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An integrated, scale-invariant model to forecast global urban growth and transportation network development

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Urban growth and infrastructure development, especially road network growth, are two interactive, coevolving processes, and to understand long-term urban growth dynamics, it is crucial to model these two processes codependently. Hence, in this study, we present a modeling framework that is capable of capturing the feedback between urban land and road network in forecasting the amount and spatial patterns at large regional scales. While this proposed model with road length as a model parameter forecasts up to 1.2 times new urban areas globally under different scenarios, traditional models with no road length consideration forecasted 1.5–3.7 times more urban areas in 2050. We also forecasted the growth in road network length and pattern considering urban areas as the attraction point. Our model forecasted a substantial amount of new roads to be added to existing global road inventory by 2050– ranging between 1.67 million km and 3.37 million km under five Shared Socio-economic Pathways (SSPs) scenarios. We present Nigeria, Brazil and Bangladesh as case studies where significant new road development is forecasted in currently underdeveloped areas. The overall output from this codependent modeling process will inform the updated connectivity pattern along with an urban growth forecast. This approach enables us to capture the influence of transportation development and the ongoing large-scale transportation infrastructure development projects on urban growth at large, regional- and global- levels for more realistic assessments of the impacts of these projects on the environment.