05/06/2011

Publication List Related to Hydrological Instruments

Publications and abstracts are listed in reverse chronological order. A limited number of reprints are available, and can be requested by referring to the NAEW number. Use your browser's "find" feature to search for words of interest. For more information, please contact:

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Logsdon, S.D., Green, T.R., Bonta, J.V., Seyfried, M.S., Evett, S.R. 2010. Comparison of electrical and thermal conductivities for soils from five states. Soil Science. 175(6):573-578. **(NAEW #468)**

Abstract:

Arrangement of soil particles, particle size, mineralogy, solute concentration, and bulk density affect electrical (EC) and thermal (TC) conductivities. The purpose of this study was to compare how EC and TC change as a function of water content, for soils under different vegetation and with different properties. Soil samples were collected from Texas, Ohio, Idaho, Colorado, and Iowa and packed into cylinders at a density of 1.2 Mg m-3, and wetted to predetermined water contents (WC) between 0.10 and 0.45 m3 m-3. A thermal time domain reflectometer (thermal-TDR) was used to determine EC and TC at each WC, at room temperature. Soils from Texas and Iowa had larger amounts of high surface-area clays that sorbed water. Colorado and Texas soils had some soluble salts. Colorado and Ohio soils had lower amounts of clay. Soil and vegetation-influenced differences within a state were only occasionally statistically significant; however, differences over long range (between states) were highly significant for both EC and TC. The TC decreased as the amount of sorbed water (related to soil specific surface area) increased. The TC increased more rapidly at low water contents than did EC, but EC increased more rapidly at high water contents. Heat would be conducted through both solid and liquid phases, but electrical charge only through the liquid phase. The tortuosity of solid plus liquid phases is rapidly reduced with even a small addition of soil water, whereas larger amounts of water are needed to reduce tortuosity for the liquid phase alone.

Logsdon, S.D., Green, T.R., Seyfried, M.S., Evett, S.R., Bonta, J.V. 2010. Hydra Probe and Twelve-wire Probe Comparisons in Fluids and Soil Cores. Soil Science Society of America Journal. 74:5-12. **(NAEW #466)**

Abstract:

Soil water content is determined from various permittivity probes. The Hydra Probe measures both the real and imaginary permittivity and estimates electrical conductivity (EC). The twelve-wire probe has been used with a vector network analyzer to determine real and imaginary permittivity and EC, and has been used with undisturbed soil cores. The purpose of this study was to compare results from the Hydra Probe and the twelve-wire probe for fluids as well as for soil cores taken from six locations in order to better understand these measurement systems. Undisturbed soil cores were collected from an Iowa prairie and adjacent soybean field, an Iowa forest and adjacent soybean field, Idaho burned and unburned sites, Colorado grassland and dryland wheat sites, Ohio grassed areas, and Texas rangeland and an irrigated field. For some of the Texas samples it was not feasible to measure electrical properties on undisturbed samples because dense soil restricted insertion of probes and wetting of samples. The measured EC and real and imaginary permittivity of fluids were compared between the two measurement systems and with theoretical values. Since the theoretical values for soils are not known, the measured values were compared between systems. Both probes showed EC and real and imaginary close to the theoretical values for fluids. In soils, we showed that an adjustment was needed in the calculated EC from the Hydra Probe to account for dielectric relaxation. The soil EC of the Hydra Probe better matched that from the twelve-wire probe after the adjustment was made.

Bonta, J.V. 2008. Drop-box Weir for Measuring Flow Rates Under Extreme Flow Conditions. Journal of Soil and Water Conservation. 63(4):134A. (**NAEW #451)**

Abstract:

Sediment and large rocks often are transported in runoff during extreme events. The sediment can deposit in a runoff-measuring structure and give erroneous readings. The drop-box weir (DBW) is one of only a few flow-measuring devices capable of measuring sediment-laden flows. Recent studies have extended its utility from large watersheds to small plots and watersheds. Furthermore, recent hydraulic studies have guided adaptation of the Coshocton wheel, a proportional sampler, for use with the configuration of the DBW used on runoff plots. This article presents a short history of the development of the DBW and it use with the Coshocton wheel on runoff plots in a study of application of manure on frozen soil. It also lists other studies where the DBW has been used.

