

SOIL DEGRADATION BY ACIDIFICATION AND EROSION AND THE THEMATIC STRATEGY OF SOIL PROTECTION IN EUROPE

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Acidification as chemical soil degradation

Precipitation-excess is characteristic of the temperate climatic zone and causes leaching and eluviation and thus soil acidification. Extreme acidification can result in poorly structured or hard-setting topsoils that do not support sufficient vegetation to prevent soil erosion. Often, plant and crop growth are limited because of decreased nutrient availability (i.e. calcium, magnesium, boron or molybdenum) and/or an increase in toxic levels of aluminium, iron or manganese (Goulding and Annis, 1998). Soil acidification occurs in areas with high rainfall (>500 mm) and permeable soils, allowing leaching of nutrients into subsoils.

Soil pH should be continually monitored in sensitive areas, as decreased pH affects the establishment and growth of certain crops and pasture species. A soil-test result of pH 5.3 in water or 4.5 in calcium chloride (CaCl₂) solution is a warning that production may be affected. Therefore, it is important to prepare effective strategies to modify and adjust crop production processes to decrease the toxicity of soil contaminants, balance soil pH, improve root growth and nutrient uptake, and increase agricultural yields (Rendgel, 2003).

Soil degradation by acidification, resulting from acid deposition, microbial processes and root exudations, is a natural process. However, in the last 150 years, natural acidifying processes have been enhanced by man-made emissions, such as ammonium-based fertilizers and repeated cropping of legume crops. Whilst S compounds were the main anthropogenic component of acid rain some 25 years ago, N compounds now dominate (Goulding and Annis, 1998).

Long-term field investigations in Lithuania indicate that regular liming of acid soils is an extremely important measure for improving soil physico-chemical properties, increasing plant productivity and biodiversity (plants and soil micro- and macro-fauna) and decreasing the availability of harmful heavy metals (Jankauskas, 2005). Comparing data from 1985-1993 with 1995-2006, the area of conditionally acid soils (\leq pH 5.5) increased most intensively in previously strongly and moderately acid soils of Western Lithuania by 8.7%. In Plungė, Tauragė and Šilalė districts it increased even by 12.3-29.9% (Mažvila *et al.*, 2008). We evaluated the European Commission's proposal to adopt a European Union strategy to combat soil acidification very optimistically, presenting the soil acidification situation at the ESSC Conference 'Soil Conservation Issues in Nordic Countries,' 25-26 May 2005 in Tartu, Estonia. Unfortunately, from studying the EU Soil Directive of 18 September 2008, the present situation looks less optimistic. Soil acidification needs to be indicated among the most important Priority Areas and Action Programmes.

Tillage erosion as a predictor of water erosion

Soil erosion is a serious problem in many areas of Europe, affecting all countries to some extent (Van Linden, 1995). About 115 million hectares (12% of the total European land area) experience water erosion and 42 million ha (4% of the total European land area) from wind erosion (Oldeman *et al.*, 1991). Around 25 million ha are seriously threatened by erosion in Western and Central Europe (De Ploey *et al.*, 1991). The extent and severity of erosion on north European soils have markedly increased over the last 50 years, particularly on arable land (Fullen, 2003). During the last 50 years, erosion has increased about 30-fold in Russia and crop production on these soils has decreased by 50-60% (Andronikov, 2000). Annual erosion rates on cultivated land vary from 0.1-20 Mg ha⁻¹ in the U.K. to 150-200 Mg ha⁻¹ in China (Morgan, 2006). Highly eroded soils tend to have reduced productivity, degraded soil structure, lower organic matter contents and are poor environments for root growth (Lindstrom *et al.*, 1994).

The intensity of soil erosion in Lithuania mainly depends on tillage erosion, which has been identified as the main cause of accelerated soil erosion on arable slopes (Kiburys, 1989; Jankauskas, 1996). Eroded Haplic Albeluvisols on the undulating topography of the Žemaičiai Uplands of Western Lithuania were influenced by erosion severity and this was reflected in reduced soil fertility decreasing barley yields by 22-62% (Jankauskas and Fullen, 2002).

Research data on sandy loam Eutric Albeluvisols at the Kaltinenai Research Station of the Lithuanian Institute of Agriculture on the undulating hilly topography of the Žemaičiai Uplands showed high soil erosion rates on slopes of varying inclinations and land use systems (Jankauskas *et al.*, 2004), indicating dependence of water erosion rates on the intensity of tillage operations (Jankauskas and Jankauskienė, 2003). Therefore, there is a need to reflect this factor in the Thematic Strategy of Soil Protection in Europe and in the EU Soil Protection Directive. The results of soil erosion investigations in Lithuania may have wider applicability on the undulating landscapes of the temperate climatic zone (Jankauskas *et al.*, 2004).

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