

GIS tool for optimisation of Forest Harvest-scheduling

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Unlike in agriculture, planning in forestry has much larger impact on sustainability. Today's decisions create consequences for generations to come. Therefore good planning is essential to maintain balance between forest production and protection of biodiversity.

Forest manager have traditionally planned harvests using their expert knowledge. This applies mainly to the spatial distribution of harvest units. The amount of timber to be harvested has then been regulated by market demand. Expert knowledge is necessary for good planning,

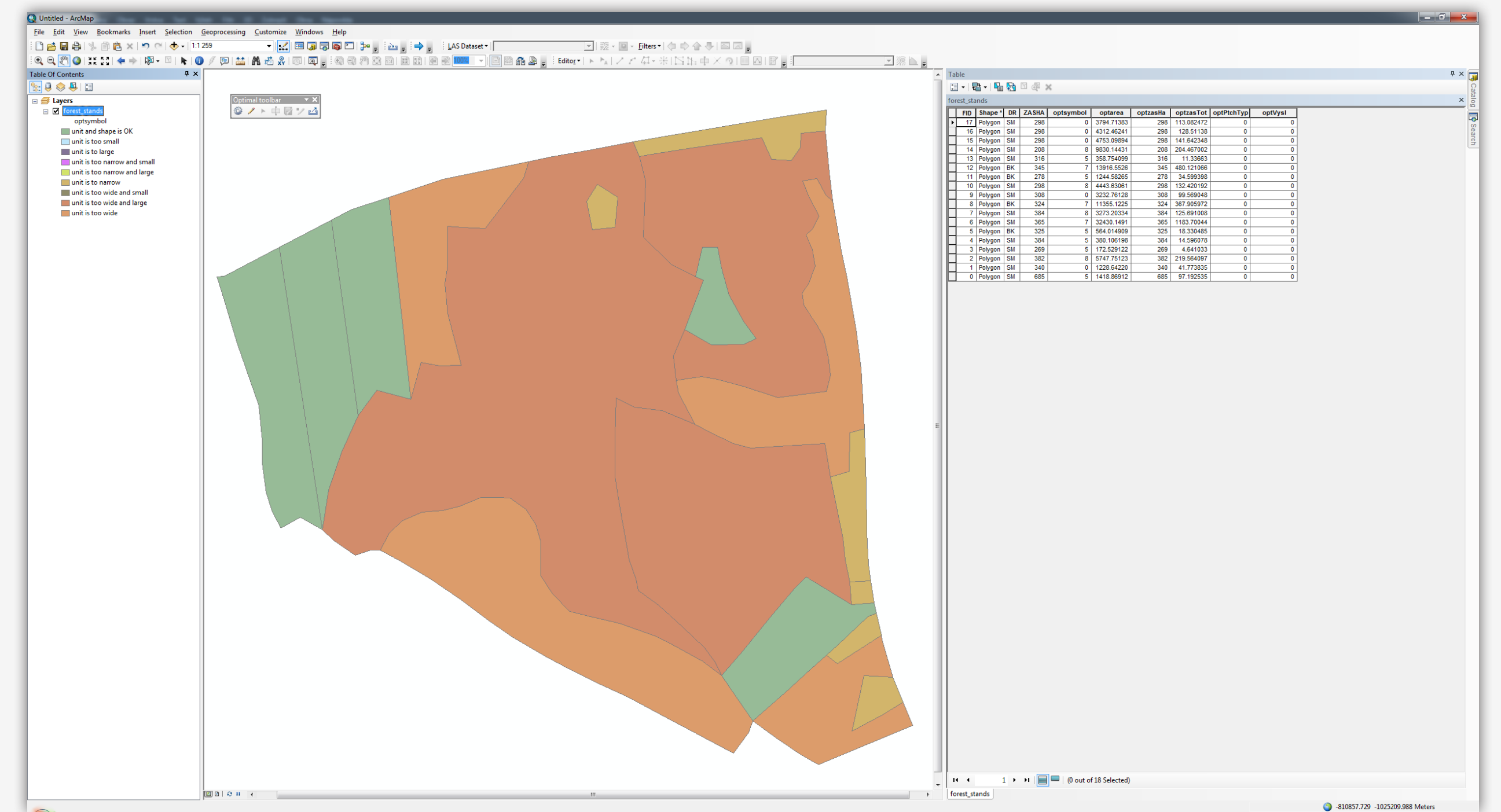
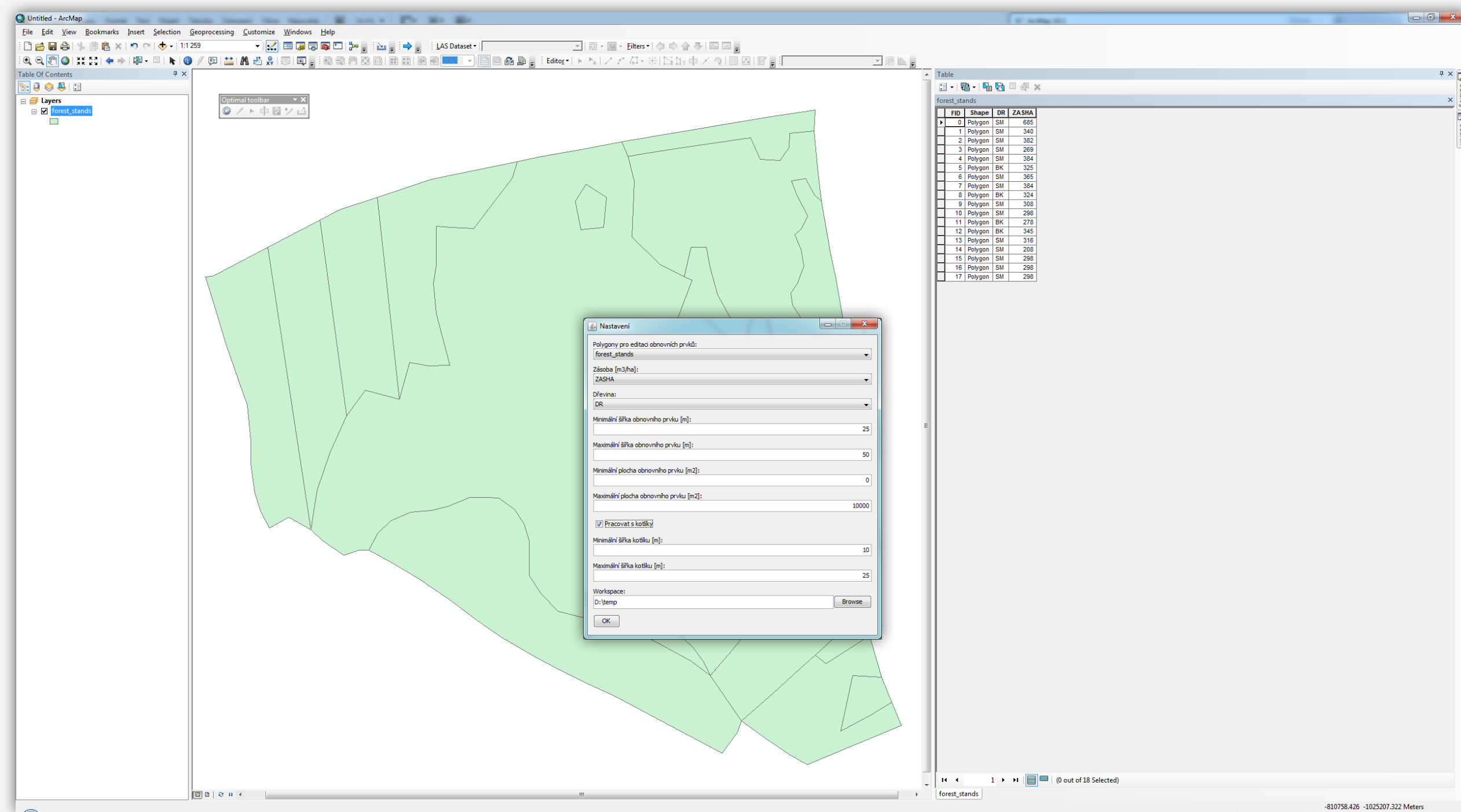
but apart of expert judgement, there is a set of rules, which can be automatized. Computerized harvest planning will lead not only to saving time of forest managers, but it will also enable them to explore various scenarios in a matter of minutes.

We introduce GIS tool (called "Optimal") for spatial and temporal optimization of forest harvests. Using Optimal, forest manager can create harvest units by cutting polygons of forest stands in digital map. After the harvest units are created by the user, the adjacency matrix

is produced automatically and it is passed to solver module. Solver performs calculation using integer programming and then it returns spatial distribution of harvest units for each harvest period. User can set number of parameters and so to create different scenarios.

