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ESTIMATION OF IMPERVIOUS CURVE NUMBERS

PROBLEM STATEMENT

The runoff Curve Number (CN) method, developed by the United States Department of Agriculture (USDA) Soil Conservation Service (SCS), is widely used to compute runoff from rainfall events (Hawkins 1993; Ponce and Hawkins 1996). It's popularity is based partly on the fact that it is perhaps the only method currently available that considers the effects of soil type, land use/treatment, surface condition, and antecedent condition (Ponce and Hawkins, 1996) in predicting the runoff volume generated from a storm event.

Two important assumptions are made in the CN method: (1) a CN value of 98 is used for impervious surfaces, and (2) the initial abstraction from an impervious surface is always assumed to be 0.04 inches. These values are assumed for all rainfall intensities, under all types of weather conditions (effects of temperature and humidity are ignored), for all types of impervious surfaces (concrete, asphalt etc.), and for all gradients of the watershed. The CN for impervious surfaces was first assigned a value of 100 (SCS 1972, Chapter 9). In other words, it was first assumed that all rainfall on impervious surfaces gets converted to runoff. Almost all of the so-called "impervious" surfaces, however, are either slightly porous or have some capacity to absorb water, which means that there is some retention even in impervious surfaces. The CN for impervious surfaces was later assigned a value of 98 (SCS 1975, SCS 1986), but without any empirical or theoretical evidence to explain that choice. An interesting footnote on the bottom of one of the tables in SCS (1975), [and also in Chow et al. (1988)], states that "in some warmer climates of the country a Curve Number of 95 may be used (for impervious surfaces)." Again, although the statement makes sense, no explanation for this statement was offered in either document. The footnote was subsequently removed from SCS (1986).

The soundness of these assumptions has been questioned by engineers and planners but never verified. The SCS manual itself states that "in some warmer climates of the country a curve number of 95 may be used (for impervious surfaces)." However, neither the SCS manual nor any other literature provides any empirical or theoretical data, or analysis, describing why a CN value 98 is used. Similarly, there is no documented evidence to show why the initial abstraction is always assumed to be 0.04 inches. Some evidence suggests that the impervious CN may be close to 94 under Florida conditions (Pandit and Regan, 1997) and that the initial abstraction varies based on the type of street surface (Pitt and McLean, 1987).

It is important to know if the impervious CN is 98 or lower because an impervious surface with a CN of 95 will produce approximately 30% less runoff compared to an impervious surface that has a CN of 98 during a 1 inch rainfall event. These differences in estimated runoffs become even larger for smaller events which of less than 1 inch. Moreover, research studies (for example Pitt and McLean, 1986) have shown that almost 90 % of the annual stormwater discharges of most pollutants are associated with rains less than 1 inch in depth. Heavy metal discharges are even more strongly associated with small rains. Pandit and Copalakrishnan (1996) and Pandit and Copalakrishnan (1997) also found that the frequent small rains are much more influential in seasonal and annual pollutant loads estimations than the larger, more infrequent, rainfall events. Thus, when pollutant loads from impervious surfaces, such as highways, are calculated using an arbitrarily selected impervious CN value of 98, instead of the actual value of 94 or 95, the results may be 30%-50% greater than the actual loads.

OBJECTIVES

The main objective of this study was to collect runoff data from 100% impervious surfaces, representative of Florida highways, and to determine the CN value and the initial abstraction of these impervious surfaces under Florida weather conditions.

FINDINGS AND CONCLUSIONS

The main conclusions can be summarized as follows:

1. The design was successful in simulating the desired rainfall events and in measuring the resulting runoff depths.
2. The system requires only a 500 gallon tank for water supply and can be ported to remote areas for simulations in these areas.
3. The CN values for concrete was essentially 100 although the presence of cracks can lower the value.
4. The CN values for asphalt were between 97 and 99. Considerably lower values can occur if there are even small "porous" zones especially at smaller rainfall intensities of less than 0.5 in/hr.
5. Steeper slopes will yield lower abstraction and, therefore, higher CN values. However, these differences were too small to be reflected in the computed CN values when the values for rounded off to the nearest integer.
6. The calculated initial abstraction values for concrete ranged from 0.0012 inches to 0.0037 inches, and were significantly lower than the 0.04 inch value assumed in the theoretical formulation of the method. The calculated initial abstraction values for asphalt ranged from 0.0017 inches to 0.0309 inches, and were also lower than the theoretical value.

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