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Using the Simple Biosphere Model SiB2 to assess the urban impact on semi-arid surface climate: a Case Study in Marrakech, Morocco

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To date, 54% of the world's population lives in urban areas and this proportion is expected to increase to 66% by 2050. Certainly, urbanization is a sign of human development and thriving economic, but in ecological terms, it is the most significant and long lasting land transformation.
We present the impact of urbanization, as a form of land use, on surface climate in Marrakech, a semi-arid city in North Africa. We combine Landsat and MODIS data in the Simple Biosphere model (SiB2) to assess the impact of the impervious surface area (ISA) on carbon, energy and water exchanges at the land-atmosphere interface. The model simulates the highest temperatures in urban class, with spring average maximum temperature differences to other land cover classes ranging between 1.6 oC and 6.0oC. During summer, these differences are smallest (0.5oC) with barelands and highest (8.3oC) with irrigated lawns. Our analysis shows the daytime and nighttime mean surface temperatures to be strongly correlated to the ISA fraction. However lower daytime temperatures are simulated for small ISA fractions suggesting an important modulation of surface temperatures by vegetation evaporative cooling.
We find that highest ratios of surface runoff to precipitation occur in urban areas, with 43.8 % of incoming rainfall expelled as surface runoff, versus only 16.74 % for all other vegetation types combined. Urban and bare lands, representing 58.66% of the area, contributed only 6.97% of the total carbon uptake, implying that, if water is not limiting in the future, the city has potential to significantly increase its carbon sequestration and reduce its carbon footprint.