ALLIGATOR POWER

Yellow Waters region in Kakadu National Park during the wet season. Photo Michael Lawrence-Taylor.

National Environmental Research Program
NORTHERN AUSTRALIA HUB

NEW RESEARCH BY **DAVID WILLIAMS** IS SHEDDING LIGHT ON HOW TIDES AND WET SEASON FLOWS TRANSFORM THE ESTUARIES AND COASTS OF NORTHERN AUSTRALIA ON AN ANNUAL BASIS.

Coastal oceanographer David Williams from the Australian Institute of Marine Science has been working in the tropical macro tidal environments of northern Australia for over 30 years. The researcher's recent work has seen him frequent the Alligator Rivers region of the Northern Territory, where crocodiles, sharks and almost 340 fish species inhabit wide turbid rivers with massive mud banks, and tides which can rise six metres in a few hours.

The pulse of these large tides drives huge volumes of water in and out of the estuaries twice each day. The rushing water also carries high concentrations of sediment. The dynamic movement of water and sediment has a significant impact on the aquatic biodiversity of the region by creating different types of habitat. It also strongly influences water quality and light penetration, which in turn affects the growth of plants including algae.

Climate change is predicted to result in sea level rise and more intense rainfall and cyclone activity, but just how will climate change, as well as coastal and land use changes impact on these unique systems? David says a better understanding of water and sediment flows is helping to provide those answers.

FOR FURTHER INFORMATION

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Secrets revealed

The project, funded under the Australian Government's National Environmental Research Program, focuses on the South and East Alligator River estuaries, from their mouth to their tidal limits within Kakadu National Park, a distance of over 100 kilometres. The estuaries occupy a wide, flat floodplain within the Park. The iconic region supports outstanding cultural, natural and economic values — values that Indigenous and non-Indigenous people are working hard to preserve.

"The South Alligator is the only river system in Australia that is completely contained within a national park," David said.

"The two Alligator river systems are only minimally disturbed by outside human activities and they encompass a wide range of features such as gorges, wetlands, escarpments, coastal floodplains and estuaries. This makes it an ideal location to research natural macro tidal estuarine processes and how they interact with the adjacent freshwater wetlands and riverine systems."

Hydrodynamic and sediment monitoring paints a fascinating model of seasonal sediment movement within these highly turbid systems. During the dry season, without large upstream flows, the area transforms into a large saltwater estuary where tides are the dominant force. With the force of the ocean behind them, the incoming tides are faster and have higher water velocities, compared to the outgoing tides which drain out of the estuary channels more slowly over a longer period. The combined result is that incoming tides carry more sediment in from Van Diemen Gulf and the lower estuary than the outgoing tides can take out. Over the course of the dry season this muddy sediment is pushed upstream along the entire length of the estuary right up to the tidal limits, depositing up to two metres of sediment in the channels.

During the wet season, large freshwater flows from the above catchment scour the sediment out again, pushing it back to the lower estuary and Van Diemen Gulf, resulting in low salinity throughout the estuary's entire length. As a result, two very distinct habitats form over the course of a year. These habitats are not only controlled by water velocity and sediment movement, but also by the large changes in salinity.

