The Influence of Different Methods for Estimating Impervious Surface Cover on Model-simulated Streamflow of the Milwaukee River Basin

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Introduction

- Increased urbanized land use has resulted in increases of direct runoff and nonpoint source pollution.

- These land use change impacts on the hydrological processes can be assessed by hydrologic models.

- Fraction of impervious surface covers is an important parameter for hydrologic modeling, especially in urbanized basins.

Impervious cover and hydrologic model

- Increased imperviousness in urban areas is known to influence:
- Local climate and surface water temperature -- Spatial and temporal distribution of land-atmosphere fluxes of water and heat, and carbon cycling. Thus it affects the PET simulation of model.
- Surface flow -- increases the risk for water pollution and floods in the watershed, hampers the recharge of aquifers and boosts erosion. Therefore affects the direct runoff and streamflow simulation of model

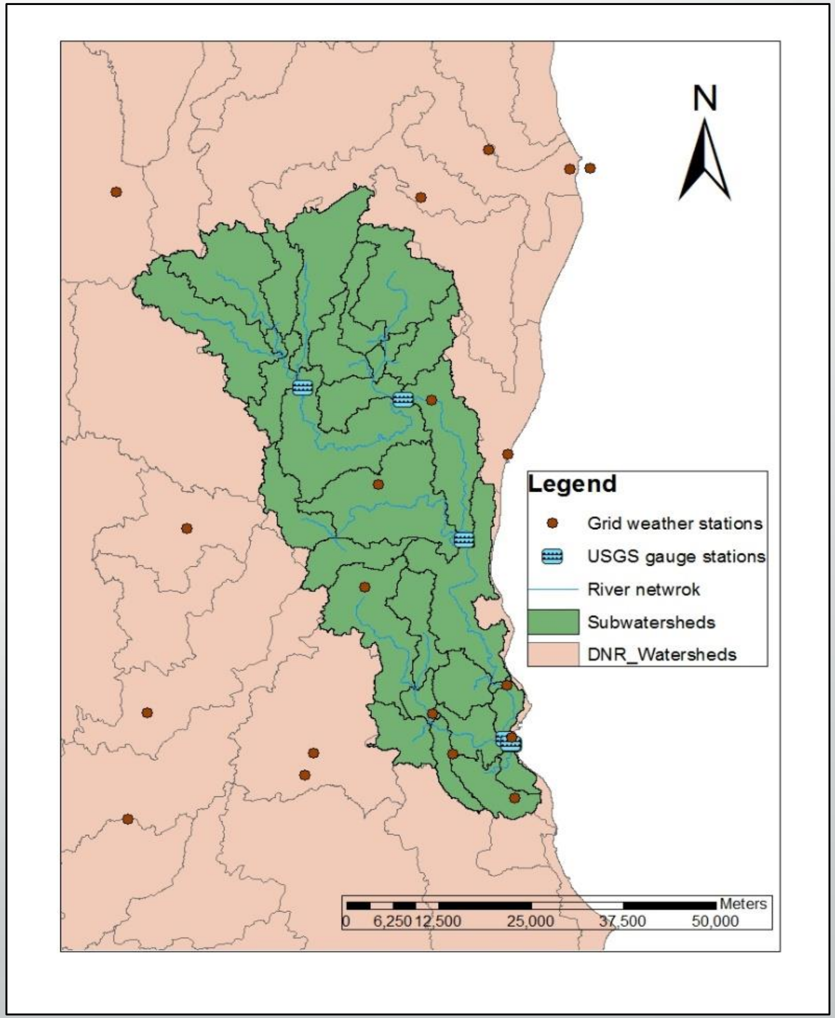
Research Questions

A new imperviousness input method was developed and the model results with the new method were then compared with the results with two old methods :

- How much difference is there between model results with the new imperviousness input method and the results with the old methods?
- How do the differences of model results relate to the urbanized land use percentage?