The GIS tool Optimal can be a part of decision support systems for different kind of forest management area with a full range of setting parameters.

Initial setup of parameters and automatic data preprocessing



User starts the work by adding geographic data layer to ArcMap map composition. The geographic data layer should contain polygons of forest management units that are intended to be harvested. The data table of this layer must contain data about species and timber volume per hectare for each forest stand. In a special dialog box user sets up constraints for construction of harvest units.

When constraints for editing are all set, user can start editing. System will automatically fill polygons with colors representing adherence to the constraints. In principle the editing is done by cutting polygons of forest stands into small harvest units. Every time, just before the polygon is cut and resulting two new polygons saved to the database, the area and width of newly created polygons is calculated and checked against the constraints. If one of the new polygons is smaller or narrower than desired, user gets warning, the action is rolled back and new polygons are not created. If the new polygon is larger or wider than desired, then it is created anyway, but the polygon in the map is filled with appropriate color, so that the user is notified that it still needs to be edited. The reason for checking the small and narrow polygons is purely practical one. It is not efficient to harvest small forest patches unless there is reason for it other than timber production. The algorithm for editing harvest units is shown in Figure 1.

When all harvest units are ready, user can export the map into adjacency matrix (Figure 2.), which is subsequently fed into optimization module.

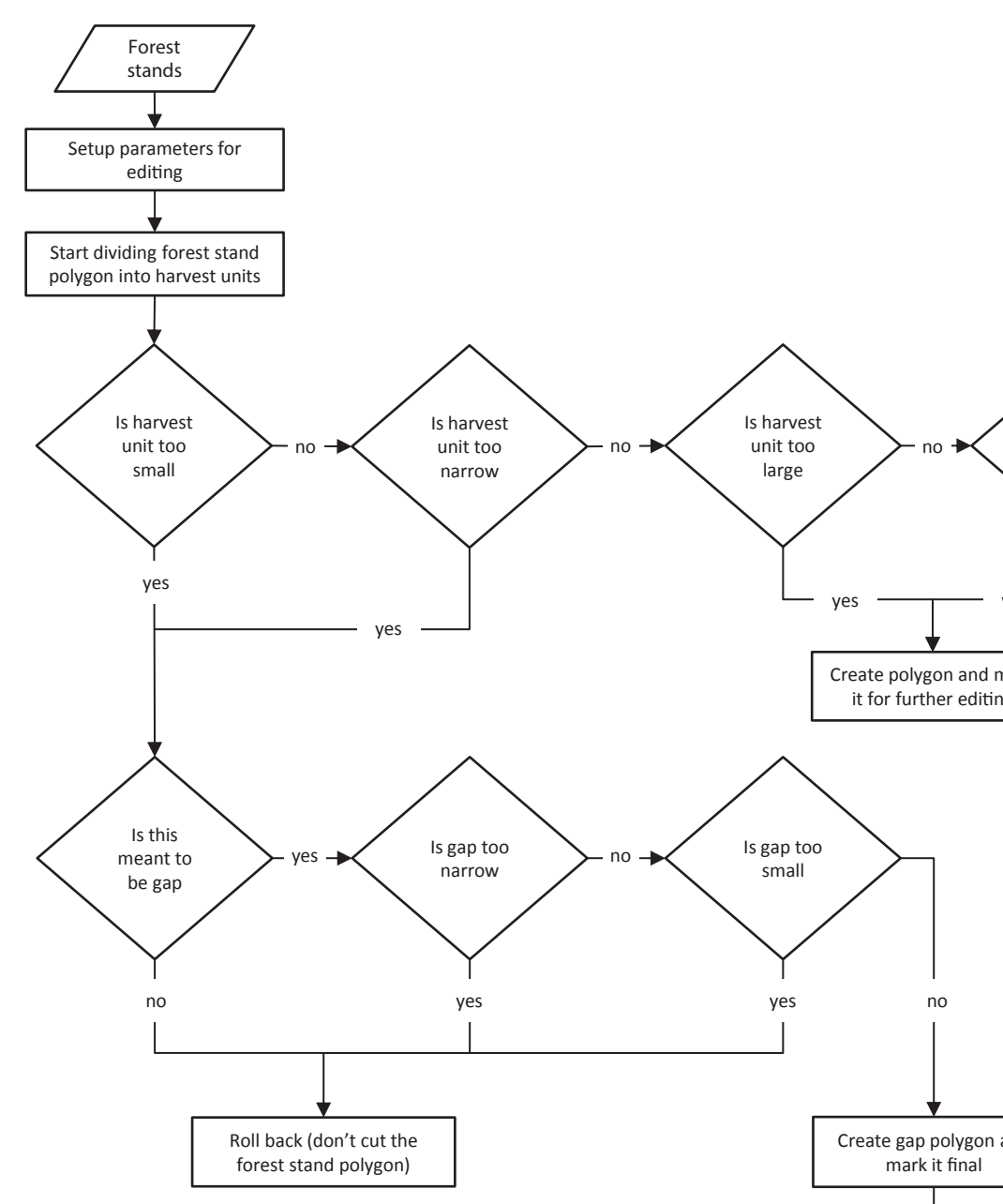


Figure 1.

