A combined permanent systematic and dynamic temporary sampling design

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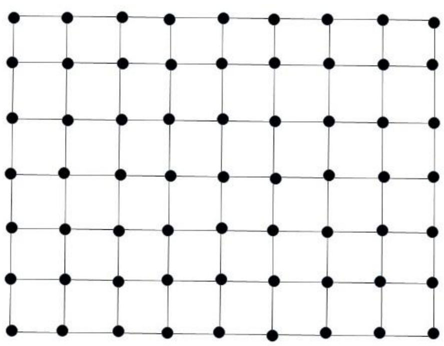
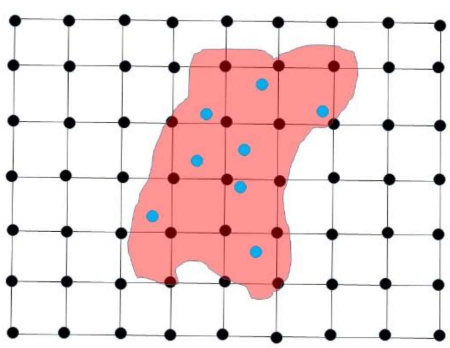
Fixed sample designs with permanent plots and constant sampling intensities are often quite inefficient when the objective is to estimate change parameters such as area of deforestation, particularly when the area in which change occurs is itself changing. For such applications, a sampling design featuring a fixed design component with permanent plots augmented with a dynamic design component with temporary plots may be preferable. In this context, a dynamic design is one for which the locations of the plots change over time to accommodate a specific sampling objective.

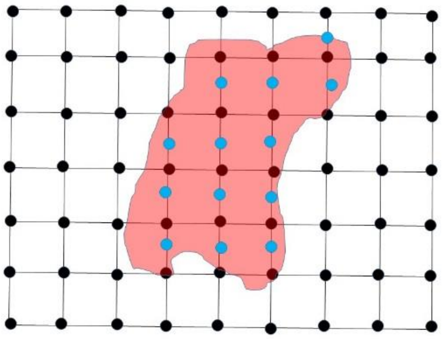
Start with a systematic design of permanent plots.



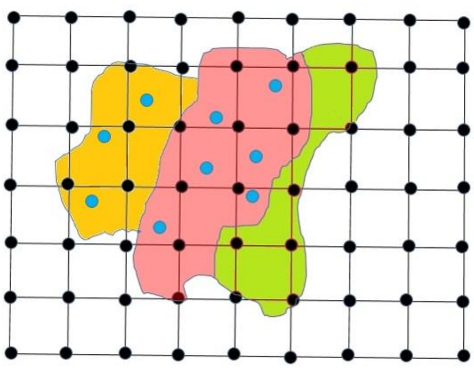
For a region of current or expected change as highlighted in red, augment the systematic sample with a random sample consisting of temporary plots in blue.



Options other than random sampling are possible including a simple intensification of the grid within the red area.



When the region of current or expected change moves to the yellow part of the previous non-change area, and change is no longer occurring in the green part of the previous change area, the temporary plots are moved from the green area to the yellow area. The sampling design in the green area reverts back to the underlying systematic design of permanent plots.



Regardless of sampling intensities, the expectation is that temporary plots stay in the same location for at least two measurements, otherwise they are not useful for estimating change.

Because the region encompassing the temporary plots has a different sampling intensity than the non-change portion of the study area, it must be considered a separate stratum for use with stratified estimators. Note that this stratum will change location over time as the change region changes location. For the first period, the change stratum will include the red and green areas in the above figure, but in the second period it will include the green and yellow areas.

These figures depict a constant sampling intensity throughout the non-change portion of the study area, but that is not a requirement; different systematic grids could be used for different parts of the study area. However, every region with a different sampling intensity must be considered a different stratum, and care must be exercised to ensure that a stratum consisting of the overlap of the change stratum and any portion of a previously non-change stratum is large enough to include at least 10 plots.

As per our telephone conversation, I suggested a simulation study for several purposes: (1) to estimate appropriate proportions of permanent and temporary plots, (2) to estimate appropriate systematic grid widths for the permanent plots, perhaps differing for different non-change regions; and (3) to investigate statistical techniques for combining data for the systematic permanent and dynamic temporary sampling designs. The simulation study would require information for constructing populations (maps) for 3-4 time periods. If forest/non-forest change is of interest, then Landsat pixels could serve as the underlying population units for each time period. Reference data in the form of either ground observations (unlikely) or carefully interpreted Landsat or aerial photography would be necessary to serve as reference data for constructing the population for each time period.

An important issue is to construct the populations with appropriate spatial correlation, i.e., realistic relationships among attributes for pixels in close proximity to each other. This is a non-trivial task. I am aware of three researchers with experience in this area: (1) Professor Guangxing Wang at Southern Illinois University in the USA, (2) Dr. Liviu Ene now with the Swiss NFI, but previously with the Norwegian University of Life Sciences, and (3) Victor Strimbu, a PhD student under Erik Næsset at the Norwegian University of Life Sciences. All three use different approaches. For the record, for another purpose I am about to initiate a joint project with Professor Wang and Mr. Strimbu to compare approaches for constructing populations for single time periods.