Study area and Data

- The Milwaukee River basin was selected as study area
- Streamflow from 1986 to 1995 was modeled using a semi-distributed hydrologic model -- Hydrologic Simulation Program-Fortran (HSPF).
- Input data include modified 1991 Land use map, DEM, hourly climate data and different imperviousness input information

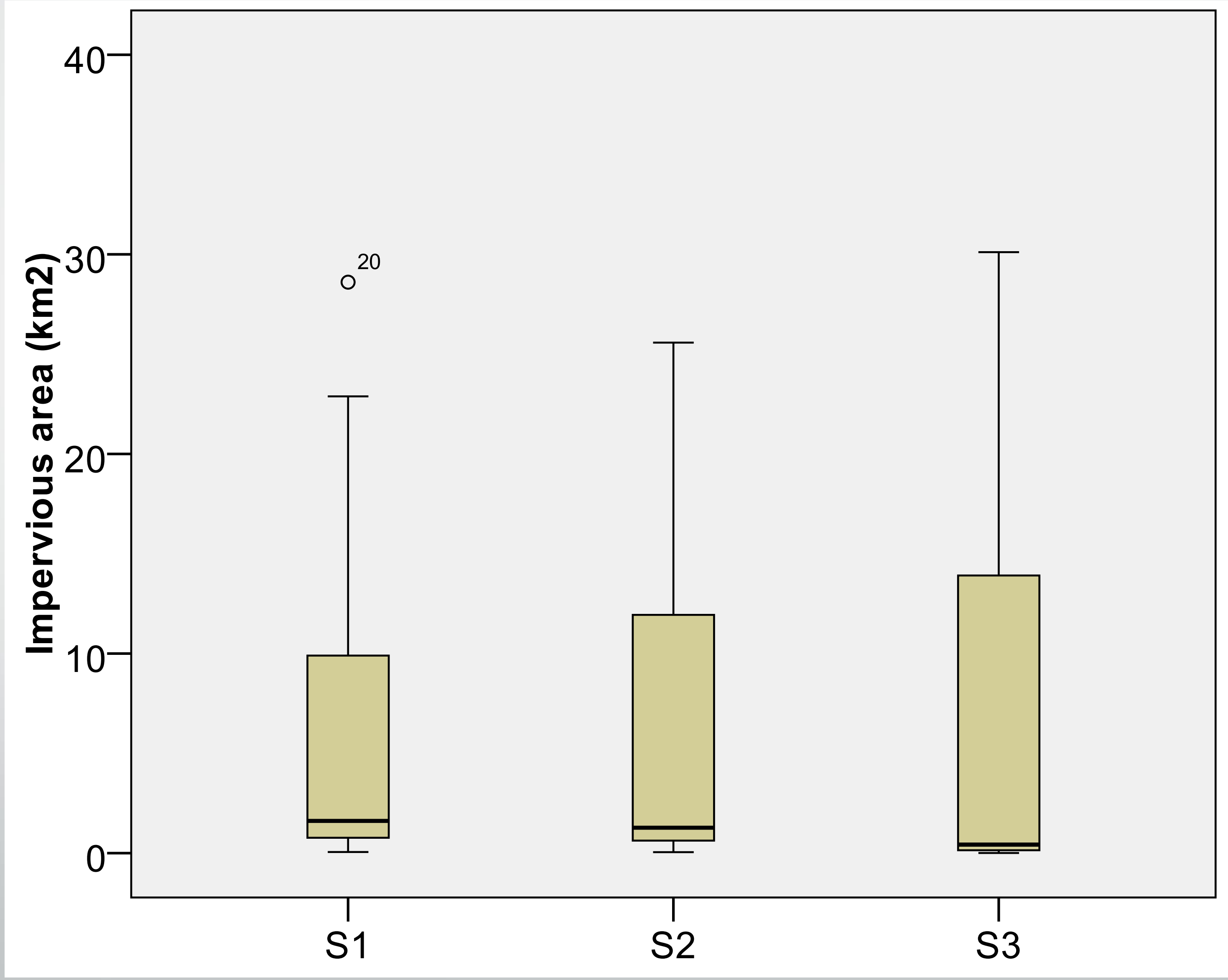


Method

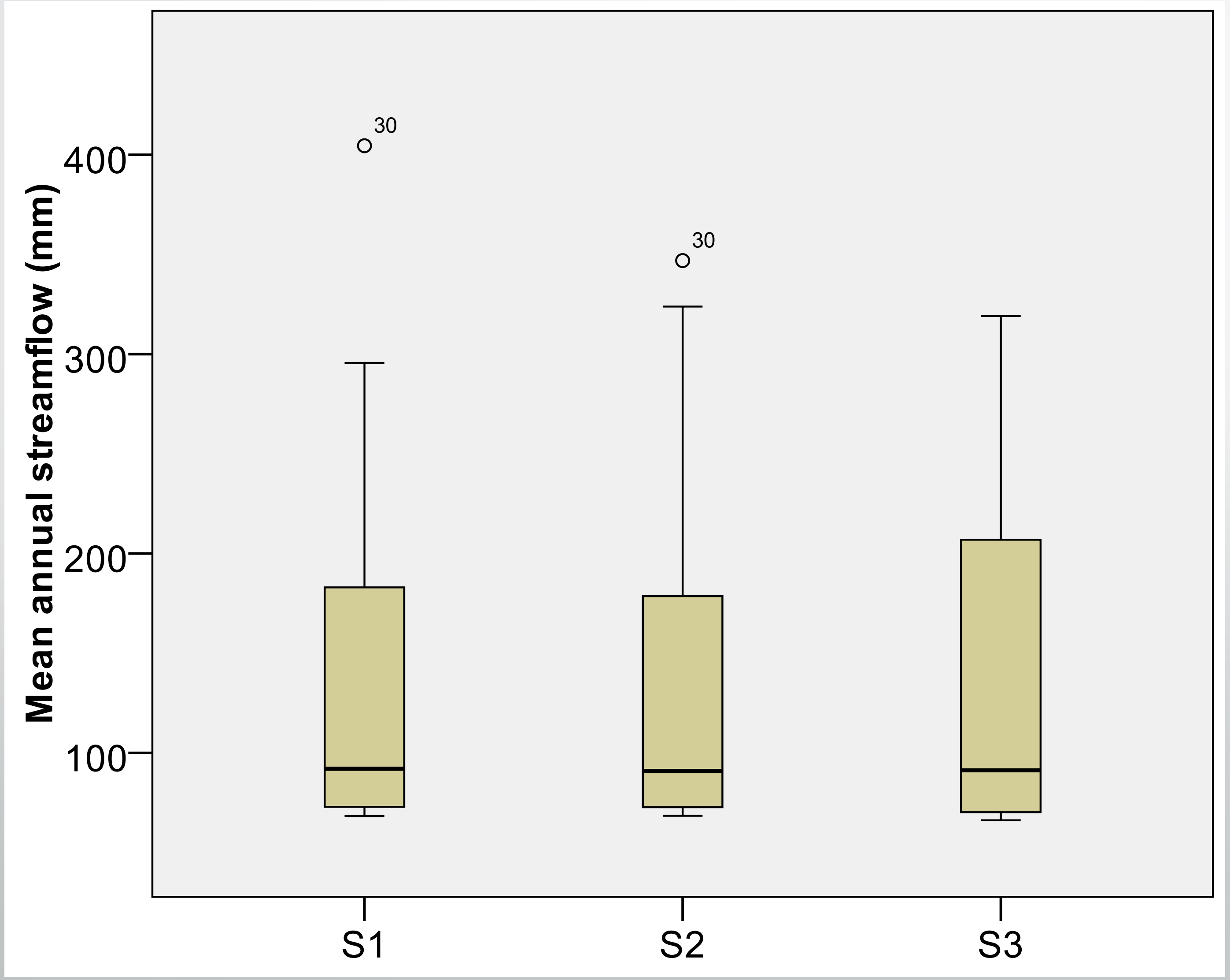
- Scenario 1: Homogeneous distribution of impervious surfaces for the entire urban area.
- S1: Urban -- 29.25%
- Scenario 2: Homogeneous distribution of impervious surfaces for commercial and residential land uses, respectively.
- S2: Residential -- 27.31%; Commercial – 62.20%
- Scenario 3: Different imperviousness for residential land use of each subbasin.
- S3: Commercial -- 62.20%; Residential – 3.88% to 94.5% for each subbasin

