UCD Impact Case Study

New Perspectives on River Models

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SUMMARY

Rivers are arteries for human civilisation, and can enable prosperity or, in the case of flooding or drought, they can bring the potential for devastation. Dr Fiachra O'Loughlin from UCD School of Civil Engineering is using freely available satellite data to better model and understand large river systems.

His work on modelling the Congo basin has brought about deeper insights into the potential flashpoints for flooding and carbon cycling as well as dynamic data that could help local communities and businesses to use the river as a resource. Dr O'Loughlin has also worked on information to help researchers and organisations build more effective models of other river basins around the world.

"The work we do on remote sensing of river basins has applications around the globe, whether it's to predict flooding or to help local communities use the resources of rivers more efficiently. As engineers, I think it's important that we look at how to help society around the globe."

Remote Sensing of River Basins

Rivers are integral features for communities and societies around the world, who depend on them for irrigation and transport. Rivers can also cause flooding of land where people live and work, and areas we depend on for producing food. Understanding the physical features of rivers and surrounding areas means engineers can build better models of flood plains to predict how rivers will behave, but on-the-ground measurements of river characteristics can often be scant.

To source information about rivers, Dr O'Loughlin turns to the sky, or more specifically to information gathered about rivers and surrounding areas by satellites operated by the European Space Agency and NASA as they pass overhead.

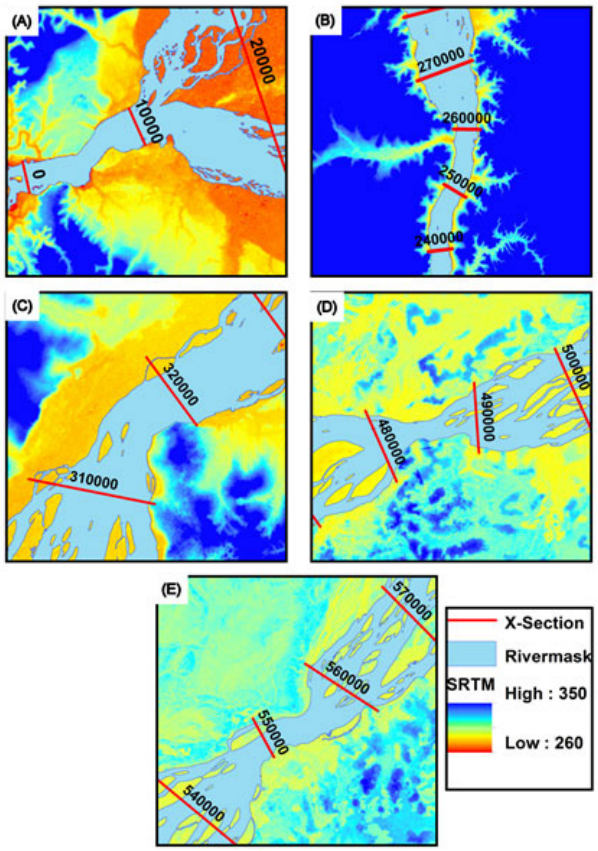
"By using satellite information, we can map rivers remotely, and use that information to build models of how they behave so we can predict aspects like water levels, and anticipate the risk of flooding," says Dr O'Loughlin. "And the information that I use to do this is freely available."

Much of Dr O'Loughlin's research has focused on the Congo River and surrounding areas in the Democratic Republic of the Congo (DRC), Africa.

Working with colleagues across the globe, Dr O'Louglin has used satellite data to measure and map the width of the Congo river at frequent intervals, and to build a hydraulic model of the central region of the Congo basin. "When we compared our data from remote sensing with available data

that was taken directly at source, the two matched well, so this increased our trust in the approach," he says of the work, which has formed the basis of new models and approaches that can be applied to rivers around the globe.

A Deeper Understanding of the Congo



Dr O'Loughlin's work on remotely sensing and mapping large river basins has **provided granular information – in many cases for the first time in this format – about the Congo River.** "I built a hydraulic model for the middle region of the Congo basin to help build more understanding about how the river system works," he explains. "Prior to my work, the area had not been studied in great detail and there was very little information easily available."

One aspect of his work mapped the width of the river at 250-metre intervals along its course, which provides an important 'zoomed-in' perspective on local features that could promote flooding of nearby lands. "Having this detail showed up several constrictions in the width of the river, where it narrows before expanding back out, and this can have a huge impact on the flow and flooding," says Dr O'Loughlin. "At these constriction points the water can rise up, and spread into the floodplains."

Dr O'Loughlin is taking an active role in **shaping the future of research on the Congo**, co-chairing a session at an American Geophysical Union (AGU) Chapman conference in Washington, DC, that focuses on the area. "We are looking at what we know about hydrology in the Congo region, and we are setting a road map for where research will go in the future," he explains.

Seeing Beyond Vegetation

One of the confounding factors when using satellite data to map flood plains is the vegetation, such as trees, in the area. This can make it difficult to find out about the nature of the underlying ground, explains Dr O'Loughlin, who has encountered the issue in his work on the Congo.

"Parts of the Congo run through swamp and forest, which is difficult to assess using satellite data," he says. "So I worked with colleagues in Bristol University, The Federal University of Rio Grande do Sul in Brazil and at Ohio State University, to come up with a way of processing the images so you can remove the vegetation."

The resulting product, Bare Earth Shuttle Radar Topography Mission (STRM), is now **freely available for researchers and other individuals and organisations to use**. "It has been released as Open License, which means it is freely available for commercial and research use," says Dr O'Loughlin. "There are at least two companies using it and it has been used by researchers around the world, for studies on the Amazon and the Mekong River. I have used it myself for work on the Congo and on the Volta River in Ghana and rivers in Ireland."

Predicting Water Levels

Another impact of Dr O'Loughlin's research is to enable the **prediction of water levels at specific locations for inland rivers**. Again, using freely available remote sensing data, he built up a resource to assess water levels for specific times and areas.

"This is of potential use for local communities," he explains. "For example, it could be used to help transport along the river, which is important in the context of the Congo. The water level in the Congo changes slowly and one of the main forms of transport for goods is barges that travel for weeks between cities. If you can predict the water levels over the

course of the journey, you can gauge the load that can be carried safely and effectively."

Understanding the dynamics of the river water can also help researchers to **understand how carbon is cycled** in the area, which is important for climate change models. "River basins in wetlands are huge carbon sinks, and by knowing whether the water in those wetlands is coming from rainfall or from rivers will help to build models of carbon in those wetlands."

Predicting water levels also offers **insight into potential floods**, and Dr O'Loughlin has built rainfall and runoff models for Ireland, which are freely available for those who wish to use them. "The work we do on remote sensing of river basins has applications around the globe, whether it's to predict flooding or to help local communities use the resources of rivers more efficiently," he says. "As engineers, I think it's important that we look at how to help society around the globe."

Research References

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Bare Earth SRTM https://data.bris.ac.uk/data dataset/10tv0p32gizt01nh9edcjzd6wa

AGU Chapman Conference, September 2018 https://chapman.agu.org/congo-hydrologic-research/