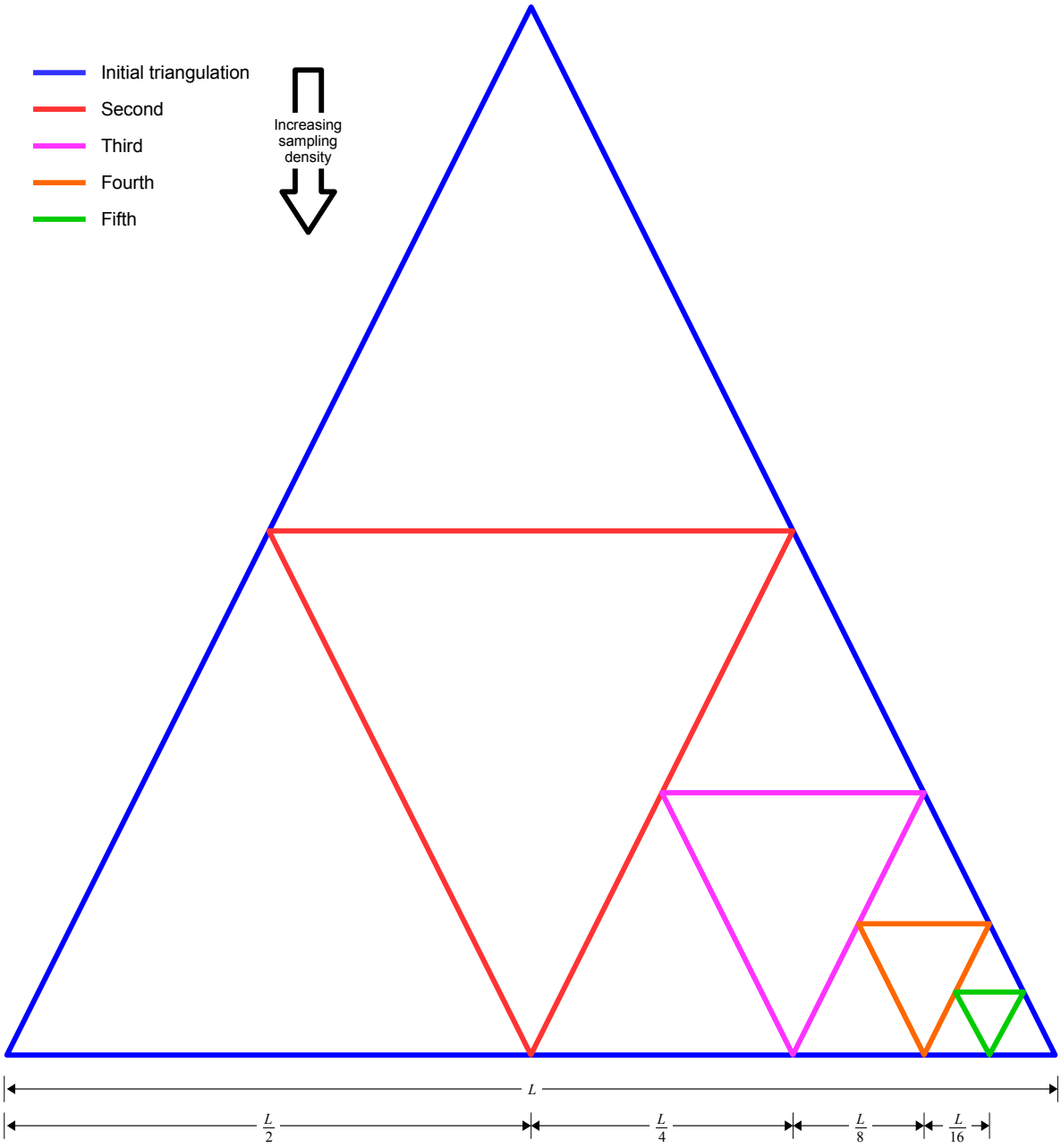
A triangulation is performed:



Sampling points can be moved or added to ensure an even spatial sample and to avoid long narrow triangular tiles.

