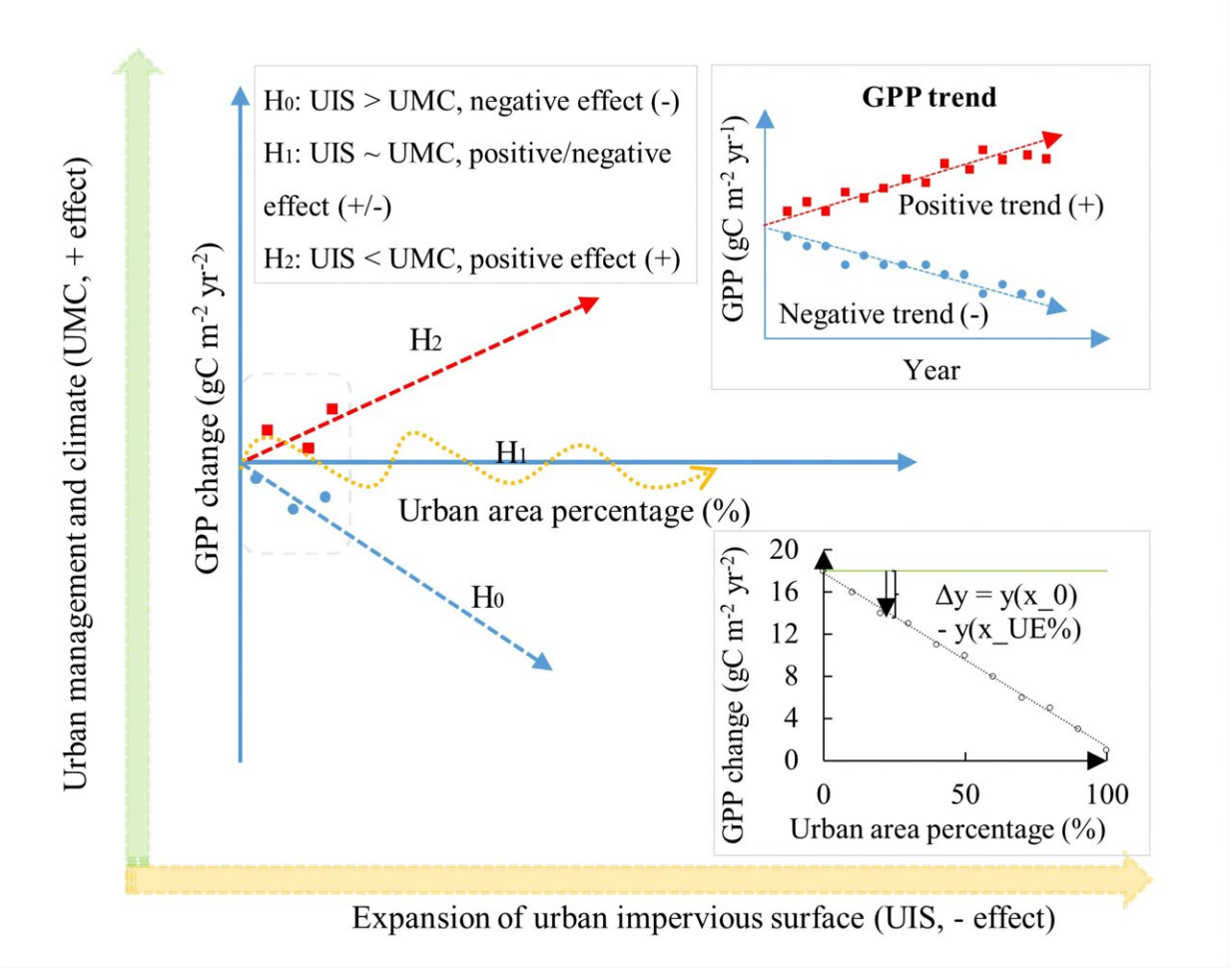
Quantifying the impact of urbanization on gross primary production

