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On the definition of risk of scarcity for water supply systems

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Conditions of scarcity for a water supply system occur when the available resource are not able to satisfy the related demands. The definition of risk of scarcity usually relies on three quantities: the reliability, that is a measure of the probability of the system to perform in a satisfactory way during a given operation period, the resiliency, aiming to capture the ability of the system to recover after a period of deficit, and the vulnerability, whose goal is to measure the severity of possible deficits. Then, the three different quantities can be merged in a single risk index by a simple weighted average. Although the basis for such a definition are clear, the operative way to define the risk index can much affect the final value and, as a consequence, the assessment of the effective risk of scarcity for a water supply system. This work aims at getting more insight on the following issues: 1) the most commonly accepted definitions of reliability, resiliency and vulnerability are based on the probability of occurrence of failure and the related persistence and intensity; however, defining such a probability is quite hard due to the fact that for most of the water supply systems the available time series of recharge, demand and number of failures are not sufficient to process them statistically. 2) Resiliency is usually defined as the mean duration of failures, whatever its probability of occurrence. However, in many cases water managers are more troubled by few persistent episodes (although less probable), than by several short episodes of water scarcity. 3) Analogously, vulnerability is usually defined as the mean deficit during failure periods, neglecting the maximum possible deficit which is sometimes more useful for management purposes. Along these lines, a new method to evaluate the risk of failure for water supply systems is proposed. The new definition of risk takes into account also the extreme events, both positive and negative. Reliability, resiliency and vulnerability are estimated using synthetic time series generated on the ground of the observed standardized precipitation indices, long enough to get a statistically significant number of different hydrological conditions. Results from a case study concerning a drinking water supply system in Central Italy (Ridracoli) are presented and discussed.