Results

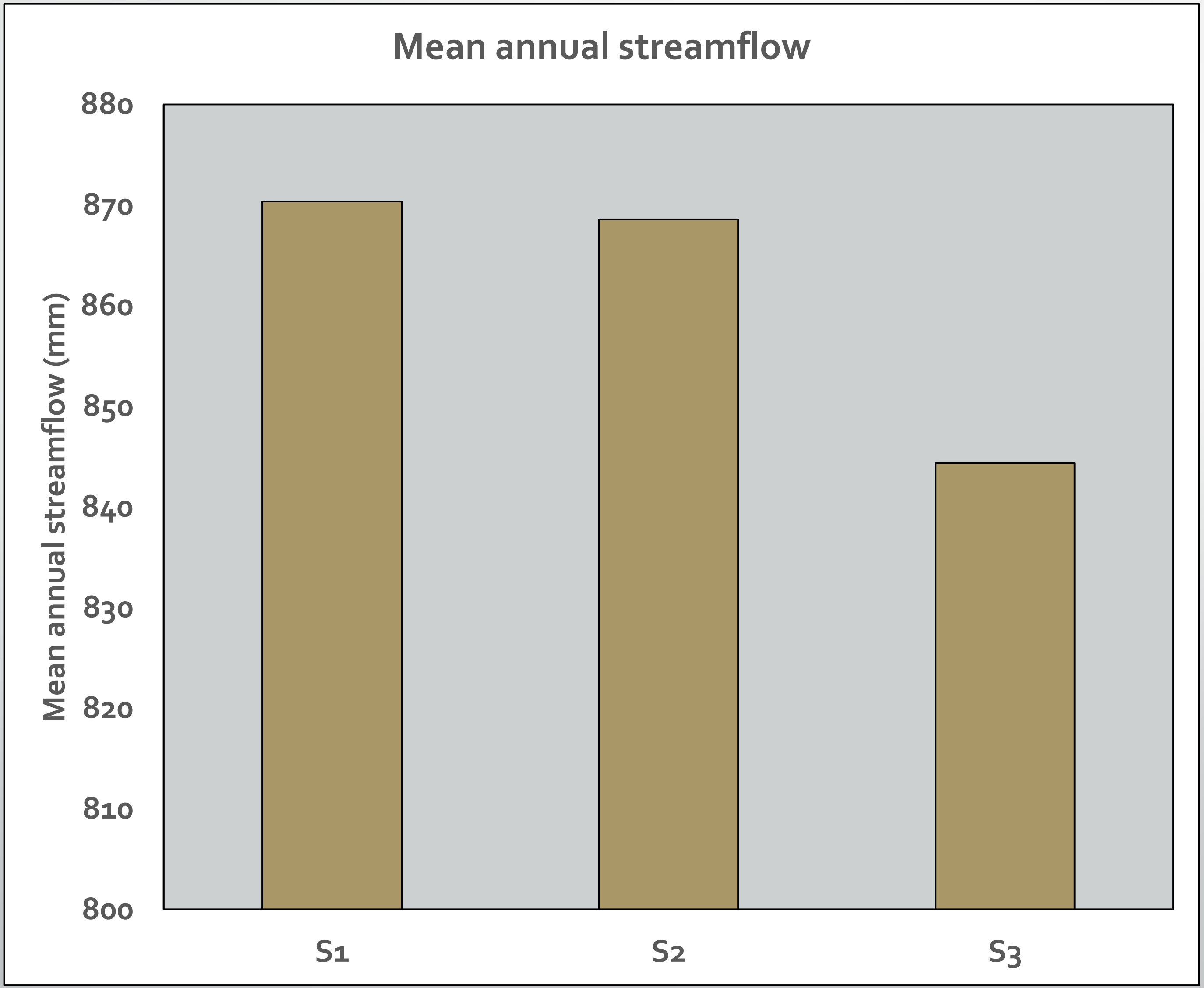
- Impervious area for 33 subbasins



Comparison of simulated streamflow