Renard, K.G. and J.V. Bonta. 2005. Discussion of, “Automated erosion wheel: A new measuring device for field erosion plots” (Klik et. al). Journal of Soil and Water Conservation 60(1):7A-8A. **(NAEW #414)**

Abstract:

The discussion of an article in the Journal of Soil and Water Conservation that suggests problems in the published paper needing further attention to help possible users of the report. Presentation is unclear and the evaluation might be improved/clarified with additional graphs and explanation. With the material presented, we would hesitate attempting to build a prototype for confident deployment in a field operation.

Tekeli, A. Emre, A. Arda Sorman, Aynur Sensoy, A. Unal Sorman, J. Bonta, and G. Schaefer. 2005. Snowmelt lysimeters for real-time snowmelt studies in Turkey. Turkish Journal of Engineering & Environmental Sciences 29:29-40. Available in PDF file or reprint. **(NAEW #410)**

Abstract:

Snowmelt lysimeters collect and measure the melt water that is released from the snow pack. The data recorded from a snowmelt lysimeter are valuable for formulation of the physical basis of modules of a snowmelt runoff model. There are few snow studies on the eastern region of Turkey in basins that feed the Euphrates and Tigris Rivers. The design and performance evaluation of the first real-time snowmelt lysimeter in this region is presented in this paper. Detailed information about the snowmelt lysimeter designs in the literature is also summarized. The water released from the monitored snow pack is evaluated on hourly and daily bases and compared with rain and snow-water equivalent values. The snowmelt lysimeter performed well, matching streamflow trends in large basins. Data from rain-on-snow, rainfall-only, and snowmelt-only events could be explained with lysimeter and other data. The lysimeter rainfall catch (about 5% greater than a rain gauge) was similar to rainfall measurements on a soil-block lysimeter in the USA. This paper contributes to the literature by documenting first near real-time snow lysimeter research in eastern Turkey. The results are useful for improving the design for other areas in this understudied portion of the world where snowmelt contributes the major portion of the runoff.

Bonta, J.V. 2004. Experiences in instrumentation and conducting investigations of drastic land disturbances in small watersheds. Proceedings of International Instrumented Watershed Symposium, Edmonton, Alberta, Canada. June 2004. http://www.osern.rr.ualberta.ca/Downloads/IIWS/bonta_paper.pdf **(NAEW #406)**

Abstract:

A seven to nine-year investigation was conducted on the impacts of drastic land disturbances in small watersheds due to coal mining and reclamation activities on surface- and subsurface hydrology and water quality. Three small watersheds (12 to 20 ha) in Ohio were monitored before mining, during mining and reclamation, and after reclamation for hydrology and water quality. The planned experimental design of the project, the actual conditions during the mining and reclamation activities, and challenges in conducting the research are discussed. Watershed research in surface-

mined areas is considered long term, high-risk research. Control watersheds must be free from previous disturbances, which is difficult to document for sites that do not have long hydrologic runoff records. It was not economically feasible to quantitatively characterize the watersheds during the rapid and transitory periods of watershed disturbance. Undisturbed and reclaimed watersheds can be visually undisturbed, but hydrologically disturbed. Surface- and ground-water hydrology and water chemistry processes may not reach a dynamic equilibrium until many years have passed. This study addressed the immediate and most apparent impacts of surface mining and reclamation, but not the more subtle impacts. The utility of, and recent research into, a flow-measuring device called the "drop-box weir" is also presented. This weir is not well known, but works well where commonly used weirs would fail for sediment-laden flows with large particles that are expected from erosion-vulnerable landscapes draining drastically disturbed areas. Recent hydraulic research with the weir extends its utility to small erosion plots and small, steep watersheds. Sampling devices for use with the weir have been developed. The design of the project led to many useful results, in spite of the challenges during the project.

