Predicting the future landscape of a river

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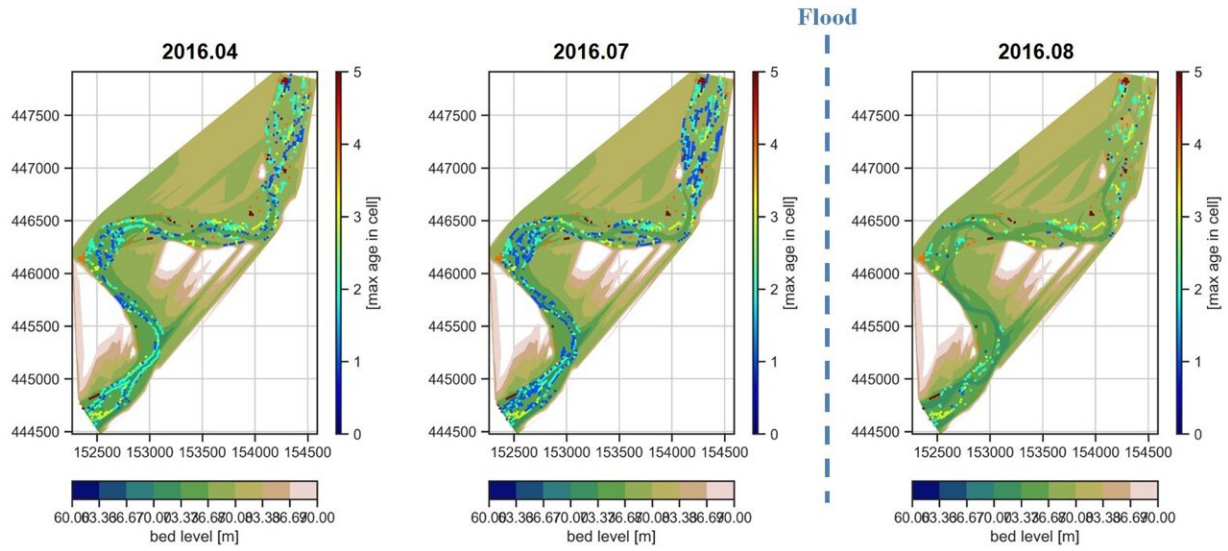


Vegetation dynamics in 2016. Credit: Korea Institute of Civil Engineering and Building Technology

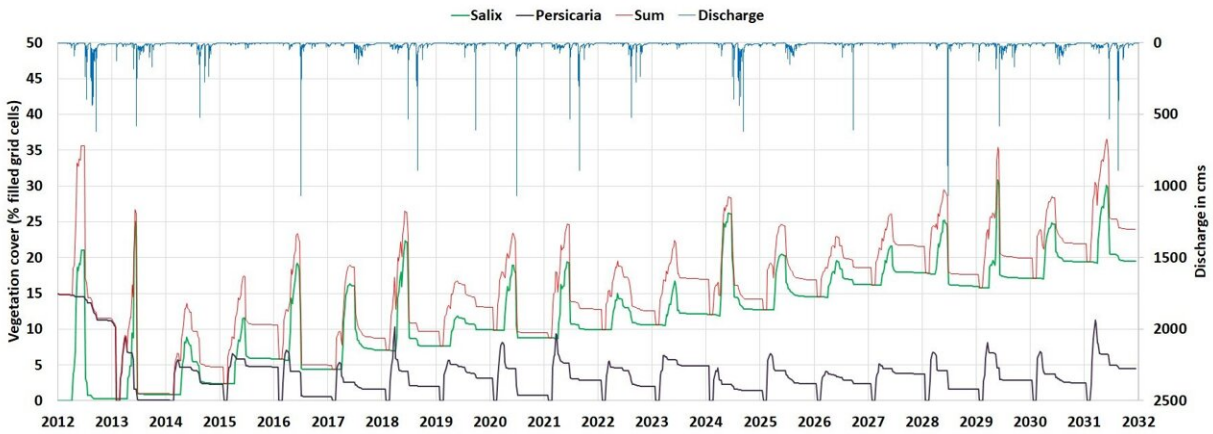
Climate change is changing the environmental condition of rivers; hence, it is no longer possible to manage modern rivers with methods that have been practiced under the past environmental conditions.

A joint research team, including scientists from Korea Institute of Civil Engineering and Building Technology (KICT) and Deltares of the Netherlands, has conducted research on prediction of the future changes in river landscapes using an eco-morphodynamic model applied to an actual river. According to the study result, the vegetation cover will

increase continuously until 2031, and the area covered by willow trees will occupy up to 20% of the river area. Using this modeling, efficiency in river management can be achieved by planning management practices in advance.

The eco-morphodynamic model developed by Deltares combines a vegetation model with Delft3D software, which is widely used in the field of river hydraulics. The Delft3D computes flow velocity, water depth and elevation of a riverbed. Then the vegetation model simulates the germination, settlement, growth and mortality of vegetation based on the Delft3D computation. Simultaneously, vegetation properties are converted to flow resistance and fed back into Delft3D.

KICT and Deltares applied the eco-morphodynamic model to Naeseongcheon Stream in Korea, which belongs to a temperate monsoon climate region with large seasonal hydrological fluctuations. Most of the Naeseongcheon Stream has characteristics similar to those of a natural river. As its riverbed is mainly composed of sand, its movement is active due to hydrological fluctuations and vegetation dynamics.



Changes in vegetation cover from 2012 to 2031. Credit: Korea Institute of Civil Engineering and Building Technology

KICT has been conducting long-term monitoring including LiDAR and hydrological surveys and vegetation map production since 2012, before significant vegetation establishment in Naeseongcheon Stream began. These monitoring data were used to build and verify the eco-morphodynamic modeling.

The modeling area is approximately 5 km long with curved reach, located in the middle-lower section of the Naeseongcheon Stream. The width is approximately 300 m, and the grid of the model was constructed considering the actual vegetation distribution that had occurred narrowly along the shoreline.

After conducting modeling with past data (2012-2019 period), the results were compared with the observed data. Compared with the ratio of coverage of tree species shown in the land cover map made with aerial photos, the area's willow trees in the new model showed a similar coverage ratio (In 2014, actual: 2.02%, model: 2.21%). In 2016, the model had adequately reproduced the actual situation by simulating the survival and growth of vegetation in the spring and the mortality of vegetation after the flood.

Considering climate change scenarios, the joint research team performed a long-term modeling of the period 2012 to 2031. The results showed that vegetation cover would continue to increase until 2031, and the area of trees would reach 20% in 2031.

This eco-morphodynamic model, jointly performed by KICT and Deltares, is a fully coupled model that links hydrology, vegetation, and morphology; and is able to reproduce the actual phenomenon better than other models. It has the advantage of increasing model reliability through application and verification in the actual river with abundant observed

data. With this model, we can predict future changes in river landscapes as well as ecosystem diversity and potential flood risks due to vegetation development.

"This eco-morphodynamic model is able to aid decision making for implementing appropriate river and vegetation management by simulating the landscape of future rivers according to climate change, though it needs continuous improvement to reflect the complexity of real rivers," said Dr. Lee, who took part in the research.

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