MODELLING OF SOIL EROSION IN NEW ZEALAND AT NATIONAL SCALE.

Aleksey Sidorchuk, Landcare Research, Private Bag 11052, Palmerston North, sidorchuka@landcare.cri.nz

The information about existence and severity of different erosion processes, collected during the NZ Land Resource Inventory (Eyles, 1985), as well as expert estimates of their spatial extent, depth and periodicity (performed by M.Page, M.Jessen for the North Island and by L.Basher, I Lynn for the South Island), shows that about 21,200 km^2 of New Zealand (12.5% of the national territory) is affected by various erosion features. The four main erosion processes are sheet and rill erosion (affected area 8,130 km^2), wind erosion (2,130 km^2), shallow landslides (1,450 km^2) and debris avalanches (800 km^2). According these estimates the total annual volume of pure erosion (detachment of soil particles) can be more than 800-1200 million tons. Calculations made recently by M. Hicks with colleagues (2002) show that the sediment yield to the lakes and ocean in New Zealand is close to 210 million tons per year. This is about 1.5% of the global sediment yield to the oceans, and approximately 8 times the global average rate, given that New Zealand represents only 0.18% of the global landmass. The delivery of eroded matter to the ocean is about 20-25%, which is also much higher the global average. These figures show the great importance of erosion research in New Zealand at the national scale both for understanding the sources of this amount of sediments and for improving land management practice.

Quantitative information about erosion by water on the hillslopes is rather poor in New Zealand, as the national net of standard erosion plots or experimental catchments was never established. Models published in the international literature need to be adapted for New Zealand conditions and supplied with appropriate parameters for the whole country or its part. In the case of sheet and rill erosion the most relevant model is the so called Universal Soil Loss Equation (USLE) and its derivatives (like RUSLE), developed in the United States Department of Agriculture (Wischmeier & Smith, 1965, 1978; Renard et al., 1997): $A = R*K*C*LS*P$. The soil erosion rate A is represented as the product of five erosion factors: rainfall erosivity R, soil erodibility K, vegetation cover factor C, relief factor LS and management practice factor P.

USLE is an empirical model, and, as any empirical model, can be used only within the range of variables, used for the model elaboration. This range of variables for USLE is rather broad, as more than 1700 plot/years of measurements from 220 plots at 22 sites (Risse *et al*, 1993) were worked out only in USA, and the efforts of international community doubled at least this huge amount of information. These data were mainly collected for a cropland at the plains, but the forested areas, rangeland and grassland; hillslopes were also investigated in terms of USLE factors. The flexibility of USLE and its derivatives simplifies its adaptation for different landscapes.

Despite USLE empirical nature and very simple structure, the physical meaning of all erosion factors is clear. The expressions for those factors can be easily derived from general equations of water and soil dynamics (see for example, Moore&Burch, 1986). Large amount of empirical knowledge concentrated in USLE multiplied on general understanding of the erosion processes makes USLE more useful tool for erosion rate prediction, than most of more modern process-based models.

USLE is the only existing model, which can be used for the national scale calculations, and it is the only model, which parameters can be estimated on the basis of national databases. Each of USLE factors (for P=1) has been calculated for New Zealand. Rainfall erosivity (R) daily estimates were made using data from 352 meteorological stations with observation periods of more than 24 years (information from Climate Data Base). The calculated values for R were correlated with the precipitation depth. The Land Cover Data Base was used for the purposes of calculation of the C factor of the USLE. For each vegetation class the temporal changes of vegetation cover subfactors and proportion of bare land were estimated from the literature and field observations. The product of daily values of R and C factors gives the temporal/spatial variable of the USLE. The other two main factors were assumed to be temporally invariant. Soil erodibility is related to the soil texture, structure, permeability and organic matter content obtained from the NZ National Soil Database (by H. Wilde) and was calculated for NZ soil groups. The slope length/inclination factor (LS) calculation was based on the national raster DEM with 25*25 m pixel size. This factor was used only for hill slopes with lengths less than 300 m.

Calculations with the USLE show that the spatial distribution of the mean (for 25 years) rate of sheet and rill erosion is very similar to the distribution of the sediment yield from the rivers. The flexibility provided by the use of erosion factors gives an opportunity to compare different climate and vegetation cover scenarios with respect to soil erosion and organic carbon flux caused by sheet and rill erosion. The model is being used to predict the rates of erosion processes at the national scale as part of Landcare Research's Erosion-Carbon programme established to improve New Zealand's ability to address its obligations to decrease greenhouse gas emission in terms of the Kyoto Protocol.

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