*Recent Developments in the Explanation and Prediction of Erosion and Sediment Yield* (Proceedings of the Exeter Symposium, July 1982). IAHS Publ. no. 137.

# Results of recent research on erosion processes in Hungary

P. SALAMIN
*Szilágyi E. f. 13/15, H-1024 Budapest, Hungary*

ABSTRACT A new classification of forms and processes of erosion is presented, together with results of Hungarian research on precipitation characteristics, the effects of splash erosion and soil freezing, the behaviour of clays, and of agricultural and other investigations.

## EROSION IN HUNGARY

According to Szabolcs & Várallyay (1980), 15.6% of the land surface (93 000 $km^2$) of Hungary is eroded and a further 2.3% is represented by outcrops of bare rock providing a total of 17.9-18% of the country. Krisztián (1981) estimates the annual erosion losses at 40 million $m^3$, i.e. 1.75 $m^3 ha^{-1}$ of cropland, equivalent to 50 000 t of N, 50 000 t of P and 300 000 t of K, supplemented by 175 000-200 000 t of fertilizer.

Hungarian research work is based on biological, chemical and physical processes, especially the latter, and involves intensive observation and analysis of the observed data by up-to-date mathematical (mainly probabilistic), computerized methods.

### *Classification of erosion processes*

A comprehensive classification of erosion processes in Hungary has been developed by Salamin (1980, 1981) taking account of the effects of frost described by Pinczés (1979) and the variable behaviour of clays discussed by Szepessy (1981). The basis of the classification is as follows:

(1) *Static state:* $E_S$
- (a) biological weathering: $E_{SB}$
- (b) chemical weathering: $E_{SCh}$
  (dissolution hydration, dehydration, etc.)
- (c) physical weathering: $E_{SPh}$

(2) *Dynamic state:* $E_D$
Destructive (negative) processes: $E_{-D}$
- (a) Processes localized at a point: $E_p$
  (rockfalls, slides, flows, subsidence, creep)
- (b) Areal latent processes: $E_{al}$
  Raindrop impact or splash erosion: $E_{als}$
  Erosion by wash and dissolution of the soil: $E_{ald}$
  Erosion due to silting (puddle erosion): $E_{alp}$
  Erosion within the soil: $E_{ali}$
  (e.g. tunnel erosion, pot hole erosion, piping, subcrustaneous erosion and soil liquefaction)
  Attrition erosion: $E_{ala}$
  Groundfrost erosion: $E_{alf}$

The effects of ice needle: $E_{SPh}$

(c) Areal open processes: $E_{ao}$
Surface sheet erosion: $E_{ao1}$
Solifluction-gelisolifluction: $E_{ao2}$
Erosion by dissolution: $E_{ao3}$

(d) Linear erosion: $E_L$
Microrill erosion: $E_{L1}$
Rill erosion (erosion in rills or shallow trough-like depressions): $E_{L2}$
Ditch erosion: $E_{L3}$
Gully erosion gullies, gorges, ravines, canyons etc.: $E_{L4}$
Erosional valleys: $E_{L5}$
Linear ground frost erosion: $E_{L6}$

(e) Depositional (positive) processes associated with erosion: $E_{+D}$
Areal depositional processes: $E_{+a}$
Linear depositional processes: $E_{+L}$
Microforms of the river bed: $E_{+L1}$
(smooth, wavy, rippled bed, surfaces with flat and oblique dunes and antidunes, etc.)
Mesoforms of the river bed: $E_{+L2}$
(sand shoals, high beds, bottom banks, point bars, fords, etc., deltas, alluvial cone accumulations or gravel terraces, erosion-accumulation terraces, etc.)