of each subbasin



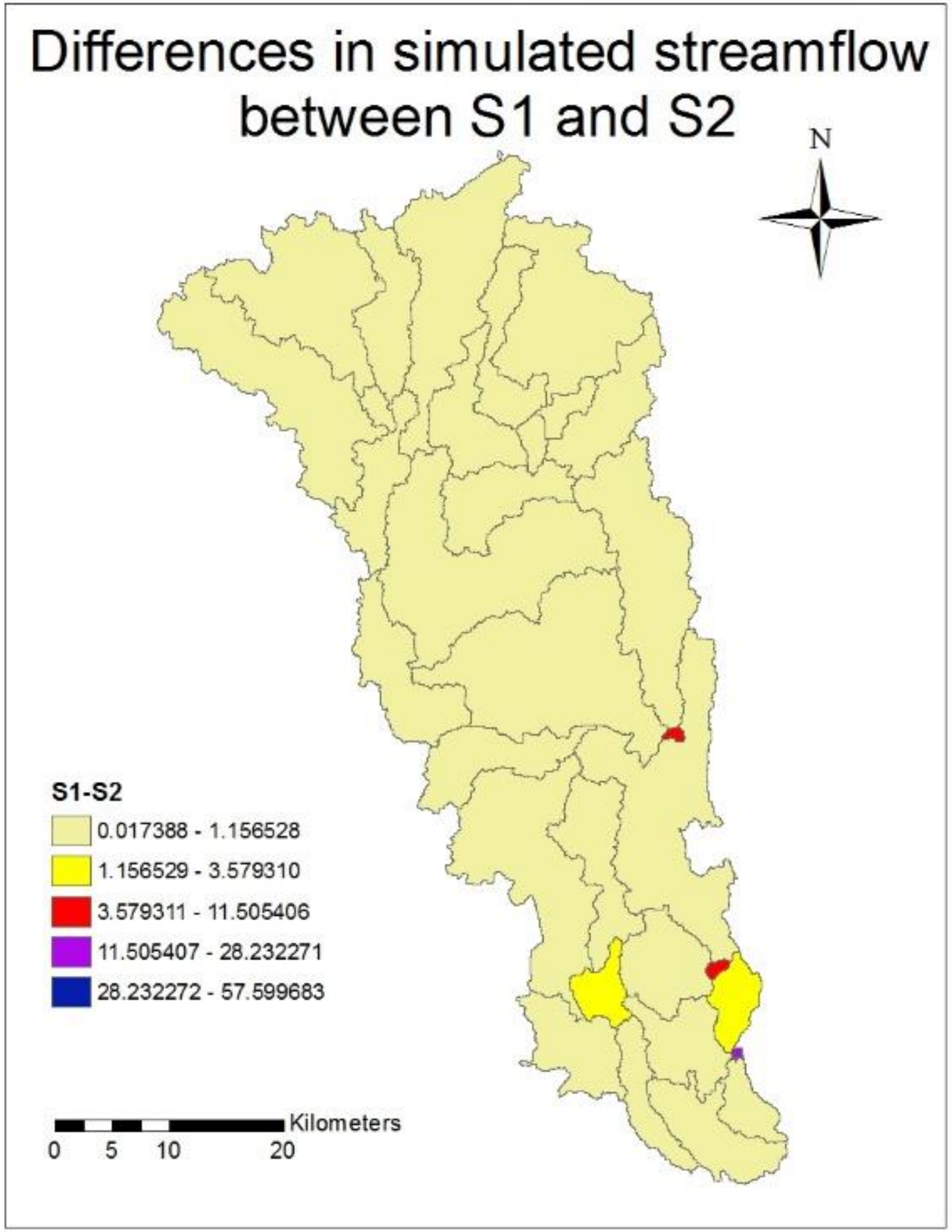
Comparison of simulated streamflow of the entire basin

