



**Australian Government**

**Department of the Environment, Water, Heritage and the Arts**

## **Marine and Tropical Sciences Research Facility Milestone Report, December 2008**

**Program 7: Halting and Reversing the Decline of Water Quality**

**Project 3.7.4: Wetlands and floodplains: Connectivity and hydro-ecological function**

**Project Leader: Dr Jim Wallace, CSIRO**

### **Summary**

The project has continued to make good progress in the last six months. Detailed calibration work with the MIKE21 Hydro-dynamic model has been completed and a strong focus on developing wetland connectivity indices has followed. This work is carried out in close collaboration with MTSRF partners in Project 3.7.3 (Richard Pearson and Angela Arthington). Connectivity indices for ten different wetlands have been completed showing how these indices vary with flood size and wetland location. Work has also started on the calculation of post flood connectivity, using LiDAR data to define the stream and drain network. The project has been invited to submit a paper on flood loads to a Special Issue of *Freshwater and Marine Research* on GBR Water Quality and this is almost completed. We will also continue to record flood depths, suspended sediment and nutrient concentrations in flood waters during over bank events in the Tully-Murray catchments during the 2008/2009 wet season.

### **Project Outputs / Milestones**

<b>Targeted Activity</b>	<b>Due Date</b>
<p>Report 1 Submission:</p> <ul style="list-style-type: none"><li>• Input into progress update for activities listed against objectives (a)-(e) listed in the ARP Project Schedule. [JCU]</li><li>• Input into progress update for activities listed against objectives (a)-(e) listed in the ARP Project Schedule. [GU]</li><li>• Progress update for activities listed against objectives (a)-(e) listed in the ARP Project Schedule. [CSIRO]</li><li>• Evidence that hydrodynamic model development for material transport and wetland connectivity is progressing. [CSIRO]</li><li>• Plan of communication outputs and products for Year 3 and summary of any liaison activities undertaken to date including minutes of meetings/workshops if applicable. [CSIRO]</li><li>• <i>Pathways to Impact</i> Report for End User Relevance.</li></ul>	<p>31 December 2008</p>

## Project Results

### *Description of the results achieved for this milestone*

#### **(a) Refine hydro-dynamic model for Tully-Murray catchments, including further testing of the sediment and nutrient sub-models.**

During the past six months the performance of the MIKE21 hydrodynamic model has been improved in two ways. Firstly, the runoff entering the model domain has been better quantified by using the DHI rainfall-runoff model (NAM) for all of the sub-catchments (66) in the Tully and Murray that feed water to the floodplain. Two of these sub-catchments have been directly calibrated using flow data from Cochable Creek and Upper Murray gauging stations, obtained from the Queensland Department of Natural Resources and Water. Within the floodplain, hydrodynamic model computed flow at the Euramo gauge station on the Tully River has been compared with measured data and some adjustments made to the hydraulic roughness parameters in the model. There is now good agreement between the modelled and measured flood flows in terms of flood magnitude and timing of peak flow. The MIKE 21 model is now ready to have its sediment and nutrient sub-models attached, but this work has been deferred to give precedence to the work on floodplain connectivity described below. It is anticipated that sediment and nutrient modelling will begin in early 2009.

Further progress has been made in estimating flood loads by analysing water quality data collected during the five flood events in 2008. This gives a total of nine flood events that have been monitored and analysed between 2006 and 2008. The new flood data support our previous conclusions that floods make a very significant contribution to the marine load. Sediment and nutrient loads in floods are large fractions (> 50%) of the total annual average river borne loads. Since much of the flood discharge is not measured by the river gauges, this flood load will add significant amounts to the currently estimated annual average riverine load. The new 2008 data also confirm that after the 'first flush' of the wet season, flood waters carry more dissolved organic nitrogen (DON) than dissolved inorganic nitrogen (DIN) and this is the opposite of their concentrations in river water. Consequently DON loads to the ocean may be much higher (nearly twice) those previously estimated from riverine data. The combined analyses of flood water quality from all of the flood events between 2006 and 2008 has been written up in a paper which is to appear with other papers on water quality research in the Tully-Murray catchments in a Special Issues of *Marine and Freshwater Research*.

We will also continue to record flood depths, suspended sediment and nutrient concentrations in flood waters during over bank events in the Tully-Murray catchments during the 2008/2009 wet season. This will be done using the semi-automated flood water quality sampling system that was designed and installed in the Tully-Murray floodplain during 2006 (see Hawdon *et al.* 2007).

#### **(b) Develop and refine hydro-dynamic model estimates of wetland connectivity and compare with other flood models used elsewhere in Australia (e.g. Murray-Darling).**

Considerable progress has been made in the use of the MIKE21 model to calculate connectivity indices for ten different wetlands in the Tully-Murray catchments. The analysis has shown that the connectivity of different wetlands during flooding events is governed by their location and the size of any given flood. For example, most of the wetlands connect sooner and for longer to the Murray River than they do to the Tully River. Further analysis is now under way to calculate wetland connectivity in the post flood period, as this has also been identified as important for wetland ecology and fish passage. This analysis draws heavily on the LiDAR data, which gives a means of identifying the stream and cane drain

network along with accurate cross-sections of these channels that are needed to identify when they will flow and between which water bodies. These wetland connectivity analyses are developed in close collaboration with Richard Pearson (JCU) and Angela Arthington (GU), so that the connectivity indices derived are of relevance to their studies of the wetland ecology. The results of these novel analysis have been reported at several fora including, (i) the Coast to Coast Conference in Darwin (18-21 August 2008); (ii) the CSIRO Seminar Series in Townsville (16 October 2008); (iii) the Healthy Water Ecosystems Science Conference in Cairns (27-30 October 2008); and the CSIRO Land and Water Science Executive (18 November 2008).