Variable density sampling

The variable density sampling method uses a recursive pseudo-fractal approach. This breaks the overly-large triangular tiles (e.g. large tiles covering densely settled areas) into smaller triangular tiles using an iterative process that produces (as needed) triangular tiles with side lengths of approximately half that of the original triangular tile:

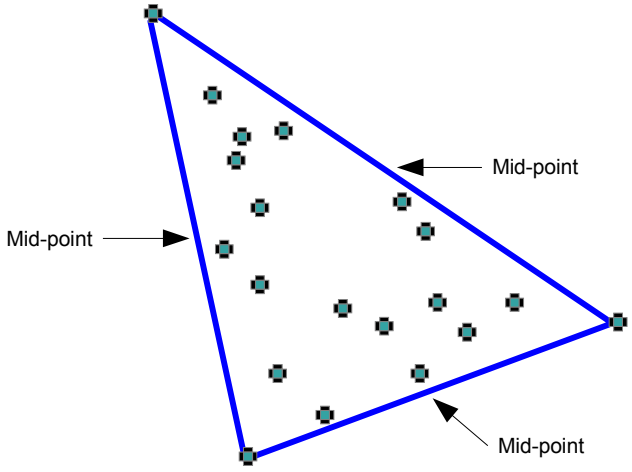


This process is only performed as needed (i.e. to overly large triangular tiles). The process can be repeated as often as is needed.

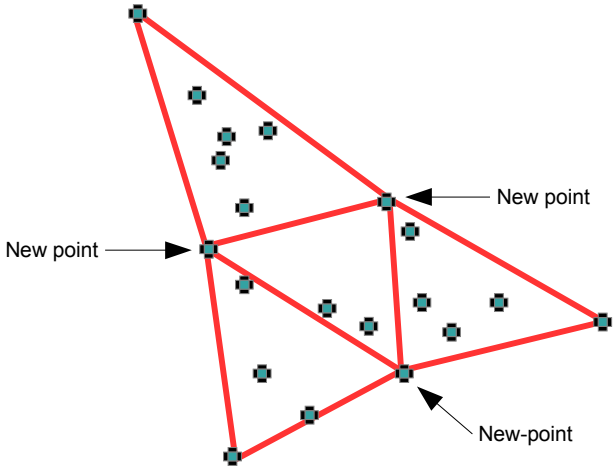
The process is iterative. A triangulation is performed after each halving step. Overly-large triangular tiles are then identified and the process repeated until the sampling density approximately matches local settlement density or meets other needs. Sampling points can be moved or added at each step to ensure an even local spatial sample and to avoid long and narrow triangular tiles.

Variable density sampling

Here is an example step for a single triangular tile:



