Land use impacts on lake water quality in Alytus region (Lithuania)

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Land use has important impacts on soils, surface and ground water quality. Urban agricultural areas are an important source of pollutants, which can reach lakes through surface runoff and underground circulation. Human intervention in the landscape is one of the major causes pollution and land degradation, thus it is very important to understand the impacts of and use on environment and if they have some spatial pattern (Pereira et al., 2013, 2015; Brevik et al., 2016). The identification of the spatial pattern of lakes pollution is in Alytus area (Lithuania) is fundamental, since they provide an important range of ecosystem services to local communities, including food and recreational activities. Thus, the degradation of these environments can induce important economic losses. In this context, it is import to identify the areas with high pollutant accumulation and the environmental and human factors responsible for it. The objective of this work is to study identify the amount of some important nutrients resultant from human activities in lake water quality in Alytus region (Lithuania). Alytus region is located in southern part of Lithuania and has an approximate area of 40 km2. Inside this region we analyzed several water quality parameters of 55 lakes, including, pH, electrical conductivity (EC), suspended materials (SM), water clarity (WC) biochemical oxygen demand (BDO), total phosphorous (TP), total Nitrogen (TN), dissolved organic carbon (DOC), as other environmental variables as altitude, lake maximum deep (MD), lake area and land use according Corine land cover classification (CLC2006). Previous to data analysis, data normality and homogeneity of the variances, was assessed with the Shapiro-wilk and Leven's test, respectively. The majority of the data did not respect the Gaussian distribution and the heteroscedasticity, even after a logarithmic, and box-cox transformation. Thus, in this work we used the logarithmic transformed data to do a principal component analysis (PCA), based on the correlation matrix. The loadings of factors that at least explained one of the variables were used for a hot spot analysis, in order to identify if there was a spatial pattern in the variables distribution (Pereira et al., 2010, 2016). The results showed that in Alytus region 45.5% of the land use was classified as agricultural area, 47.3% as forest and semi-natural areas, 3.3% as water bodies, 2% as artificial surfaces and 1.9% as wetlands. The water properties of the studied lakes were the follow: pH 8.3±0.41, EC 336.31±106.49 μS/cm, 9.55±3.09 mg/l, WC 2.55±1.41 meters, BDO 3.53±1.30 mg/l, TP 0.0425±0.027 mg/l, TN 0.92±0.39 mg/l, DOC 9.61±0.79 mg/l. On average, the altitude of the lakes was 113.98±17.06 meters, MD 15.98±12.08 and lake area 243.85±386.52 ha. The PCA identified three different groups (factors). The factor 1 had high loadings in MD and WC, and high negative loadings in BDS, TP, TN and SM. The factor 2 showed high negative loadings in pH, EC and DOC. Finally, the factor 3 had high positive loadings in the area of the lake and high negative loadings in altitude. The hot spot analysis carried out with the loadings of factor 1 showed that that the area at northeast of Alytus region had a significant concentration lakes with high amounts of BDS, TP, TN, and SM, and in the west an area of lakes with high WC and MD. The hot spot analysis applied to the factor 2 loadings, showed that there was a group of lakes with high pH, EC and DOC, and a cluster located in the northeast part of Alytus region with a low level of pH, EC and DOC. Finally, the hot spot analysis applied to the factor 3 loadings, identified that the areas where the high lake area were located in the northwest of the study area, and small lakes were identified in the northeast. The lakes located at high altitude were located in the northeast area and the ones at low altitude at northeast part of Alytus area. Overall, the area with lakes with high pollution are located at northwest of the study area, where the lakes were more shallow, the altitude was low and the majority of the surroundings are covered by agricultural areas. The degradation of water quality of this area may be attributed to the fertilizers and pesticides applied by farmers in this area, contributing to the degradation of water quality and the quality of the services offered by this area.

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