Bonta, J.V. and F.B. Pierson. 2003. Design, measurement, and sampling with drop-box weirs. Applied Engineering in Agriculture 19(6):689-700. **(NAEW #389)**

Abstract:

Rangelands, surface mines, construction sites, unprotected and long slopes, gullies, eroding stream channels, and erosion plots will yield large sediment loads under high intensity rainfalls. Conventional flow-measuring devices can easily become clogged with sediment and debris during a major runoff event, resulting in the loss of runoff and sediment records. Flow measurements can also be inaccurate using conventional flow-measuring devices in steep channels. The drop-box weir (DBW) was developed to overcome many of the problems encountered in sediment-laden flow measurement. The weir creates turbulence in a box that entrains and passes sediment through the weir. It is not a well-known device, and it has not been widely used. Yet it is only one of two devices suitable for obtaining flow records with large sediment concentrations. It has utility for a range of watershed sizes from small erosion plots to large watersheds. Information on what is known about the design and operation of the DBW, and of sediment sampling approaches using the DBW, was compiled. Weir sizing, rating-curve development, and sampling strategies were presented to facilitate its use and to identify its limitations. There are four known configurations of the DBW: the original weir with upper weir lips; a modification of the DBW for erosion plots (removal of upper weir lips); a modification of the DBW for small watersheds in steep and skewed channels (removal of upper weir lips and use of baffle); and a Korean version of the weir (larger chute opening to minimize blockage of trash – suitable for large and small watersheds). For each of the four configurations, rating tables and weir-sizing guidelines were summarized. Low-flow rating curves must be developed from field data for individual weirs, but laboratory curves can be used for larger flow rates. Curve-fitting procedures are outlined specifically for determining rating-curve equations where field data are obtained. Water samplers designed specifically for use with DBWs are described.

Other design considerations are discussed for practical use of DBWs including measurement of stage, maintenance, and sediment traps. Research needs for hydraulic modeling and sediment sampling are presented.

Malone, R.W., J.V. Bonta, and D. Lightell. 2003. A low-cost composite water sampler for drip and stream flow. Applied Engineering in Agriculture 19(1):59-61. **(NAEW #381)**

Abstract:

The collection of flow-proportional samples when flow rates range from slow drip flow to slow stream flow is important in hydrology. A rotating slot sampler was modified for this purpose and its field and lab performance were monitored. The major design criteria include: function for flow rates between 0.5 and 200 mL/min (0.008 and 3.2 gal/h); minimize sampler-fraction variance between trials; allow total flow volume estimate from sampler-fraction volume; compact in size; useful in remote conditions; low-cost; low-maintenance; and easily constructed from readily obtainable materials. The designed sampler collected approximately 2.0% of total flow (sampler-fraction) with a sampler-fraction coefficient of variation between trials of less than 5%. The sampler allows total flow to be estimated and flow-proportional samples to be collected.

Bonta, J.V. 2002. Modification and performance of the Coshocton wheel with the modified drop-box weir. Journal of Soil and Water Conservation 57(6):364-373. **(NAEW #379)**

Abstract:

Water-chemistry, sediment, and runoff data from erosion plots and small watersheds are often needed for erosion and water-quality studies where sediment concentrations can be large. Data may also be needed under conditions where approach channels are not appropriate for conventional measuring devices, such as in steep and skewed channels. The performance (sampler fraction) of the modified drop-box weir as the approach to the Coshocton wheel proportional water sampler was evaluated to meet these needs. Three splash-shield configurations on the sampling slot of the Coshocton wheel were investigated to control splashing of water and duplicate water sampling. Of the three shields, a dual-splash shield was required to control water splashing below the sampling slot, and to insure proportional sampling of large flows. The Coshocton wheel worked well with the drop-box weir as the sampler approach uder steady and unsteady flow conditions. The average proportional sampler fraction for the dual-shield configuration under steady flows was 0.0127, and for unsteady flows was 0.0120. This difference was not statistically significant. Coshocton wheel rotational speed was regular and increased with flow rate to about 35 rpm. After that, rotation became irregular and the wheel stalled. No difference was found in a maximum-depth-of-flow parameter needed for sizing a drop-box weir based on sampler performance, compared with the parameter determined by performance of the drop-box weir alone (i.e., the wheel sampled proportionally at 100% of the design flow for the weir). This study extends the utility of the combined drop-box weir and Coshocton wheel system to steep

and skewed channels.

