HUNGARIAN CONTRIBUTION TO THE RESEARCH ON POSITIONING AND APPLICATIONS - IAG COMMISSION 4

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According to the research objectives of the international IAG WG 4.2.4: Monitoring of Landslides & System Analysis (chair of the working group: Gyula Mentes) the Geodetic and Geophysical Institute was working:

- on development of dynamic monitoring and data evaluation systems for landslide prone areas,
- on study of the interactions between landslides and geophysical, geological, geomorphological, hydrological, geomechanical, meteorological, etc. processes,
- on study of the relationships between landslide movements and vital processes of vegetation.

For the investigations three test sites were used in Hungary (high banks of river Danube at Dunaföldvár and Dunaszekcső and a wooded slope in the Hidegvízvölgy-valley in the vicinity of the town Sopron). On the high bank in Dunaszekcső a geodetic network was established for GPS, electronic distance measurements and precise levelling. The intermittent geodetic measurements were repeated in time intervals according to the rate of the movements (Bányai et al. 2013a, b, Mentes et al. 2012). On both high banks continuous tilt measurements were also carried out by highly sensitive borehole tiltmeters (Mentes and Bányai 2014). In Dunaföldvár, in addition to the continuous tilt measurements the vertical movements of the high bank were measured by a borehole extensometer developed in the Geodetic and Geophysical Institute (Mentes 2011a, 2012). At both test sites the precipitation, the ground water level and the water stage of the River Danube were also recorded. This complete measurement system is very suitable for the investigation of the kinematic behaviour of landslides and together with other (e.g. hydrological, meteorological, etc.) parameters for the study of dynamics of landslides. On these test sites the influence of geological, geomorphological, hydrological, meteorological, etc. factors and their role in triggering landslides were investigated.

New method was developed for the integrated evaluation of different geodetic measurements (Bányai 2011) and a new dynamic model was developed for a better understanding of the recurring landslides in Dunaszekcső (Újvári et al. 2011, Mentes et al. 2012, Bányai et al. 2013b, Bányai et al. 2014a).

In this period new measurement methods applying accelerometers (Mentes, 2011b) and their mathematical background for detecting very small displacements were developed for early detection of landslides. An instrument for calibration of accelerometers was also developed (Mentes, 2011b). According to the results of the research, the acceleration measurements can be used for stability assessment of landslide prone areas. The InSAR technology was intensively studied and scattering surfaces (passive reflectors) were developed for increasing the accuracy of this technology for landslide and tectonic observation (Bányai et al. 2014b).

The results of the investigation of the relationships between high bank tilts and vital processes of the vegetation demonstrate that the daily tilt amplitudes show a clear seasonal characteristic which coincide with the active (from April till October) and passive (from November till March) periods of the vegetation. Figure 7 shows the relationships between PET, and the monthly averages of the precipitation and tilt amplitudes at the two test sites. Figure 1 demonstrates very clearly that during higher potential evapotranspiration (PET) the tilt amplitudes are also high. It can also be observed that in dry periods, when the amount of the precipitation is small, the tilt amplitudes are higher than in the rainy seasons. The effect of precipitation on the seasonal variations of the tilt amplitudes is of minor importance which means that the vegetation has much more important role in the water balance of the upper layer of the soil than the precipitation (Mentes and Bódis 2011, 2012, Bódis and Mentes 2012).

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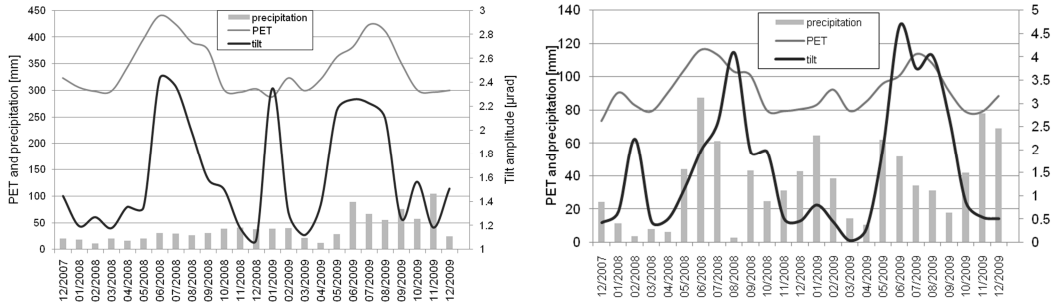
On the test site in the Hidegvíz-valley (Figure 2) beside the ground tilt (EW and NS directions) the following meteorological and hydrological parameters were measured:

- direction and velocity of the wind: at heights of 30, 23, 19, 14 and 2 m;
- air temperature and humidity: at heights of 30, 23, 19, 14 and 2 m;
- total solar radiation: at heights of 30, 23 and 2 m;
- precipitation: at a height of 20 m;
- soil temperature: at heights of 0.05, 0 m and at depths of: 0.05, 0.1, 0.2, 0.5, 1 m;
- soil moisture content: at depths of 0.1, 0.2, 0.3, 0.4, 0.6, 1 m.

