Probabilistic properties of the Curve Number

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1 The main problem

What is the variability of the Curve Number in the SCS-CN method?

2 Abstract

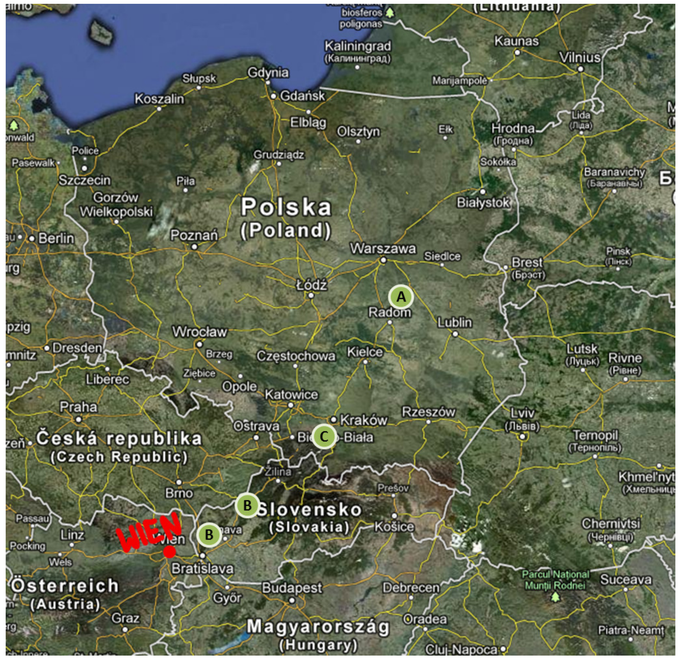
The SCS-CN method allows to predict the runoff volume in small, ungauged catchments. Due to observed variability of the CN, its probabilistic properties in Slovakian and Polish catchments were analyzed. Results contain: the determination of the theoretical distribution function, confidence intervals, comparison to ARC I and ARC III and the asymptotic fitting.

3 Catchments

A. The Zagożdżonka River, centre of Poland

B. Carpathian Slovakian catchments: Stupavský, Račianský, Gidra, Vištuk, Petrinovec,

C. Carpathian Polish catchments: Poniczanka, Mszanka, Kasinianka, Lubieńka, Skawica.



4 The SCS-CN method

The SCS-CN equations:

$$H = \begin{cases} \frac{(P-\lambda S)^2}{P+(1-\lambda)S} & \text{if } P \geq \lambda S, \\ 0 & \text{otherwise} \end{cases} \quad \text{and} \quad S = 254\left(\frac{100}{CN} - 1\right)$$

$H-$ the direct runoff, $P-$ the rainfall depth, $S-$ the watershed storage parameter $\lambda-$ the initial abstraction ratio.

CN depends on land use and soil type, in the model is assumed to be constant and is tabulated $\Rightarrow CN_{\text{theor}}$

In practice CN **varies and is a random variable**

5 Sample analysis

The solution of the SCS-CN equations if $\lambda = 0.2$ is

$$CN = \frac{25400}{S+254} \text{ where } S = 5(P + 2H - \sqrt{4H^2 + 5PH})$$

For events (P_i, H_i) we get a sample CN_i.

The empirical density function of the CN is negatively skewed

The variable $100 - CN$ **is positively skewed**. It was investigated to fit a typical theoretical distribution function [3].

6 Distribution fitting

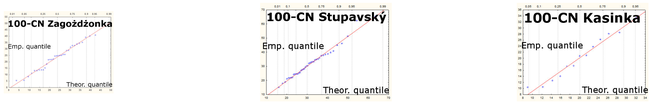
- **Statistical tests** of goodness of fit: Kolmogorov-Smirnov (KS), Cramer-von Mises (CM), Anderson-Darling, Shapiro-Wilk.
- Quantile-Quantile plots and correlation coeff. r.

Criteria:

(a) $W = KS + CM + 1 - r^2$ achieves minimum

(b) Akaike Information Criterion (AIC)

Theoretical distribution for $100 - CN$ is Generalized Extreme Value.



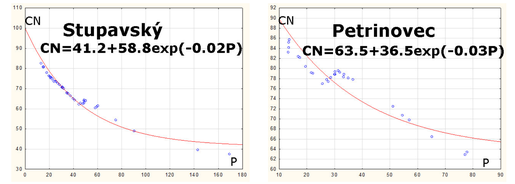
7 Confidence intervals and ARC I, III

Confidence intervals indicate **the most probable** CN**s**. The comparison to the $CN(I)$ and $CN(III)$ conditions (Hawkins formula) implies the SCS-CN model may

- overestimate the direct runoff (Stupavský, Račianský)
- underestimate the direct runoff (Petrinovec, Poniczanka, Skawica).

8 The asymptotic fitting

The drift of CNs with increasing rainfall depth [2] is recognized using $\lim_{P' \to \infty} CN(P', H')$ where P', H' are independently sorted P and H.



Stupavský: $CN(P) = 41.23 + 58,77e^{-0.02P}$

Petrinovec: $CN(P) = 63.53 + 36.47e^{-0.03P}$

Zagożdżonka (result of Banasik, Woodward [1]):

$$CN(P) = 74.03 + 25.97e^{-0.06P}$$

9 Acknowledgments

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10 References

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