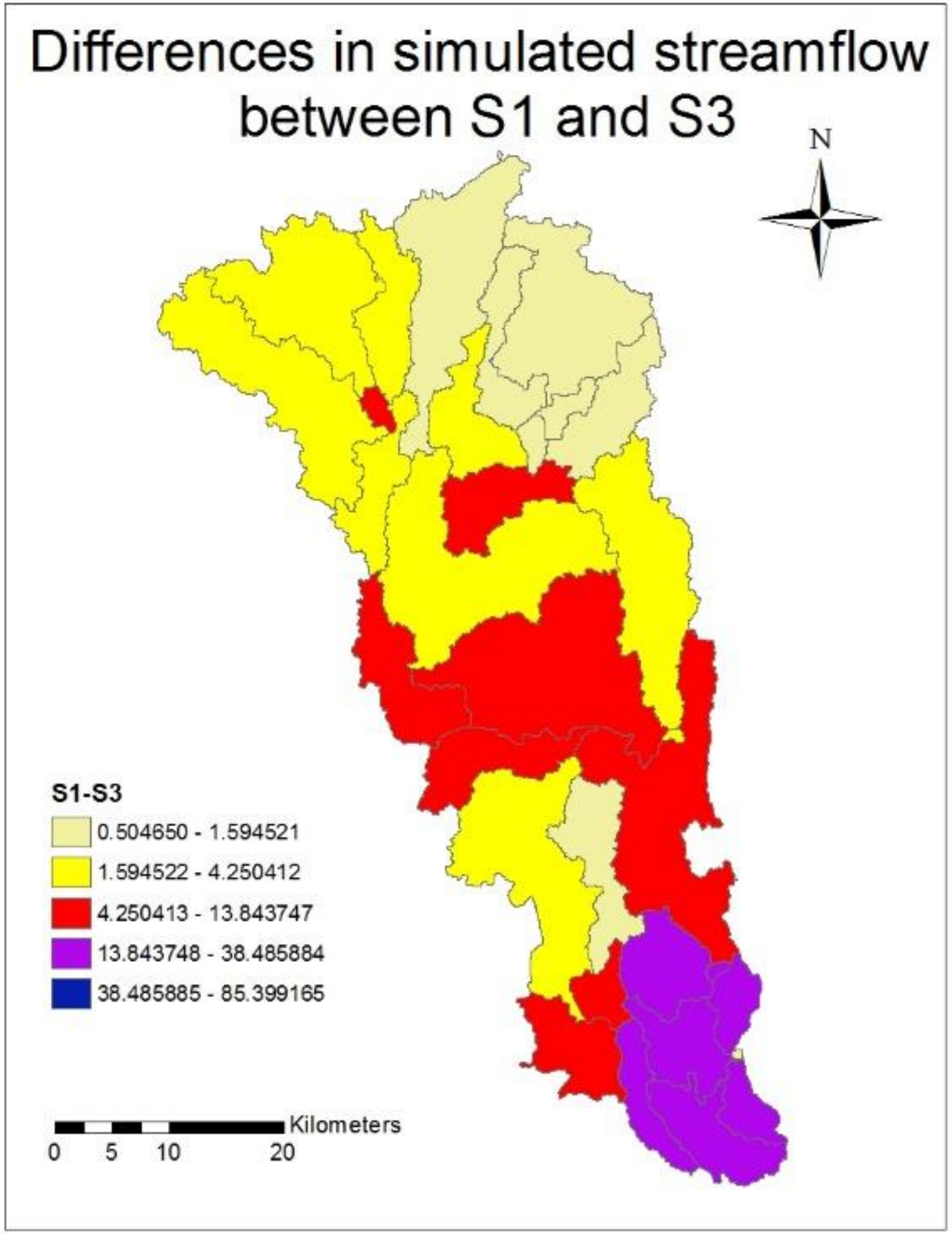


Daily differences in simulated streamflow of the three scenarios for the entire basin