Quantitative relationships were determined between the measured tilt values and the above mentioned parameters (Mentes et al. 2014). It was pointed out that under unfavourable conditions, the common effect of the investigated parameters can trigger slope slides. The complex study of these effects can contribute to the identification of different ground processes and can provide useful information for development of early warning systems and mitigation of landslide hazards.



a) b)

Figure 1. Relationships between PET (potential evapotranspiration), monthly averages of the precipitation and tilt amplitudes on the Dunaföldvár (a) and Dunaszekcső (b) test site

a) b)

Figure 2. The Hidegvíz-valley test site. a) Instruments for hydrologic measurements, b) tower for the measurement meteorological parameters

References

Bányai L (2011): 3D integrated adjustment of geodetic measurements (in Hungarian with English abstract). Geomatikai Közlemények, 14, 45-54.

Bányai L, Mentes Gy, Újvári G (2013a): Geodetic Observation of High Bank Failures at Dunaszekcső (in Hungarian). Geodézia és Kartográfia, 65(11-12), 7-11.

Bányai L, Mentes Gy, Újvári G, Gribovszki K, Papp G (2013b): The motion tendency and model of the landslide in Dunaszekcső deduced from coordinate time series (in Hungarian with English abstract). Geomatikai Közlemények, 16, 73-82.

Bányai L, Mentes Gy, Újvári G, Kovács M, Czap Z, Gribovszki K, Papp G (2014a): Recurrent landsliding of a high bank at Dunaszekcső, Hungary: Geodetic deformation monitoring and finite element modelling. Geomorphology, 210, 1-13.

Bányai L, Szűcs E, Kalmár J, Eperné Pápai I, Bán D (2014b): The basics of InSAR technology and the characteristics of scattering surfaces (in Hungarian with English abstract). Geomatikai Közlemények, 17, 59-67.

Bányai L, Újvári G, Mentes Gy (2012): Kinematics and dynamics of a river bank failure determined by integrated geodetic observations. Case study of Dunaszekcső landslide, Hungary. In: Pandian MS (Ed.): Proceedings of the Annual International Conference on Geological and Earth Sciences (GEOS 2012), Singapore, 3-4 December 2012. Organized and Published by Global Science and Technology Forum (GSTF).

Bódis VB, Mentes Gy (2012): The role of vegetation in the daily and yearly small tilt variations of the Danube's high bank, Hungary. Zeitschrift für Geomorphologie, 56(2), 133-141, DOI: 10.1127/0372-8854/2012/S-00095

Mentes Gy (2011a): Borehole Wire Extensometer for Measurement of Small Displacements. In: Kopáčik A, Kyrinovič P, Roič M (Eds): INGEO 2011 Proceedings of the 5th International Conference on Engineering Surveying 2011, 307-314.

Mentes Gy (2011b): Apparatus for producing small displacements with different time functions and for calibration of accelerometers (in Hungarian with English abstract). Geomatikai Közlemények, 14(1), 97-104.

Mentes Gy (2012): A new borehole wire extensometer with high accuracy and stability for observation of local geodynamic processes. Rev. Sci. Instrum. 83, 015109, DOI: 10.1063/1.3676652

Mentes Gy, Bányai L (2014): Observation of Landslide Movements by Geodetic and Borehole Tilt Measurements. In: Kopáčik A, Kyrinovič P, Štroner M (Eds.): Proceedings of the 6th International Conference on Engineering Surveying INGEO 2014, Czech Technical University Prague, Faculty of Civil Engineering, 2014. Prague, Czech Republic, 3-4 April 2014. TS2-4 Networks and GNSS application. 53-58.

Mentes Gy, Bányai L, Újvári G, Papp G, Gribovszki K, Bódis VB (2012): Recurring mass movements on the Danube's bank at Dunaszekcső (Hungary) observed by geodetic methods. Journal of Applied Geodesy, 6(3-4), 203-208, DOI 10.1515/jag-2012-0011

Mentes Gy, Bódis VB (2011): Relationships between short periodic slope tilt variations and vital processes of the vegetation. Proceedings on the Joint International Symposium on Deformation Monitoring. Hong Kong, China, 2-4 November 2011. Session 3I: Natural Effects (Groundwater, Erosion, etc). 3I-02. 158.

Mentes Gy, Bódis VB (2012): Relationships between short periodic slope tilt variations and vital processes of the vegetation. Journal of Applied Geodesy, 6(2), 83-88, DOI: 10.1515/jag-2012-0009

Mentes Gy, Bódis VB, Vig P (2014): Small slope tilts caused by meteorological effects and vital processes of trees on a wooded slope in Hidegvíz Valley, Hungary. Geomorphology, 206, 239–249. http://dx.doi.org/10.1016/j.geomorph.2013.09.027

Újvári G, Bányai L, Mentes Gy, Papp G, Gribovszki K, Bódis VB, Bokor Zs (2011): Post-event movements on the high bank at Dunaszekcső (in Hungarian with English abstract). Geomatikai Közlemények, 14(1), 105-110.