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Influence of urban areas on surface water loss across USA watersheds

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Human activities are one of the factors responsible for the rapid depletion of surface water resources. The projected growth of urban population, along with the associated process of urban sprawl, is expected to further increase anthropogenic surface water withdrawals. Although this scenario is threatening water security globally, highlighting the need for efficient and sustainable strategies of water and urbanization management, a spatially explicit analysis of the interaction between urban areas and surface water loss is still missing. In this analysis we use maps of urban areas and locations of surface water loss derived from remote sensing data across the watersheds in the United States to understand the spatial influence of human settlements on surface water depletion. By examining the distribution of the frequency of surface water loss locations as a function of distance from urban areas we find that in most of the basins as well as in the whole study area the depletion of surface water resources is higher close to human settlements. Therefore, we define a probabilistic distance-decay model to reproduce the observed decrease in surface water loss frequency and we observe that in 96% of the study area our model is effectively able to predict the observed decrease in surface water loss locations with distance from urban areas at the basin level (Pearson's correlation coefficient r = 0.5). The same result is found for the whole study area as well (r = 0.997). Finally, we test the reliability of the distance-decay model through the comparison between the observed distance from urban areas at which on average surface water loss occurs and the theoretical value derived from the model evaluated for each basin and for the whole study area. The strong correlation (coefficient of determination R^2 = 0.88) between the observed and theoretical distances proves that our probabilistic model applied across the U.S. represents a robust tool that can support the identification and the prediction of surface water depletion and can be possibly applied to other study areas.