(f) Particular erosion processes: $E_P$
Shore erosion ($E_p$ and $E_L$): $E_{PB}$
Vertical (well-like) erosion: $E_{PV}$
(karst- and loess-wells)
Complex-erosion and deflation: $E_{PED}$
Particular erosion processes in lowlands: $E_{PP}$
($E_p$, $E_{als}$, $E_{ald}$, $E_{alp}$, $E_{alf}$, $E_{ao}$, $E_{PB}$, $E_{PED}$
Particular erosion processes in hilly and mountainous districts: $E_{PHM}$
Human effects: $E_{PA}$
(accelerated erosion)
Deforestation: $E_{PA1}$
Inadequate land cultivation: $E_{PA2}$
Overgrazing: $E_{PA3}$
Mining activity: $E_{PA4}$
(e.g. mainly open-cast mining)

(3) *Great complex surface destruction:* $\Sigma E$

*Mapping*

Mapping is an important requirement for erosion control and two interesting developments in Hungarian practice based on the work of Salamin (1980) may be described. One involves the transformation of the geodetic map to a so-called map of profile gradients. On this map developed by the author and his co-worker, J.Winter, the gradient characteristic of erosion was indicated by analogy with the relief map, by connecting the points of equal gradients with contour lines. The resultant contour map is extremely useful for evaluating erosional processes. This new way of mapping may be recommended in all cases where widespread soil conservation problems exist.

The second involves the development of a dual approach to mapping the extent of soil erosion. The degree of degradation in relation to the original situation (cf. Kerényi & Pinczés, 1979) has been represented in the traditional way, and the actual thickness of the soil (horizons A-C) has also been depicted. The former gives information on the extent of destruction while the latter affords valuable information for water management.

## RESEARCH RESULTS

### *Precipitation characteristics*

Information on high-intensity, short-duration storms is limited by the relatively short data sequences. Developments in analysis include the introduction of the concept of fictitious summer months and fictitious regional stations as suggested by Péczely *et al.* (1968-1972) and Salamin (1981). Based on the factual similarity of stochastic parameters throughout Hungary during the summer months, and using the approach outlined above to increase the number of sample elements, reliable probability characteristics have now been determined. Analysis of the relationship of precipitation quantity, timing and state to the incidence of erosion has also been undertaken (Salamin, 1981).

Salamin (1980, 1981) has directed attention to the intensity/duration characteristics of rainstorms and the limitations of values of average intensity. For instance, 65% of the 38.3 mm of rain which fell on 10 June 1963 on the Great Hungarian Plain fell in 10 min, with an intensity approaching 150 mm $h^{-1}$.

Another important factor associated with precipitation effects is the impact of raindrops on the soil. Kerényi (1981) examined the effect of raindrops by means of a rainfall simulator and clarified the complex mechanisms involved in raindrops splashing on the soil. A relationship between the weight of material removed, the drop energy and the slope (up to 20°) was found to be significant. The method employed for analysing the erosion rate, the drop energy, and the mass transfer whereby displaced grains are separated into particles moving downslope and upslope was particularly ingenious. Perhaps the most interesting part of this study was the definition of the so-called threshold energy, $E_0$ (J $m^{-2}h^{-1}$), where grains are just displaced along a trajectory. Threshold energy is determined as a function of slope and soil moisture. These studies provide valuable information for the control of the harmful impact of splash erosion.

Csekő & Szalai (1980) in their laboratory and field experiments introduce the comprehensive description of rainfall erosivity in connection with sprinkling irrigation in terms of intensity I (mm $h^{-1}$) and total drop energy per unit volume $\Sigma E/\Sigma E$ (J $m^{-2}mm^{-1}$). Application of the results to natural rainfall is now proceeding.

### *Soil properties*

From among the multiplicity of results on dispersivity tests of cohesive soils, the following results presented by Szepessy (1981) can be highlighted.

(a) Proneness to erosion and the degree of swelling of clay soils are likely to be causally related.

(b) Two phenomena, tunnel erosion and soil liquefaction, can be ascribed to the common cause of dispersivity and the same soil will erode or liquify depending on the forces acting on it.

(c) Clay soils can show contradictory erosion behaviour, more particularly dispersive soils are susceptible to erosion and liquefaction while flocculated (fluffy textured) soils are erosion resistant.

All these factors have been taken into account in establishing the classification of erosion processes (see $E_{ali}$).

The effect of ground frost on soil erosion has been investigated in detail by Pinczés (1979). His results have been incorporated into the classification system with $E_{alf}$ and $E_{L6}$.

*The effects of agricultural activity*

Pinczés (1980) has investigated the increase in so-called accelerated erosion ($E_{PA}$) produced by human interference, particularly agricultural production, and its relation to the relief, soil, vegetation and various management systems in several localities on loams in the Bodrogkeresztur region, and on loess in the Tokay region. His results clearly show the effect of the various agricultural management systems.

