Editorial

Curve Number Method: Time to Think Anew?

Richard H. Hawkins, Ph.D., P.E., F.ASCE

School of Natural Resources and Environment, Watershed Resources and Ecohydrology, Dept. of Agricultural and Biosystems Engineering, Dept. of Hydrology and Water Resources, Univ. of Arizona, Tucson, AZ 85721. E-mail: rhawkins@ag.arizona.edu

DOI: 10.1061/(ASCE)HE.1943-5584.0000954

> The dogmas of the quiet past are inadequate to the stormy present. The occasion is piled high with difficulty, and we must rise to the occasion. As our case is new, we must think anew. We must disenthrall ourselves, and then we shall save our country. (Abraham Lincoln)

As most hydrologists know, the curve number method is popular, enduring, ubiquitous, versatile, and widely used to calculate event rainfall-runoff volumes. To many, it is quite comforting. It is also badly in need of some updating.

Originally created on short notice in the mid 1950s for the ad hoc needs of Public Law 566, the curve number method was targeted at and developed for agricultural uplands and overland flow. With its origins in the USDA, PL566 (a USDA program) was preordained for acceptance, and its handbook-guided use in planning and design led to millions of dollars of cost sharing and grants. Thus it was accepted without much question. Happily, it also fit nicely into a waiting technologic niche in the emerging science and profession of hydrology. It had an assuring aura of cutting edge. In this setting, it was too big to fail.

As a working man's hydrology, it is simple, transparent, and appealing, and it is true to its USDA origins in that soils and land condition play major roles. At that time, an alternative model with the benefits of the curve number method was not available, and there still is not. Within its genus, it is monotypic. It serves as the *poster boy* and hypothesis for rainfall-runoff, and its terms and concepts (however approximate) serve a vocabulary role for the general hydrology case. The curve number concept was developed in the "quiet past" of Lincoln's statement and may be "inadequate for the stormy present" of modern hydrologic engineering. It is overdue for an overhaul for several compelling reasons.

Experiences with the procedure and comparisons with other rainfall runoff studies over the past 50 years have been both eye-opening and unsettling. Many tables and assumptions posted in the foundation documents [NEH4/630; USDA Soil Conservation Service (1954); USDA Natural Resource Conservation Service (2003)] are not matched by on-the-ground data or supported by critical analysis. Curve numbers (CN) tables based on soils and cover are often wide of the mark, a condition exacerbated by the model's demonstrated primary sensitivity to the choice of the CN. Furthermore, some watersheds were found to perform quite differently from the basic CN runoff response patterns, leading to great differences between the model and reality. The inferred internal infiltration sequence is questionable. The hydrologic soils classifications, a supposed strong point considering the source agency, seem internally inconsistent and vague. These observations, and a host of others like them, become more common as applications depart from the rain-fed, agricultural upland, large-storm settings that spawned the original development. The expository literature continues to mount (Hawkins et al. 2009).

At the same time, temptations to apply it well beyond its simple upland agriculture origins have grown in response to modern needs. It has been an easy off-the-shelf filler hydrology for rainfall-runoff and other targets, such as urban and river basin hydrology and agricultural and water quality models. Many of the latter apply creative extensions of the CN method to daily time-step continuous models. It is now comfortably embedded in flood control, environmental impact, and sediment-erosion methodologies world-wide.

Finally, times and expectations have changed. There are now five decades more data upon which to base methodologies, much better means of analyses, and a greater variety of recognized lands and land uses. Equally important, as a profession, more is expected now than was expected in the mid 1950s. In its birth years, the CN method did not experience professional peer review, and most of the foundation data and calculations have since been lost. Alas, it was established by administrative fiat. This is now an age that values open communications, scientific cross-pollination, freedom of information, consilience, stakeholder participation, data sharing, and intellectual honesty. Is it not time to nudge quality and credibility up a notch?

How and under what auspices might such needed renovations occur? Considering its development, origins, and history, and in a spirit of *noblesse oblige*, an unavoidable onus of leadership rests with the USDA. Via the image and authority of the USDA, the user world has followed its lead for over 50 years, but in the 21st century the user community should be an active contributor, too, perhaps through professional societies such as ASCE, American Society of Agriculture and Biological Engineers (ASABE), and American Water Resources Association (AWRA). It is no small task and promises to create discomfort.

These issues are raised here to provide food for thought, grist for discussion, and, hopefully, reader feedback in these pages.

References

Hawkins, R. H., Ward, T. J., Woodward, D. E., and Van Mullem, J. A. (2009). *Curve number hydrology: State of the practice*, American Society of Civil Engineers, Reston,VA.

U.S. Department of Agriculture, Natural Resource Conservation Service. (2003). "National engineering handbook, part 630, hydrology." U.S. Dept. of Agriculture, Washington, DC, 600.

U.S. Department of Agriculture, Soil Conservation Service. (1954). "National engineering handbook, section 4, hydrology." U.S. Dept. of Agriculture, Washington, DC, 600.

J. Hydrol. Eng. 2014.19:1059-1059.