<u>Mikoviny Sámuel</u>

<u>Doctoral School of Earth Sciences</u>

Leader of doctoral school:
Dr.h.c.mult.Dr.Ferenc Kovács
university professor
ordinary member of the Hungarian Academy of Sciences

Determination of Precipitation and Runoff Parameters for the Mátraalja Open Cut Area

Summary of doctoral dissertation

for PhD degree

Marianna Vadászi

certified hydrogeologist engineer
certified gas engineer
grant holder PhD student

Research institute: Department of Mining and Geotechnology
Faculty of Geotechnical Engineering
University of Miskolc

Supervisor: Dr Zoltán Buócz
associate professor
PhD in technical sciences

Miskolc, 2003

1. Preliminaries and objectives of research

In fulfilling the demands for electrical energy, coal and coal based power plants play a considerable role even nowadays, besides hydrocarbons (oil and gas) and nuclear energy. In the countries of Central Europe (Germany, Poland, the Czech Republic, Hungary) brown coals (lignites) used for energy production purposes are basically produced in open cuts. In Hungary there are open cuts of considerable importance in the Mátra and Bükkalja area (Visonta, Bükkábrány).

The production of lignite in open cuts involves a considerable transformation of the natural environment. Preliminary dewatering before the start of production causes a lack of water in large areas while hanging layer consolidation results in surface movements. The stripping of hanging layers, the exploration and exploitation of coal beds make radical changes in the landscape and the restoration of the original terrain, recultivation occurs only after a longer period. Thus open cut production temporarily changes the original order of some parts of the landscape so environment should be restored later.

The dissertation deals with some questions related to the flood control of open cuts, in the first place with the determination of precipitation, evapotranspiration, surface runoff etc. values and the calculation of quantitative, intensity and reliability parameters related to the protection against flood of open cuts. These parameters gain decisive importance in the protection of open cuts against floods as preliminary dewatering and the protection against floods of open cut pits and the technological system depend on the amount of precipitation, the amount of water derived from rain coming with an unexpectedly high intensity and from the melting of snow.

Inadequate flood protection, e.g. a collecting ditch system of inadequate capacity may result in the flooding of the open cut, which may cause environmental pollution as well as technical and economic damage.

The northern part of the Carpathian Basin, especially the Mátra-Bükkalja region is an area with a positive water balance, which means that surface runoff is a positive factor, especially in the autumn-winter period and during a summer rain of high intensity, when in a short period the rate of evapotranspiration and seepage is relatively low in comparison with precipitation. Thus in a given case significant runoff should be taken into account, which may cause floods and an environmental catastrophe in the absence of proper water treatment/ water drainage.

On the basis of what has been mentioned above, the objective of the research is to analyse the precipitation and water balance conditions of the Mátra-Bükkalja region and primarily to determine surface runoff parameters, in the knowledge of which flood control can be planned.

2. Research methods, investigations completed

During the research I consulted the relevant literature extensively and studied literature related to a narrower field, as well. In the dissertation I always indicated the sources of any adopted data.

Precipitation, water discharge and runoff data were taken from Vízrajzi Évkönyvek and Atlaszok ('Hydrographic Annals and Atlases')[5, 81]. Supplementary data were supplied by the National Institute of Meteorology. The research was done at the Department of Mining and Geotechnology, where I took part in the elaboration of research reports [6, 77].

In general, precipitation, evapotranspiration and runoff data were processed and analysed with conventional statistical methods [80].

In the collection and processing of data, the analysis of minimum, maximum and average data was done separately. Expected values were determined for different probability levels (50, 90, 95 and 99%) by the determination of distributional and density functions.

3. Research results

1. On the basis of the statistical analysis of precipitation data between 1973 and 2000 in the Mátra-Bükkalja region, it was concluded that **average** precipitation values are 560 mm/year, 60-70 mm/month and 55-60 mm/day. Annual and monthly precipitation values show a normal distribution, on the average there is precipitation every 3-3.5 days.

   Expected maximum values belonging to the different probability levels are:

Precipitation	**Level of probability**		
	99%	90%	50%
Annual [mm/year]	1,000 – 1,250	900 – 1,000	700 – 800
Monthly [mm/month]	350 - 400	150 - 170	60 – 70
Daily [mm/day]	110 - 130	80 - 90	55 – 60

2. On the basis of the analysis of the **cyclic type** changes of annual precipitation values, it was concluded that in the area investigated precipitation cycles of 3.4 – 3.6 years, 4.9 – 5.8 years and 11 – 13 years can be detected. Probably there also exists a cycle of more than 18 years, which the investigations indicate to be 25 years long.

3. The analysis of the changes within a year of **solar radiation energy** yielded the result that there is an annual 'deficit' of radiation energy of 9-17% in comparison with the tendency of change in spring and early summer while it is 23-30% in relation to the autumn months.
   According to the evaluation method identical with the one mentioned above, the average annual 'deficit' of **evaporation** is 15-21%, with the 'deficit' of the months September-December amounting to 47-49%.
   The deficit of **potential evapotranspiration** is 9-18% and 15-30%, respectively.
   The average annual deficit of **actual evapotranspiration** is 26-29%, the value for the months concerned is 33-39%.
   Summer water shortage results in an average annual **evapotranspiration shortage** of 16-20%, which is 25-30% in the late summer and early autumn months.