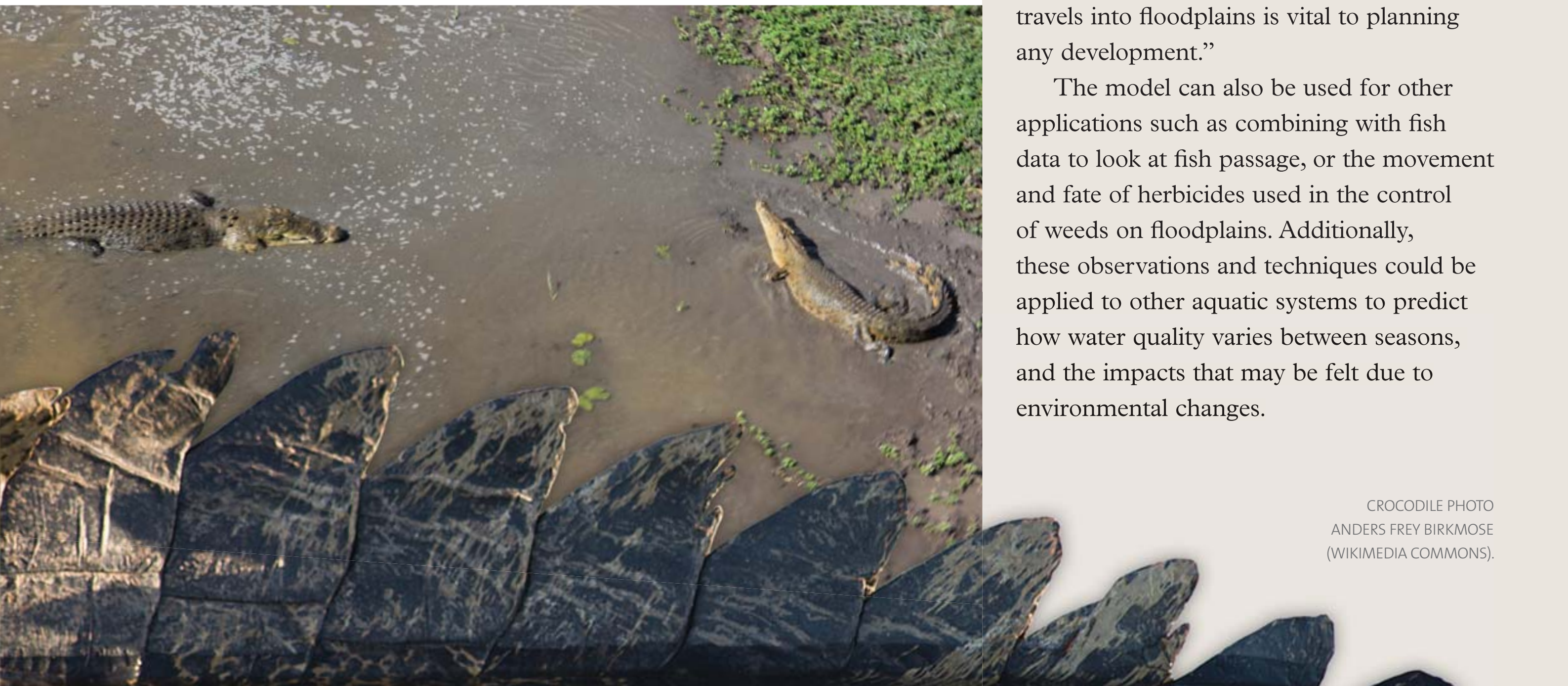
Over a three-year period researchers carried out many observations, including basic water quality measurements. "We found that the majority of the nutrients come from the adjacent freshwater wetlands where the growth of plants, algae and phytoplankton are high," said David.

"During the wet season these nutrients and organic matter are flushed into the estuary by the large freshwater flows and tides. When the freshwater flows cease at the end of the wet season, so does the vast majority of the nutrient inputs. The material delivered over the course of the wet season sets up the estuary with nutrients for the remainder of the year."

David says the biodiversity and productivity of the estuary is very dependent on the function and health of the upstream wetlands. As many of the fish in the wetlands also spend part of the life in the estuary, the wetlands and estuary are intrinsically linked. The productivity of the estuary is dependent on the wetlands and the riverine inflows.

"Understanding this has allowed us to develop models where we can reasonably accurately predict the impacts to the estuary from climate change, weed invasion or development within the catchment," he said.

Crocodiles on Kakadu's mud banks during the wet season. Photo Duncan Buckle.



CROCODILE PHOTO
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Predicting patterns

Detailed hydrodynamic models were created based on extensive field measurements. The research team surveyed the bathymetry (bottom of the estuary and channels) and measured tides and water velocity during both the wet and dry seasons. The team then used LIDAR remote sensing to survey the adjoining floodplain and the tributary channels, which carry water between the estuary and floodplain.

These models were compared against observations researchers took in the field. They were then used to run a number of potential future scenarios, such as elevated sea levels, to predict the effects on the estuary, coastal floodplains and freshwater wetlands.

"These models are particularly relevant to research looking at estuarine plant and animal species, as well as the management of water quality. They show that saltwater intrusion depends on the rate of sea level rise, as well as how stable the channel banks are—which is also partly dependent on sediment transport," David said.

"Even small sea level changes could alter these system's freshwater habitats, which would have damaging impacts to the life they support and also local industry. Park managers will be faced with difficult choices about where to prioritise resources to protect areas and they need to be well informed about which actions could work."

"Our modelling can be used as a base on which to develop strategies in areas where managers choose to undertake actions to mitigate the effects of saltwater intrusion. Understanding where and how salt water travels into floodplains is vital to planning any development."

The model can also be used for other applications such as combining with fish data to look at fish passage, or the movement and fate of herbicides used in the control of weeds on floodplains. Additionally, these observations and techniques could be applied to other aquatic systems to predict how water quality varies between seasons, and the impacts that may be felt due to environmental changes.