Bonta, J.V. and V.C. Goyal. 2001. Modified drop-box weir for monitoring watershed flows under extreme approach channel conditions. Trans. Of the ASAE 44(6):1581-1591. **(NAEW #370)**

Abstract:

Flows under extreme weir approach conditions are difficult to accurately measure, and occur when there are rapid flows, steep channels, skewed flows in sinuous channels, and flows laden with sediment. Building on previous studies, the drop-box weir was modified and evaluated for use in steep and skewed stream channels found in small watersheds. Modifications to the modified drop-box weir (MDBW) included preventing water from overtopping the back wall of the box (forcing all water to enter the sides of the box), extending the vertical side walls at the V section of weir to preclude water flow out of the weir-measuring section at high flows, and use of a channel baffle for energy dissipation. Three energy-dissipation configurations upstream of the box and 20 upstream approach conditions were tested. The approach-channel angles ranged from 0o to 45o, and approach-channel slopes from 5% to 75%. The investigations showed that an upstream baffle yielded a stable rating curve compared with two other energy-dissipation measures. Statistical analyses of the rating curve parameters of the MDBW for each of the 20 approach conditions were similar, leading to the conclusion that the rating was independent of approach channel angle and slope at all flows when an upstream baffle was used to dissipate flow energy. The rating curve was composed of five linear segments on a log-log grid with relative gauge-height (R = gauge height/depth of V notch of weir) boundaries at 0.058, 0.11, 0.27, and 0.49. Data suggest that departures in the low-flow rating (R#0.27) between weirs may be due to differences in weir fabrication, and field rating using the results and procedures of this study are recommended. Changes in the slopes of these linear rating segments were associated with observed flow conditions in the weir. A maximum R of 0.63 was recommended for sizing a MDBW, but a R = 0.78 could be used if monitoring equipment had sufficient water-depth resolution. The rating curve developed in this study was nearly identical to those developed in another independent study in which flows were directed at a 90o approach angle by gutters, and also with part of the rating curve of the original drop-box weir. This suggests the rating of this study is applicable to extreme approach angles beyond the 45º angle tested in this study. Guidelines for weir sizing and developing rating-curves for the MDBW are given.

Bonta, J.V. and V.C. Goyal. 2000. Comparison of drip-flow/low-flow measuring devices for infiltrometer runoff measurements. Trans. of the ASAE 43(6):1489-1498. **(NAEW #358)**

Abstract:

Runoff is generated on landscapes in a deterministic and random, but unquantifiable manner, and measurements of the spatial variability of infiltration and seepage under

natural-precipitation conditions are highly desirable. Runoff from small natural-precipitation infiltrometer plots (0.25 m2) under natural conditions can be merely drip flows, or they can be larger flows when runoff is produced simultaneously from high-intensity rains and seepage. A study of a drip-flow/low-flow nozzle/rotor flow-measuring system that met design requirements for runoff measurement is presented. Comparison of different nozzle configurations led to the selection of the rotor of a Price current meter, in combination with a unique nozzle that incorporated a drip diverter, an internal flow baffle, and drip-control silicone beads. The best nozzle/rotor combination yielded a rating curve with a resolution less than design requirements, and worked well with flows as high as ~6 L min-1, greater than design requirements. A combined function using linear segments for low flows, and a 4th degree polynomial for high flows, comprised the rating curve. The average residual error about the function was 0.113 L min-1. Unsteady flow tests with the nozzle showed that the rating curve and nozzle/rotor assembly worked well, with the median error in volume of -21 ml for 12 synthesized "events." The device is a standalone measuring system that can be placed anywhere on the landscape, and only electrical pulses, representing rotor-rotation speed require measurement. The nozzle/rotor system can be used for other applications in which drip and low flows need to be measured, such as for rain gauges, percolation flows from lysimeters, spring flows, etc.