Field tests by Krisztián (1981) have clearly demonstrated that the protective action of vegetation depends on the degree of erosion, although this conclusion is primarily valid for areal latent processes $E_{al}$, and to a lesser degree, for surface sheet erosion $E_{aol}$.

*Other work*

Finally, research trends that are important but not of direct relevance to the introductory classification system can be considered. Environmental erosion problems have been investigated from the pedological viewpoint by Stefanovits (1977) and more universally by Salamin (1978, 1981). Both field and laboratory techniques have increased in sophistication and the field techniques described by Kerényi & Pinczés (1979) and by Pinczés (1980) are worthy of mention. Salamin & Winter (1980) have overcome the hydraulic engineering problems of fullscale model testing of splash erosion $E_{als}$ and of surface sheet erosion $E_{aol}$ by lengthening the test plot to 100 m. Another interesting feature is the development of practical conservational solutions for the protection of agricultural development.

Lastly, reference must be made to the need for up-to-date education, within the field of erosion, as emphasized by Salamin at the 1979 UNESCO Conference.

## REFERENCES

Csekő, G. & Szalai, G. (1980) Az eső minőség és a vizadagolás összefüggései (Relationships between rain grade and water dosage). *Hidrol. Közl.*, 253-259.

Kerényi, A. (1981) Mesterséges eső utóhatásának kvantitativ vizsgálata szerkezetnélküli talajon (Quantitative analysis of the splash effect of artificial rain on textureless soils). *Agrokémia és Talajtan* (in press).

Kerényi, A. & Pinczés, Z. (1979) Methods for, and results on the examination of the effect of baserock and slope angle erosion. In: *Colloque sur l'Erosion Agricole des Sols en Milieu Tempéré non Méditerranéen* (Strasbourg), 81-87.

Kristian, J. (1981) Összefoglalás a legujabb erózióviszgálati kutatásokról (Recapitulation of recent research on erosion). Kompolt Publication.

Péczely, G., Salamin, P. & Winter, J. (1968-72) Nagy intenzitásu, rövid idötartamu záporok vizsgálata (Investigation of high-intensity, short-duration rainfall). *Tech. Univ., Budapest, Publication.*

Pinczés, Z. (1979) The effect of ground frost on soil erosion. In: *Colloque sur l'Erosion Agricole des Sols en Milieu Tempéré non Méditerranéen* (Strasbourg), 107-112.

Pinczés, Z. (1980) The effect of crop production and training systems on soil erosion. *Geogr. Rev.* (Budapest), 375-379.

Salamin, P. (1978) A vizgazdálkodás, valamint a domb- és hegyvidéki településfejlesztés környezetvédelmi szempontjai (Environmental aspects of water management and of hillside and highland development). In: *Proceedings of a Meeting of the Hydrological Society of Hungary*, Szekszárd.

Salamin, P. (1980a) *La Lutte Contre l'Erosion.* EPFL, Lausanne.

Salamin, P. (1980b) The role of water in the formation of the relief of Hungarian lowlands, hilly and mountainous regions. *Geogr. Rev.* (Budapest), 321-330.

Salamin, P. (1981a) *Rôle des paramètres de la précipitation dans l'aménagement de l'assainissement des eaux.* SHF, Paris.

Salamin, P. (1981b) Erózió elleni küzdelem és környezetvédelem (Struggle against erosion and environment protection). *Tech. Univ., Budapest, Publication.*

Salamin, P. (1981c) Struggle against erosion. In: *International Workshop on Hydrological Education* (ed. by J.Pace). ČSVH-UNESCO, Bratislava.

Salamin, P. & Winter, J. (1980) Hydraulic laboratory test methods for determining the erosion of agricultural soils. *Periodica Polytechnica, Civ. Eng.* 24(3-4).

Stefanovits, P. (1977) *Talajvédelem és Környezetvédelem* (Soil and Environment Protection). Agricultural Ed. Budapest.

Szabolcs, J. & Várallyay, G. (1980) Limiting factors of soil fertility in Hungary. *Geogr. Rev.* (Budapest), 352-356.

Szepessy, J. (1981) Vizépitési földmüvek talajainak diszperzitásvizsgálata (Dispersivity tests on soils in hydraulic earthworks). *Viz. Közl.*, 219-238.