October 17 2022



A. Vegetation within an urban gridcell (URV or GPP) is affected by (1) expansion of urban impervious surface (UIS), which is a metric for urban expansion (UE), and (2) urban management and climate (UMC). H0, H1, and H2 (red, yellow, and blue lines) are the three-basic hypotheses for analyzing the offsetting effects of urbanization on GPP. B: Interannual trend of urban GPP

during 2000–2016. C: Corresponding result after normalization of urban GPP and nonurban GPP. Credit: *Journal of Remote Sensing* (2022). DOI: 10.34133/2022/9868564

With more than half of the world's population living in urban areas and urban areas continuing to expand, the role of urban vegetation in carbon sequestration becomes more important. A common assumption about the gross primary production (GPP) of vegetation—a measure of the amount of carbon captured by vegetation—is that it would decrease as urban areas increased, as more concrete, asphalt and other impervious surfaces would mean fewer trees, bushes and other plants.

This assumption has not been explored extensively until recently, when researchers from Henan University in China and the University of Oklahoma used satellite-based datasets to quantify the effects of urbanization from 2000-2016. They found that GPP in urban areas continued to increase during this time.

The researchers published their findings in the *Journal of Remote Sensing* in August 2022.

"Urban vegetation plays an indispensable role in the terrestrial carbon cycle and plays an important role in regulating urban climate," said corresponding author Xiangming Xiao, professor in the Department of Microbiology and Plant Biology at the Center for Earth Observation and Modeling at the University of Oklahoma.

"But the impacts of urbanization on GPP at the global scale have received little attention and are not well understood, in part because urban areas account for a small proportion of the global landmass and because there are many types of land cover within a city, making it

difficult to model and estimate GPP for those pixels that are classified as urban. Furthermore, urban areas can be hard to define."

To take these issues into account in establishing their methods, the researchers used a definition of urban ecosystems that encompassed expansion of impervious surfaces, urban land management and changes of local climate. They then used satellite-obtained data of impervious surfaces that showed gridcells at a spatial resolution of 5km and compared the data with a different dataset to confirm a reasonable consistency between the datasets.

"To quantify the impact of urbanization on GPP over years within individual urban gridcells, we developed a conceptual framework that considers the effects of both urban expansion, as measured by urban impervious surface, and urban management and climate (UMC) on urban-rural vegetation (URV) and frames the hypotheses on their likely impacts on GPP dynamics, based on literature review and synthesis," said Yaoping Cui, professor at the Key Laboratory of Geospatial Technology for the Middle and Lower Yellow River Regions at Henan University.

The researchers proposed three hypotheses: the impact of UIS on GPP is similar to the impact of UMC on GPP, which results in no net change in annual GPP; the impact of UIS on GPP is larger than the impact of UMC on GPP, which results in a decrease of annual GPP; and the impact of UIS on GPP is smaller than the impact of UMC on GPP, which results in an increase of annual GPP.

They found that almost 79.3% of the urban gridcells were consistent with the last hypothesis—that is, even though the proportion of urban impervious surface area within a single urban gridcells has been increasing from 2000-2016, the annual GPP of almost 80% of urban gridcells has been increasing as well.

"The negative impact of urban expansion (characterized by impervious surface) on GPP is largely compensated by the positive impact of urban management and local climate factors (UMC) in urban areas," Xiao said.

"Our findings on the continued increases of annual GPP in most of urban gridcells shed new insight on the importance of urban areas on terrestrial carbon cycle and the potential of urban management and local climate and environment on improving vegetation in urban areas."

The researchers said that next steps include making this data available for policymakers so that best management practices could further improve urban vegetation GPP. They also said they would like to examine other factors impacting urban vegetation.

"Our next goal is to separate the effects of natural and human activities on various types of vegetation in urban areas," Xiao said.

More information: Yaoping Cui et al, Continued Increases of Gross Primary Production in Urban Areas during 2000–2016, *Journal of Remote Sensing* (2022). DOI: 10.34133/2022/9868564

Provided by Journal of Remote Sensing