Initial triangulation



Second triangulation

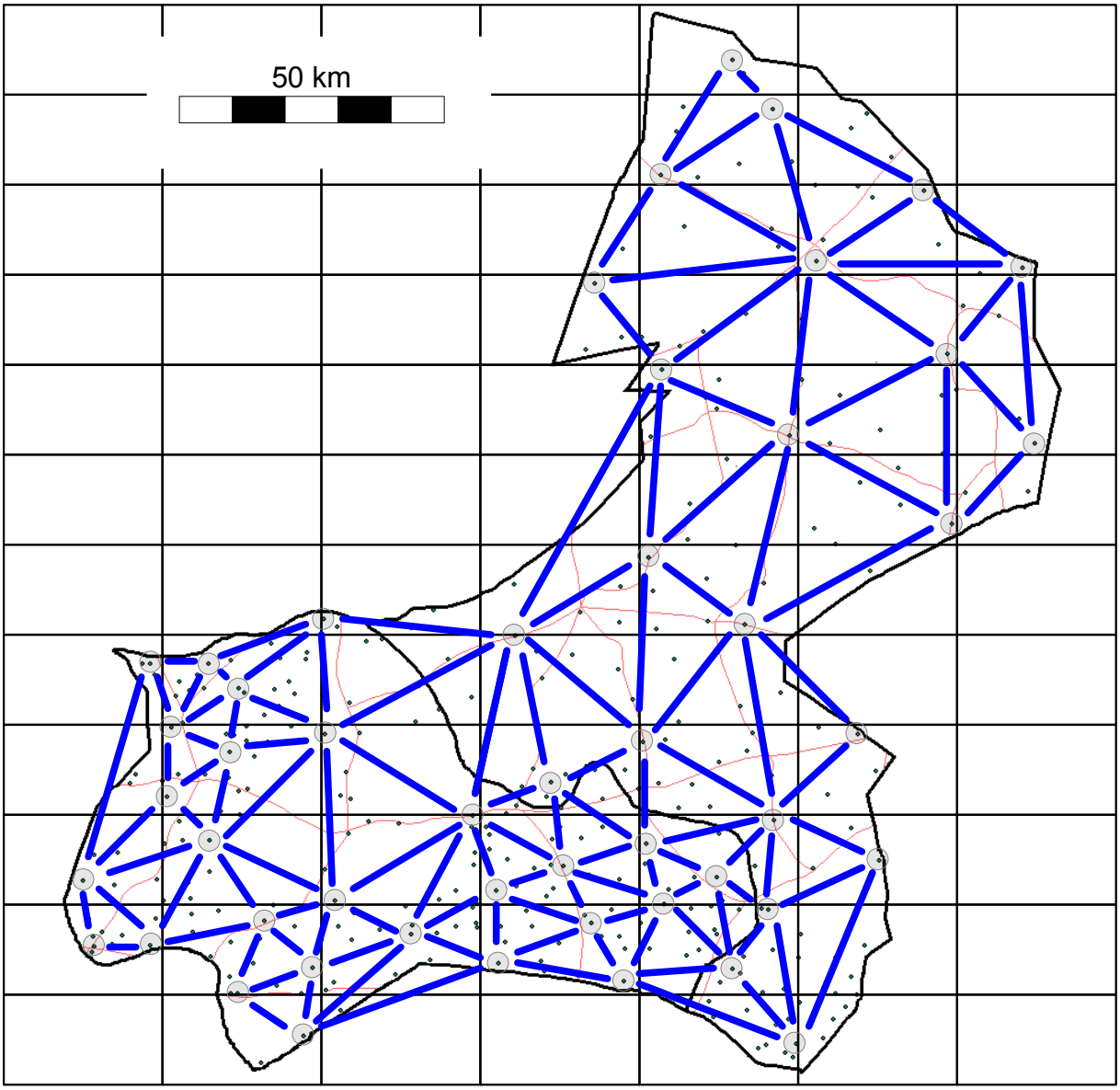
Each step follows a similar process to the initial S3M sample:

1. Sampling point are located at the mid-points of the sides of overly large triangular tiles.
2. Each sampling point is moved to the nearest community.
3. Triangulation is performed using the new sampling points.
4. Sampling points can be moved or added to ensure an even spatial sample and to avoid long and narrow triangular tiles.

The process continues until the sampling density approximately matches local settlement density or meets other needs.

Variable density sampling

Two steps (i.e. the initial S3M sample followed by a single halving step) were required for the example survey area:



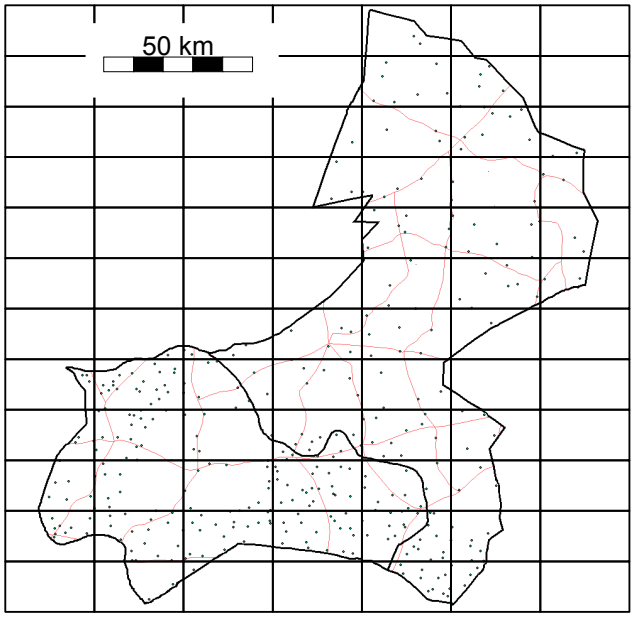
Use as many halving steps as needed to match sampling density to local settlement density or to meet other needs.

