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Predictive modelling of forest cover change in the Gerecse Hills, Hungary

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The change of land cover pattern in the Gerecse Hills was reconstructed for the last 33 years using Landsat and Sentinel satellite imagery. The data (mainly taken in the late summers) was analysed for five dates: 1985, 1990, 2000, 2011, and 2018 determining the land cover using NDVI values. For the study area a sharp decline of forested area can be observed in the 1990s, which is followed by a slow reforestation, then again a drop of forested area in 2018. At the present days the extent of the forests is 175 sq. km. Focusing on the forest cover, the dynamics of the change was identified between the dates and normalized to uniformly represent the change of 10 years long periods. For this, we applied the method of Brown et al., (2000) which produces two stochastic variables: FNF (forest to non-forest), and NFF (non-forest to forest) for each pixels of the processed area. This method uses a moving averaging kernel to calculate the variables' value. It provides a solution to apply weight of the neighbouring cells' state when calculating a cell's value. The variables were calculated for the four transitional periods and were subsequently used as control values for polynomial curve fitting. The produced temporal functions are suitable to use them for predicting the variables' value in the near future (within a decade). Each of the pixels has their own set of functions which ensures the spatial independency of the simulation. From the values of the two variables the possible change of the forest cover can be calculated relative to a preceding observed state. The method was validated with using the modelled functions to compile the forest coverage map for the observed dates and then comparing the results with the observations. The difference was between 1 and 4.3% for the whole area, which is considered as the error of the model.
A prediction was calculated for the year 2025. The predicted FNF and NFF values were compared for each pixels, and the likelihood of forestation/stagnation/deforestation was calculated. The results showed that in the year of 2025 +/-5 a moderate increase of total forest cover can be expected (186 sq. km), which is approximately the same as in the mid-1980s, but the forested areas will be patchier than at that times.
The type of land cover is a key factor in the soil erosion, and especially the forest cover acts as an important moderator. If the forest is cleared, the soil erosion increases by orders of magnitudes (Zhou et al. 2008). Estimations of forest coverage change in the near future may help to localize those areas where environmental changes may produce hazards, such as rapid erosion.

References:
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