Bonta, J.V. 1999. Water sampler and flow measurement for runoff containing large sediment particles. Trans. of the ASAE 42(1):107-114. **(NAEW #344)**

Abstract:

A flow-measuring and composite water-sampler system was needed for sampling sediment-laden flows containing large rock particles from strip-mine spoil erosion plots. The median percentage of soil particle sizes greater than 16 mm of the greater-than 2 mm fraction was 25%. A modified drop-box weir was used for measuring flows, and for providing a well-mixed water and sediment flow that could be sampled. A "diverter" composite sampler was designed to divert the entire flow from a waste position to a sample position, and precluded the need to subsample (split) the sampled flows. Indoor testing of the sampler showed the sampler worked well with the modified drop-box weir. Field evaluation showed the sampler and drop-box weir worked well under natural rainfall conditions. Recommendations for improvement in sampler and weir operation are given. Use of the sampler for other applications is also discussed.

Bonta, J.V. 1998. Modified drop-box weir for monitoring flows from erosion plots and small watersheds. Trans. of the ASAE 41(3):565-573. **(NAEW #340)**

Abstract:

Sediment-laden flow and chemical-constituent concentration data from erosion plots and small watersheds are often needed for erosion and water-quality impact evaluations and modeling. The original drop-box weir was modified to pass the design flow through the V-notch and box sections of the weir. Approach conditions consisted of gutters and

aprons that divert runoff water and sediment to the box at right angles. An evaluation of the effects of these approach conditions on the original rating for the drop-box weir and the effects of not having a false back wall for erosion-plot use was conducted. A rating for low flows was obtained. The rating for the drop-box weir with the new approach conditions was different from the original rating. Three rating equations were fit to the data simultaneously for the three flow ranges. Observations of weir performance suggested that the reason for the three equations was related to the stepped side weirs. This study and other published studies led to the conclusion that the drop-box weir should not be modified unless a new study of the effects of the changes on the rating are evaluated. The gage height for the design flow for sizing the modified drop-box weir in small stream channels was established. A decision table was developed for appropriate use of the drop-box weir.

Edwards, W.M., H.E. Frank, T.E. King, and D.R. Gallwitz. 1976. Runoff sampling: Coshocton vane proportional sampler. ARS-NC-50. 9 pp. **(NAEW #206)**

Abstract:

This sampler collects a composited representative sample of runoff from each storm event at sites where flow is measured by a broad-crested or similar overfalling weir. The sample can be used to determine average concentrations and total transports of liquid and suspended solid components of the runoff event.

Proportionality is maintained by a revolving vane and movable outfall that collect a consistent fraction of all runoff above a threshold or base flow level. Timer and double vane options provide for adequate sample volume from large or small runoff events. The sampler uses only basic electrical and mechanical components and has performed well on watershedsas large as 300 acres where the maximum design flow rate is 500 ft_3/s.

Bentz, W.W. and C.R. Amerman. 1968. A tipping bucket device for measuring very low flows. Agric. Eng. 49(12):750-751. **(NAEW #153)**

Abstract:

This paper describes the design and performance of a large tipping bucket device that is used for measuring very small flow rates, such as from spring flows.

Parson, D.A. 1955. Coshocton-type runoff samplers. ARS-41-2. 15 pp. **(NAEW #71)**

Parsons, D.A. 1954. Coshocton-type runoff samplers, laboratory investigations. SCS-TP-124. 16 pp. **(NAEW #65)**

Abstract:

This paper documents the development of a modification of the original Coshocton wheel sampler developed by W. Pomerene at Coshocton, Ohio. Principles of operation,

performance data, fabrication information, and installation guidelines are given. This version of the Coshocton wheel is used worldwide.