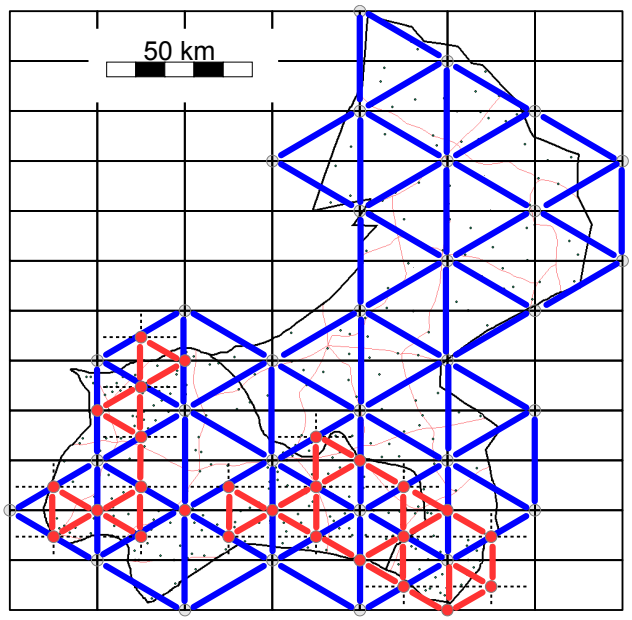
It is likely that many halving steps will be needed in peri-urban and urban parts of the survey area.

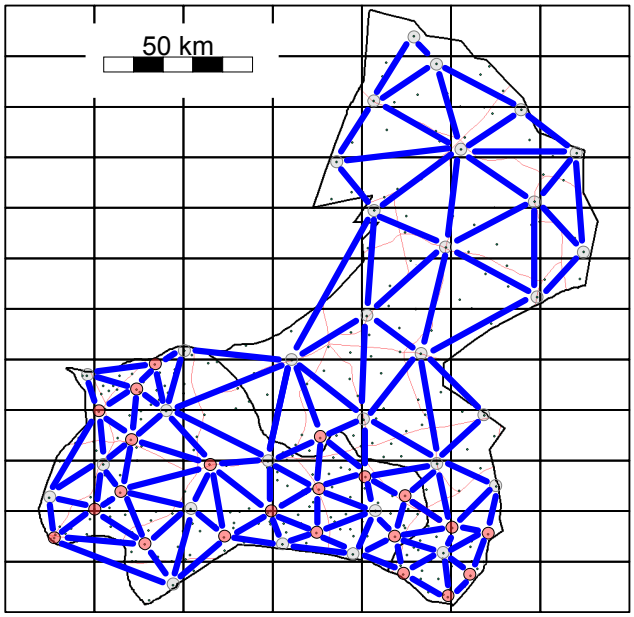
Many halving steps may also be required for sampling along tight ribbons of settlements such as those that follow a river or a major road.

An alternative approach

An alternative approach to that outlined above is to scale the sampling density based on the original sampling grid and to produce the triangulation in the final stage:







1. Draw and position grid with large value of d. In this example d = 20 km.
2. Mark initial S3M sampling positions.
3. Make triangular tiles using initial S3M sampling positions.
4. Make smaller tiles (where required) by quartering each rectangle in the grid.
5. Repeat (4) as needed.
6. Move sampling positions to nearest communities.
7. Triangulate.
8. Revise triangulation (i.e. add, move, or remove sampling points) to create a “good” triangulated irregular network.

This will produce a similar triangulation.