4. The statistical analysis of surface runoff data gave the result that there is **no more surface runoff** with an annual average precipitation value of 200 – 300 mm/year and a maximum precipitation value of 300 – 400 mm/year in the Tarna-Verpelét catchment area, so there is a negative water balance. **In the area the average runoff factor is 14-16%,** the

average value of **maximum runoff is 35-37%.** There was no general correlation between precipitation and surface runoff (water discharge) variables which could serve as the basis of runoff forecasts.

5. The distribution of **surface runoff** data follows a **lognormal** pattern. Maximum water discharges (40-50 m^3/s) occurring with a frequency of 100 years exceed 25-50 times the average water discharge (1-2 m^3/s) of the summer months.

6. The maximum average and the maximum specific runoff values ($m^3/s/mm$) **belonging to a unit of precipitation amount** (mm) occur in the months January-April. The January – April values of maximum specific runoff occurring with a frequency of 20-100 years exceed the average runoff values of the summer months 20-25 times.

7. The largest values of maximum specific runoff ($m^3/s/mm* km^2$) **belonging to an area unit** (km^2) occur in the months January – April. The largest values of maximum specific runoff exceed the minimum values of average runoff 25-30 times.

8. The highest frequency of the **absolute maximum values of the runoff factor** occur in February, or January and March.
   According to the distribution functions (at different probability levels) the **average** and **maximum runoff parameter values** occur in the months **January-April** and **December**. In the summer months (June-

September) there may be a local runoff parameter of 0.50 – 0.85 with intensive precipitation of several hours and days.

According to the data in the relevant literature in summer periods there may be values of 0.25 – 0.90.

9. The planning of flood control (collecting ditches, barrage systems of streams and rivers) can be based on **precipitation** and **runoff parameter** values belonging to probability levels 95-99%.

4. Publications in the topic of the dissertation

1. Vadászi,M., Some Problems of the Application of C.W. Thornthwaite's Evapotranspiration Calculation Method. Lucralile Stiintifice ale Simpozionului International 'UNIVERSITARIA ROPET 2000.' Ecologie si Ingineria Mediului. Petrosani: Universitas, 2000. pp. 17-20. ISBN 973-8035-64-3.

2. Vadászi, M., Észrevételek a C.W.Thornthwaite párolgás-számítási módszer hazai alkalmazhatóságára. ('Remarks on the Applicability of C.W. Thornthwaite's Evapotranspiration Calculation Method in Hungarian Conditions.') Hidrológiai Közlöny Vol.81 (2001). No.3. (May-June) pp. 160-162.

3. Vadászi, M., Az 1973-1997. évek csapadék jellemzői a Mátra-Bükkaljai területen. ('Precipitation in the Mátra-Bükkalja region in the years 1973-1997') Hidrológiai Közlöny Vol. 81 (2001). No.3. (May-June). pp. 163-168.

4. Vadászi, M., A fajlagos vízhozam alakulása a Tarna-Verpelét vízgyűjtő területen. ('Variations in specific water discharge in the Tarna-Verpelét catchment area.') Hidrológiai Közlöny Vol. 81 (2001). No.3. (May-June). pp. 193-196.

5. **Vadászi, M.,** Az egységnyi területre eső fajlagos lefolyás értékek a Mátra-Bükkaljai területen. ('Specific runoff values per area unit in the Mátra-Bükkalja region.') A Miskolci Egyetem Közleménye, Környezetvédelem eljárástechnika A sorozat, Bányászat, Vol. 55. (2001) pp. 165-173. HU ISSN 0237-6016

6. **Vadászi, M.,** Comparison and Evaluation of Evapotranspiration Calculation Methods. MicroCAD 2001 International Scientific Conference 1-2 March, 2001. Section B Geoinformatics, Environment Protection pp.135-139. ISBN 963-661-457-1; 963-661-459-8

7. **Vadászi, M.,** Variation in Time of Potential and Actual Evapotranspiration Values. Lucralile Stiintifice ale Simpozionului International 'UNIVERSITARIA ROPET 2001.' 18-20 octombrie 2001. Petrosani, Ecologie si Protectia Mediului (8) Editura Focus. pp. 187-191. ISBN 973-85487-1-3.

8. **Vadászi, M.,** A fajlagos vízhozam alakulása a Mátra-Bükkaljai területen. ('Variation in specific water discharge in the Mátra-Bükkalja region.') Bányászati Kohászati Lapok, Bányászat, Vol. 134. (2001) No. 7. (November-December). pp.521-527.

9. **Vadászi, M.,** A csapadék, a felszíni lefolyás és a lefolyási tényező maximális értékei az egyes hónapokban. ('Maximum values of precipitation, surface runoff and runoff parameters in the different months.') MicroCAD 2002 International Scientific Conference 7-8 March, 2002. Section A. Geoinformatics, Spatial Informatics (Conference publication) pp.131-135. ISBN 963-661-515-2

10. **Vadászi, M.,** Az evaporáció és a transzspiráció értékének változása az év folyamán. ('Variations in evaporation and transpiration values during the year.') Hidrológiai Közlöny Vol. 82 (2002). No.3. (May-June). pp. 155-158.

11. **Vadászi, M.,** A potenciális és a tényleges párolgás értékek alakulása az év egyes hónapjaiban. ('Variations in potential and actual evapotranspiration values in the particular months of the year.) Hidrológiai Közlöny Vol. 82 (2002). No.3. (May-June). pp. 159-164.

12. **Vadászi, M.,** A napsugárzási energia éven belüli változása és kapcsolata a havi középhőmérséklettel. ('Variations within a year of solar radiation energy and its relationship with monthly mean temperatures.') Hidrológiai Közlöny Vol. 82 (2002). No.3. (May-June). pp. 165-170.