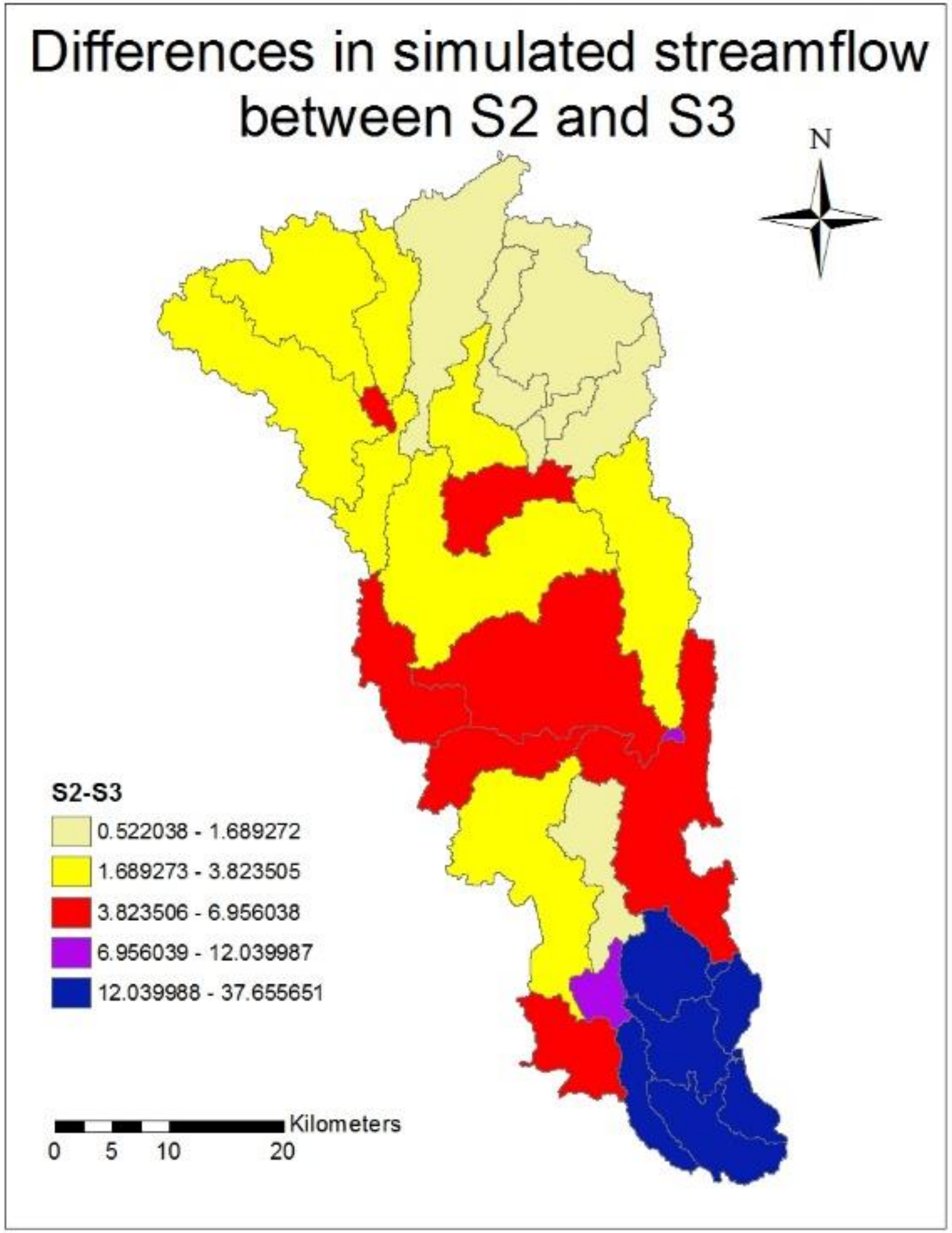
- Statistics of each pair of simulated results

Pair	Mean (mm)	St. dev. (mm)	Sig.(2-tails)
S1 - S2	0.35	2.20	0.00
S1 - S3	5.11	19.17	0.00
S1 - S3	4.76	18.13	0.00


Differences in simulated streamflow between S1 and S2
N
S1-S2
0.017388 - 1.156528
1.156529 - 3.579310
3.579311 - 11.505406
11.505407 - 28.232271
28.232272 - 57.599683
Kilometers
0 5 10 20



Differences in simulated streamflow
between S1 and S3
N
S1-S3
0.504650 - 1.594521
1.594522 - 4.250412
4.250413 - 13.843747
13.843748 - 38.485884
38.485885 - 85.399165
Kilometers
0
5
10
20


Differences in simulated streamflow between S2 and S3
N
S2-S3
0.522038 - 1.689272
1.689273 - 3.823505
3.823506 - 6.956038
6.956039 - 12.039987
12.039988 - 37.655651
Kilometers
0
5
10
20

Conclusion

- The more the imperviousness distributed, the larger ranges of impervious area and simulated streamflow the basin has.
- The simulated results show that the three methods resulted in substantially different streamflow.
- It was also found that these differences in simulated streamflow are significantly correlated with urban land use percentage.
- The results suggest that future research with urbanized basin should pay attention to the spatial distribution of fraction of imperviousness.