Modelling sediment input from Passauna catchment

Calcluation of monthly sediment input and long-term sediment balance in the Passauna catchment with the application of Revised Universal Soil Loss Equation and use of satellite images

Context

Soil loss in watersheds is a major threat to food and water security. Food supply is impaired by the degradation of fertile lands due to erosion, while water supply is restricted due to the storage loss caused from sedimentation. The major contributor in terms of soil loss and sediment input is the agricultural land. Because of the seasonal crop rotation, the agricultural areas remain a certain period of year uncovered, thus vulnerable to water erosion. As erosion is not equally distributed, spatially and teporally, detailed information about the location of erosion and sediment input hotspots is of high importance for the authorities, for managing the river basin in a proper manner.

Objectives/Goals

- Calculation of long-term sediment input budget.
- Identification of erosion and sediment input hotspots.
- Basis for watershed managing strategies.
- Increased model accuracy through inter annual resolution based on satellite data.

Methodology

For the calculation of sediment input and erosion from the catchment the Revised Universal Soil Loss Equation (RUSLE) was applied. The challenges were mainly encountered in defining a proper land cover factor for the arable land, as this factor is directly connected to the crop rotation practices and the type of crop. In this case, we used an empirical approach for calculating the C factor. For calculating the C factor the Normalized Difference Vegetation Index was used (Durignon et al. 2014). As the NDVI data had a monthly resolution, the model was able to simulate also in a monthly time step. This approach gave the opportunity to understand and simulate also the annual dynamics of sediment input from Passauna catchment. For the R factor we used the monthly factors calculated from Waltrik et al. 2015 While for the K factor a sampling campaign was organized, where 23 soil samples were taken and analyzed.

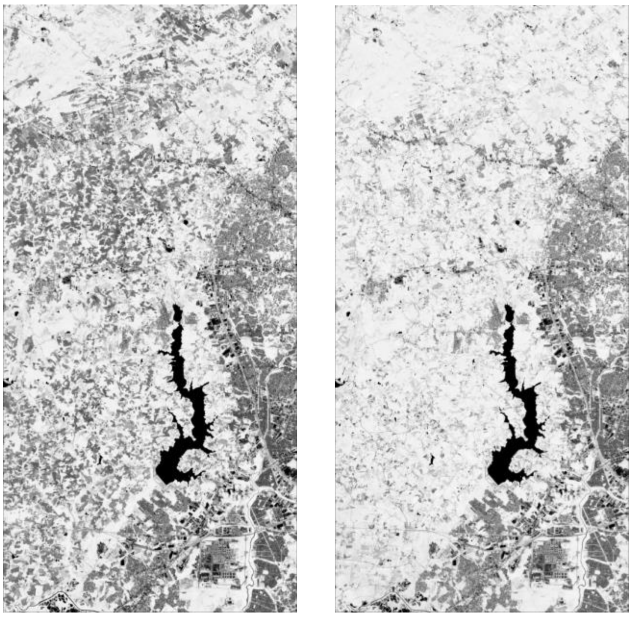

Fig. 1a. NDVI Nov.2017 Fig. 1b. NDVI Jan. 2018

Dark=no cover, Light= covered ©EFTAS

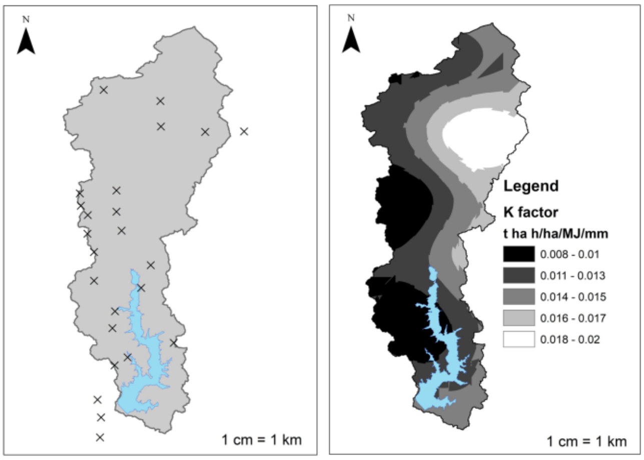

Fig. 2a. Soil sampling points Fig. 2b. K factor

Results

The spatial distribution of soil erosion and sediment input were created in a monthly basis (Fig 3). The simulated period was May 2017 until April 2018. The determining factor for soil loss is the rain intensity. The wet months are characterized by high erosion, while the dry months by low soil loss. Although the soil is covered with vegetation in the wet months the rain erosivity is rather high and creates soil erosion. In total for the simulated period the sediment yield was 70,000 ton/yr. In 30 years the total amount of sediment coming in the Passauna reservoir is 2,100,000 ton. Most of the catchment has Very slight erosion rates

