Cities are becoming increasingly vulnerable to flooding because of rapid urbanization, installation of complex infrastructure, and changes in the precipitation patterns caused by anthropogenic climate change. The present paper provides a critical review of the current state-of-the-art methods for assessing the impacts of climate change on precipitation at the urban catchment scale. Downscaling of results from global circulation models or regional climate models to urban catchment scales are needed because these models are not able to describe accurately the rainfall process at suitable high temporal and spatial resolution for urban drainage studies. The downscaled rainfall results are however highly uncertain, depending on the models and downscaling methods considered. This uncertainty becomes more challenging for rainfall extremes since the properties of these extremes do not automatically reflect those of average precipitation. In this paper, following an overview of some recent advances in the development of innovative methods for assessing the impacts of climate change on urban rainfall extremes as well as on urban hydrology and hydraulics, several existing difficulties and remaining challenges in dealing with this assessment are discussed and further research needs are described.