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A hydrometric and hydrological approach test at microscale

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Abstract

The objectives of this article were: to test the hydrometric accuracy of some water level variation measuring and recording devices using a metal measuring tank with weir, and to automatically determine runoff intensities and elements. These field tests were performed in order to ensure high accuracy and low uncertainty of studies at hydrological micro-scale (plot scale). Hydrometric tests targeted two level measurement conditions: (i) rise and storage - without overflowing, volumetric measurement V= f (H); and (ii) rise and overflowing, weir measurement Q = f (H). Hydrometric accuracy was evaluated by comparing the measured and recorded level using three instruments with a tell-tale level. This field experiment was conducted in Voineşti Experimental Basin, belonging to the National Institute of Hydrology and Water Management. Levels series data were processed with the software application ParExp v1, in order to automatically convert them into discharges (Q). Hydrometric and hydrological test results highlighted certain aspects. The accuracy estimated for water fluctuation measurement and recording instruments in a weir water tank, for both level measurement conditions revealed accuracy errors (insufficient accuracy) when the runoff hydraulics was changed (storage Q_{acum} ÷ overflowing Q_{dev}). To remedy such instrumental deficiencies, a metrological control shall be performed under specific operational conditions (e.g., water tank) in order to meet increasing needs for high quality hydrological data. The hydrological data processing using the ParExp v1 software application, at the junction of specific "*rise and storage*" and "*rise and overflowing*" flows indicated a temporal error (delay). The user may remedy this error by eliminating data from the Q_{acum}-Q_{dev} junction range until reaching the maximum/stabilized level.
Finally, we estimate that through the improvement of some technical elements, hydrological data obtained at a micro-scale level can be used for hydrological models of calibration.

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Keywords: hydrometrc test; accuracy; water tank; measurment; level; discharge; experimental plot;

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1. Introduction.

Studies at hydrological micro-scale of 1sq cm → 1 sq km [1, 2, 3, 4], allow us to understand the mechanism through which runoff hydrological elements (e.g. runoff from sloping; floods) are generated and travel time by simulating natural (e.g. artificial rainfall) or anthropogenic (e.g. chemical soil fertilization) processes within a short time interval.

The hygrometry of runoff plots (e.g. instruments for measuring and recording water level variations) is informatively indicated in Toebes & Ouryvaev [2], Technical regulations, Volume III [5] and Guide to Hydrological Practices, Volume I [6]. In Romania, the National Institute of Hydrology and Water Management (NIHWM) developed a guide intended for the experimental activities assembly, containing also aspects regarding the hydrometric activity on experimental plots [7]. Also, NIHWM has been performing complex hydrometric and hydrological activities on experimental plots at Experimental Hydrology Voineşti [8, 9], even since 1964.

Water and suspend load discharges on experimental plots can be measured/determinate by applying several methods (i) full volume V=f(H); partial volume (by division); (iii) with overflowing, using the ratio Q=f(H); (iv) by combining the three methods. Runoff intensity is measured using hydrometric instruments (e.g. submersible pressure sensors/transducers, ultrasonic and radar water level) installed in water tanks or plastic bucket calibrate.

The experimental runoff plots of different sizes used in various studies helped us understand geomorphological, pedological (water erosion), hydrological, chemical and ecological processes [10, 11, 12, 13, 14, 15, 16, 17, 18, 19]. In all mentioned cases, in order to determine the runoff (water level), the volumetric method was applied (runoff collecting bucket), without considering the runoff rates/intensities.

Our field experiments indicated certain inconsistencies between the levels measured using different instruments and the monitored (observed) levels. By doing so, our main objectives were: (1) to test the accuracy – measured and recorded values – of hydrometric instruments installed in a metal measuring tank with weir, and (2) to automatically detect runoff intensities and elements on experimental plots.

2. Data collection and analysis.

This study was conducted in Voineşti Experimental Basin (VES). For field hydrometric tests, it was used the equipment of a balance plot of the water infiltrated into the soil: collector ditch; calibrate water tank (V = 0.38 cubic meter; H = 160 mm; α = 45º) (Fig. 1b); 3 water level fluctuation measuring and recording instruments; a 10 L bucket; a timer. Hydrometric instruments used for testing (Tab. 1) are included in the category of devices that come in contact with water. The water necessary for performing the tests was transported using a 900 L tank truck fitted with pump (Fig. 1a).

Table 1. Data on the instruments used to measure the water level variation

Technical data	Hydrometric device		
	OTT SE-200*	Limnigraph VALDAI	U20L-04*
Measure scale	±30 m	±10 m	0-4 m
Measuring type	float-cable counterweight system		ceramic pressure cell
Resolution	0,001 m	0,001 m	0,14 cm
Accuracy	± 0,003%	N/A	± 0,2% (0,8 cm)

* - According to the manufacturer's data sheet. N/A= Not available

Test methodology

For testing, water discharges (Q_{afl} - l/s) were measured by pumping a water flux at a constant intensity from the tank truck into a bucket (Fig. 1a), and while filling up the bucket, the volume (I) was related to time (s). In order to