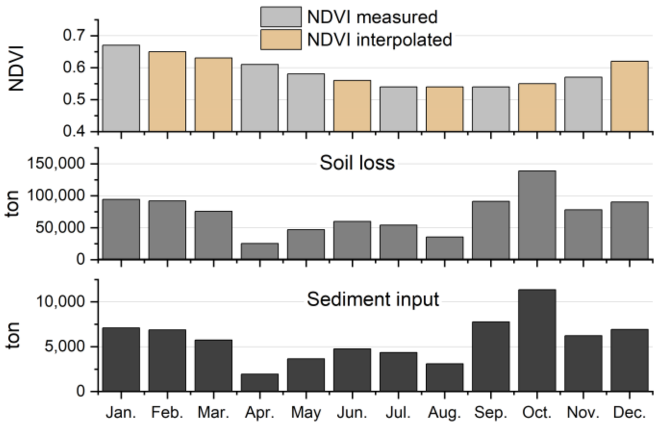

Fig. 3. Interanual dynamics of sediment input and soil loss

Table 1. Erosion classes in Passauna watershed

Soil erosion classes	% of watershed
Very Slight (<2 t/ha/yr)	55.5
Slight (2-5 t/ha/yr)	3.5
Moderate (5-10 t/ha/yr)	3.7
High (10-50 t/ha/yr)	15.8
Severe (50-100 t/ha/yr)	9.0
Very Severe (100-500 t/ha/yr)	11.3
Catastrophic (>500 t/ha/yr)	1.4

Discussion

The total amount of sediment measured with the hydroacoustic system, sediment sampling and dynamic penetrometer is 4,200,000 tons. There is a discrepancy of around 50% between the two outcomes. The difference exists partially because of a calibration error in the RUSLE factors and in part as in the RUSLE calculation the gully-channel erosion and internal production of the reservoir are not included. RUSLE is a reliable tool for order of magnitude calculations and especially location of problematic areas in the watershed. In the located hotspots several measures like contour farming, reduced tillage afforestation of agricultural areas in high slopes could be implemented.

Compared to Sauniti et al. 2004 the results show less erosion (62.7% very slight, slidght and moderate compared to 52% from Sauniti et al 2004.) The changes between the two studies are found mainly in the forested areas where the present study finds very slight erosion in contradiction to the previous one.

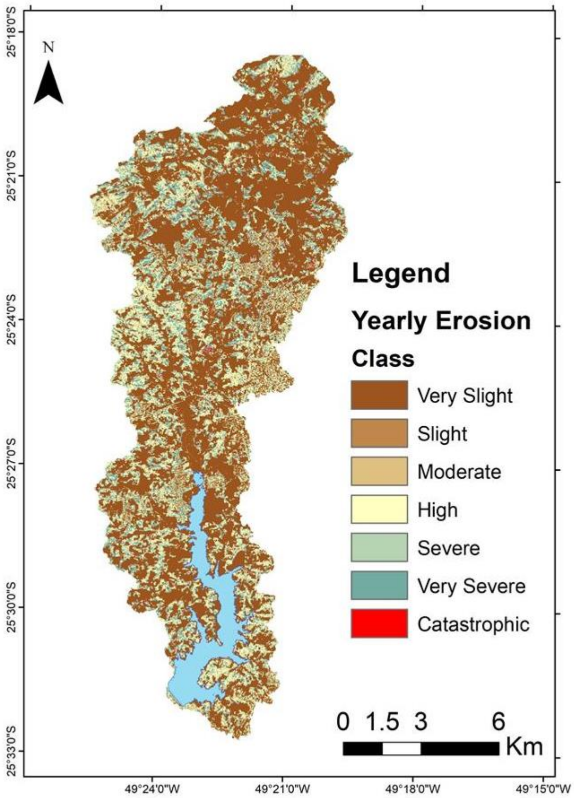

Fig. 4a. Soil erosion classes in Passauna catchment.

Innovation/Outlook

- ✓ Long-term sediment mass estimation for the operation.
- ✓ Interanual dynamics of sediment input.
- ✓ Use of remote sensing for land cover factor estimation.
- ✓ Use of the sediment input and soil loss maps for future strategical planning and sustainable management of the watersched.

Authors Sotiri, K.; Hilgert, S.; Duraes, M.; Wolf, N.; Armindo, R.; Fuchs, S.
Contact klajdi.sotiri@kit.edu
Funded by Federal Ministry of Education and Research, BMBF
Web www.mudak-wrm.kit.edu