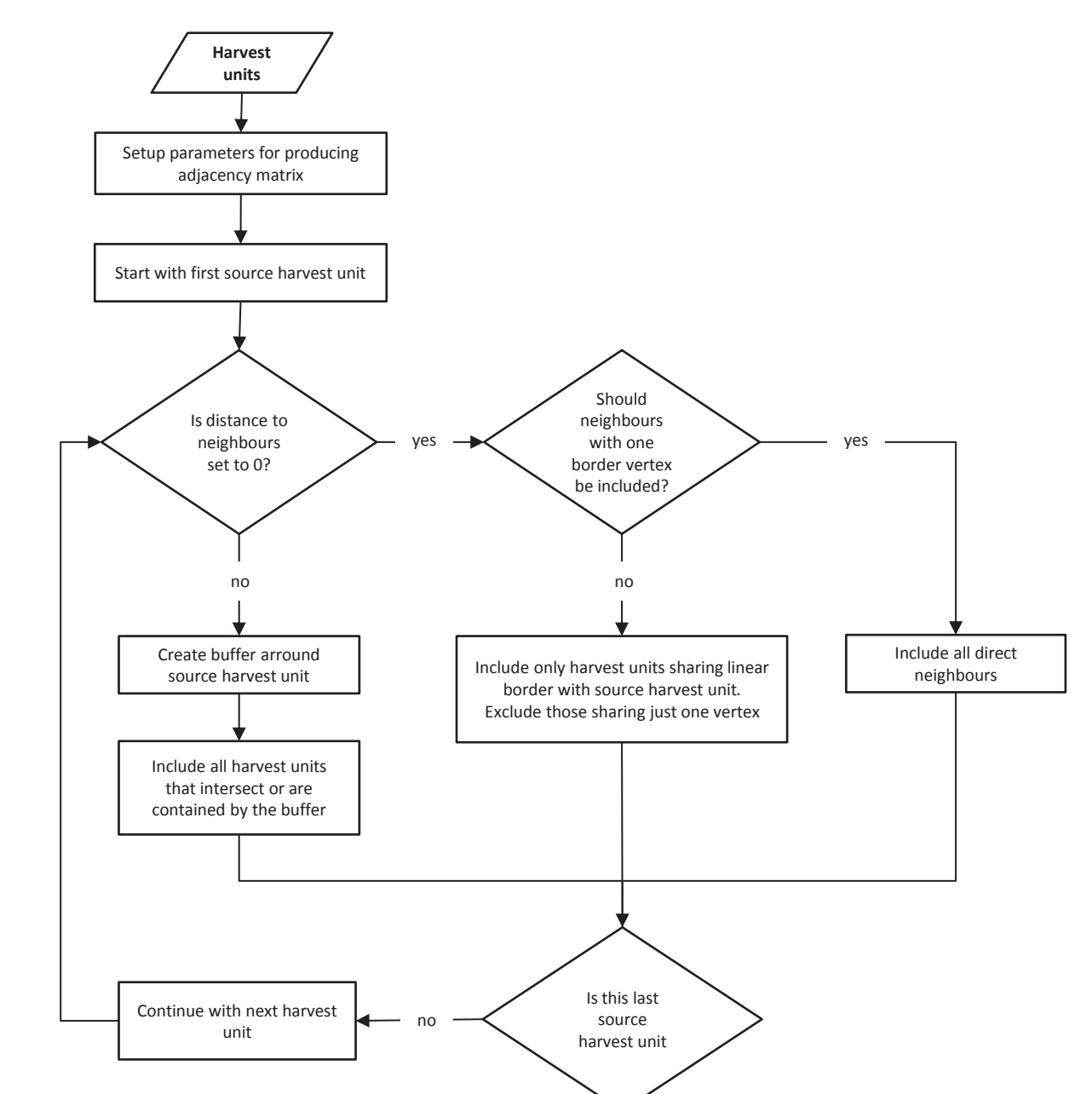
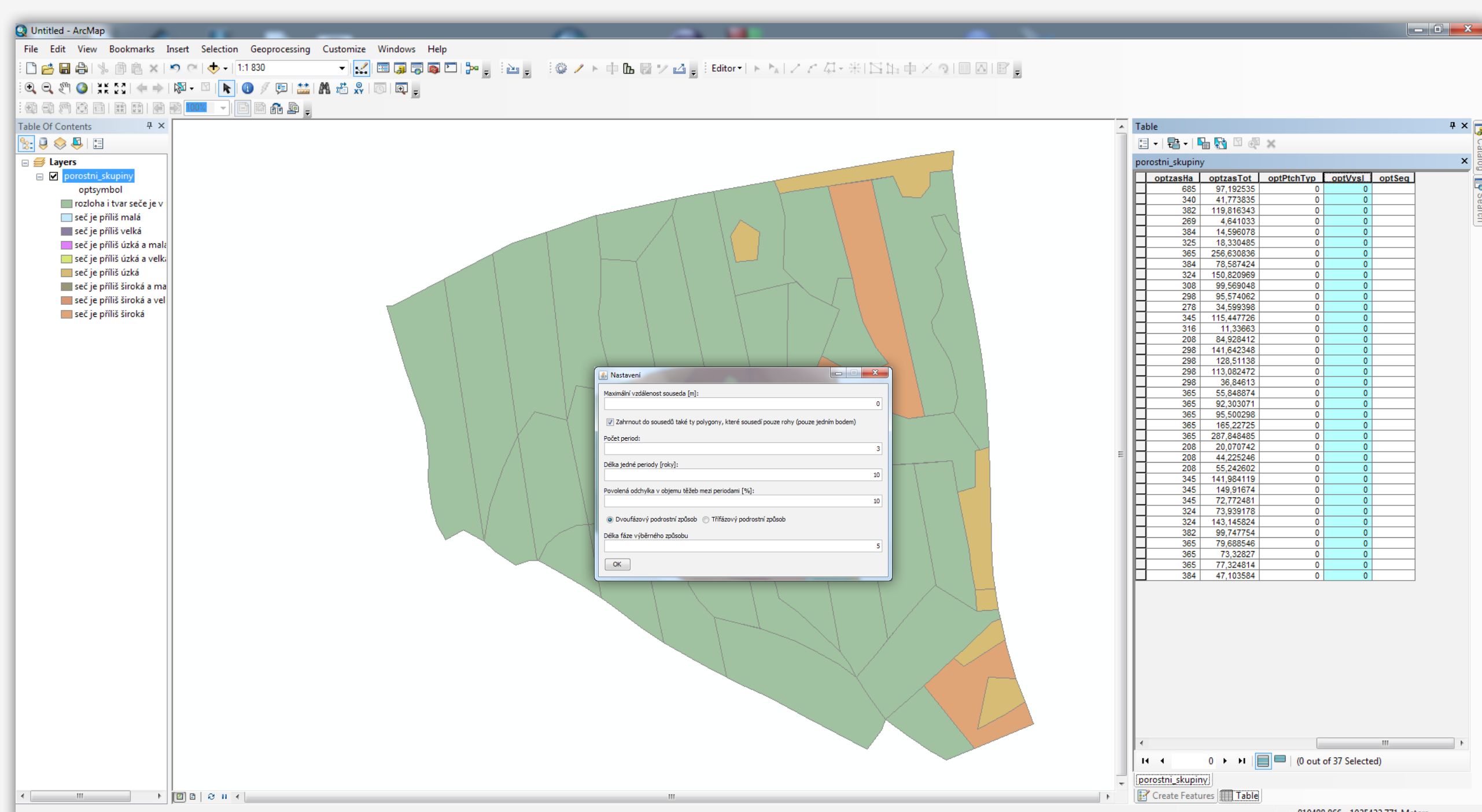
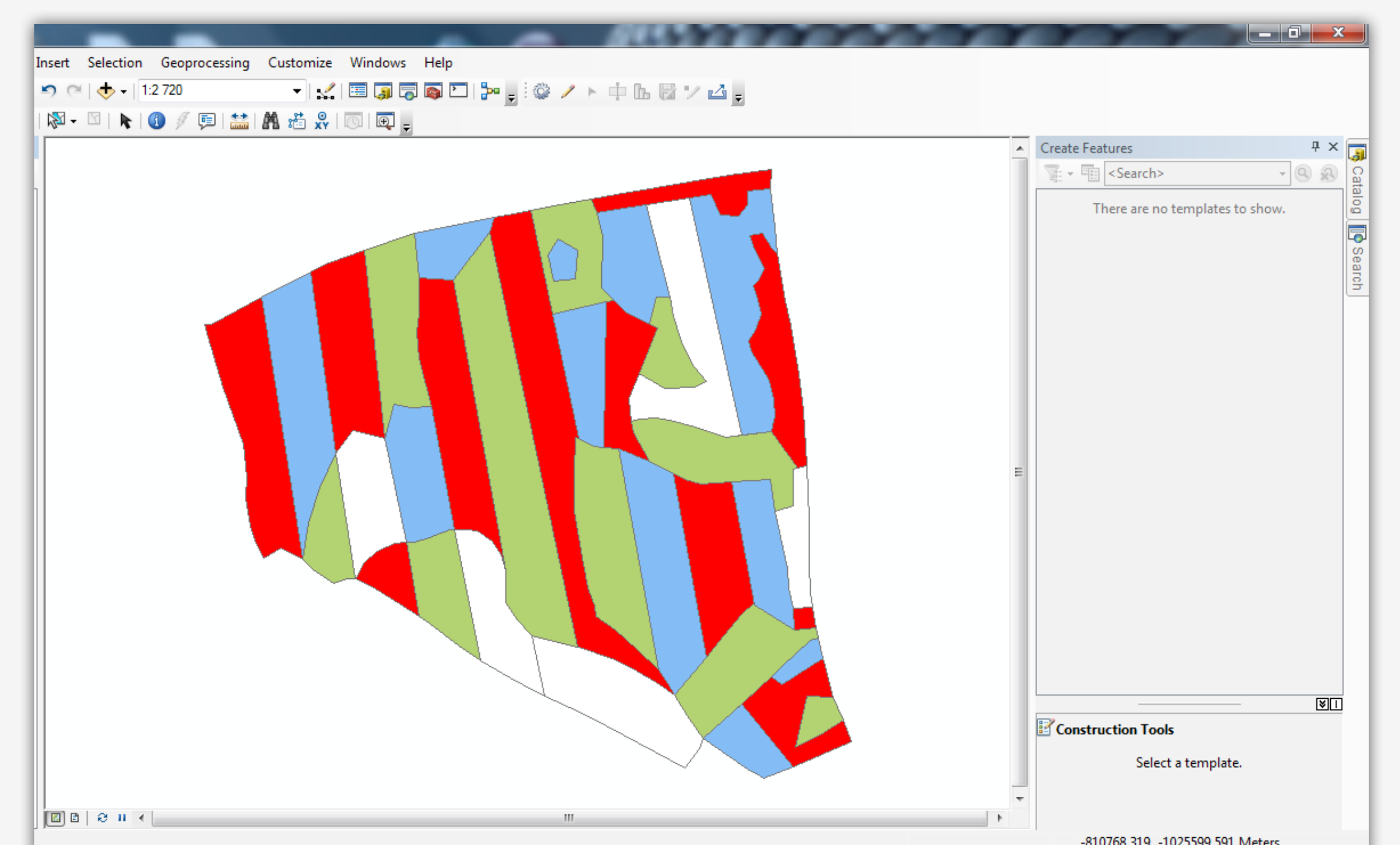


Figure 2.

Manual polygon editing to produce harvest units



Legend
 Not harvested
 Harvested in 1st period
 Harvested in 2nd period
 Harvested in 3rd period



Optimization of shelterwood forest management system

There is more and more used the shelterwood management system in the central Europe and it is more nature closed management system.

The basic principle is to edit harvest sequences which contain information about direct of harvesting and total count of harvest units for shelterwood system. Further, it can be set the type of shelterwood system (2 or 3 phase) and the length of each phase. The model is developed for linear mixed integer programming as well.

This module has been developing recently.

Example: 6 forest stands regenerated within 3 planning periods (30 years) by 2-phase shelterwood management system.

Legend
 Seeding cut
 Final cut
 Regenerated strip