Several meetings have been held between CSIRO staff in Project 3.7.4 and JCU staff and students. These continue to be extremely useful in helping to refine the focus of Projects 3.7.3 and 3.7.4 and the PhD work associated with them. The result is a strongly linked joint hydrological and ecological study of a series of wetlands in the Tully-Murray. Data is freely exchanged between the partner organisations (e.g. Wetland ecology surveys carried out by JCU and GU are reported at our joint meetings and CSIRO hydrological and dissolved oxygen data in Kyambul lagoon have been shared with JCU and GU to help in the interpretation of the chemical and ecological status of this wetland).

**(c) Summary of communications and liaison activities.**

- Jim Wallace invited to submit a paper on flood loads to the Special Issue of *Marine and Freshwater Research* summarising water quality research in the Tully-Murray catchments.
- We hosted a visit by JCU students from Cairns to our floodplain field installations in Tully (30 July 2008).
- Jim Wallace presented the results of MTSRF Project 3.7.4 at the Coast to Coast Conference in Darwin (18-21 August 2008).
- Angela Arthington presented the combined results of MTSRF Projects 3.7.3 and 3.7.4 at the CERF Conference in Canberra (16 September 2008).
- Fazlul Karim presented the results of the MTSRF 3.7.4 hydrodynamic modelling and connectivity work at the CSIRO Seminar Series in Townsville (16 October 2008).
- Jim Wallace presented the results of the MTSRF 3.7.4 Project to the Healthy Water Ecosystems Science Conference in Cairns (27-30 October 2008) and the CSIRO Land and Water Science Executive (18 November 2008).
- Fazlul Karim presented the MTSRF 3.7.4. Project to the Healthy Water Ecosystems Science Conference in Cairns (27-30 October 2008).
- The floodplain connectivity and wetland ecology studies were also presented (by Professor Angela Arthington) at an Eco-hydrology meeting at the Australian Tropical Forest Institute at JCU in Cairns on 21 November 2008.
- Freshwater quality sub-projects collaboration: Further meetings have taken place between Jim Wallace, Richard Pearson and Angela Arthington to develop sub-project details and collaborative links between Projects 3.7.3 and 3.7.4.
- The Cardwell Shire Floodplain Steering Committee has been kept briefed on progress with the MTSRF Projects 3.7.4 and 3.7.3.

**(d) Publications arising from the project and associated research include:**

- WALLACE, J.S., STEWART, L.S., HAWDON, A., KEEN, R., KARIM, F. and KEMEI, J. 2009. Flood water quality and marine sediment and nutrient loads from the Tully and

- Murray catchments in north Queensland, Australia. Paper for the Special Issue of *Marine and Freshwater Research* on "Great Barrier Reef water quality" (In Prep.).
- ARTHINGTON, A. H. 2008. Water scarcity, environmental flows and floodplain ecology. In proceedings of the CERF Conference, 16th September 2008, Canberra.
  - WALLACE, J.S., STEWART, L.S., HAWDON, A. and KEEN, R. 2008. The role of coastal floodplains in generating sediment and nutrient fluxes to the Great Barrier Reef lagoon in Australia. *International Journal of Ecohydrology and Hydrobiology* (Submitted).
  - KARIM, F., HENDERSON, A., WALLACE, J., RASH, P. 2008. An assessment of wetland connectivity in the Tully-Murray floodplain using a hydrodynamic model. In proceedings of MTSRF Annual Conference, 28-30 April 2008, Cairns.
  - WALLACE, J.S., STEWART, L.S., HAWDON, A. and KEEN, R. 2008. The impact of floods on sediment and nutrient fluxes from the Tully-Murray catchments to the GBR lagoon. CSIRO Land and Water Science Report No. /08; 53pp.
  - KARIM, F AND WALLACE, J.S. 2008. Assessment of Sediment and Nutrient Transport across the Tully-Murray Floodplain using the SedNet Model. Report to the Marine and Tropical Science Research Facility. CSIRO Land and Water Science Report No. 59/08; 18pp.
  - WALLACE, J.S., HAWDON, A., KEEN, R. and STEWART, L. 2007. Flood water quality and sediment and nutrient loads to the Coral Sea after cyclone Larry. In: *Abstracts: Cyclone Science Seminar: Impacts of cyclones on terrestrial tropical ecosystems – insights from severe cyclones Larry and Monica*. 27-18 September 2007, Australian Tropical Forest Institute, JCU, Cairns
  - HAWDON, A., KEEN, R., KEMEI, J., VLEESHOUWER, J. and WALLACE, J.S. 2007. Design and application of automated flood water quality monitoring systems in the Wet Tropics. CSIRO Land and Water Science Report 49/07; 27pp.
  - WALLACE, J.S., ARTHINGTON, A.H., AND PEARSON, R.G. 2007. Hydro-ecological modelling in coastal catchments: connectivity and hydro-ecological function. Report from the MTSRF Workshop held at the CSIRO Davies laboratory, Townsville, 19 – 20 April 2007. CSIRO Science Report XX/07; 55pp.
  - WALLACE, J.S., HAWDON, A., KEEN, R. and STEWART, L.S. 2007. Water quality during floods and their contribution to sediment and nutrient fluxes from the Tully-Murray catchments to the GBR lagoon. Report to FNQNRM for their Water Quality Improvement Plan. CSIRO Science Report Y/07; 35pp.
  - WALLACE, J.S., BOHNET, I., DISHER, M., FORD, P., GEHRKE, P., HARTCHER, M., HAWDON, A., HENDERSON, A., HODGEN, M., McJANNET, D., KEEN, R., McKEOWN, A., LARSON, S., METCALFE, D., ROEBELING, P., STEWART, L., VLEESHOUWER, J., WEBSTER, T., WESTCOTT, D. and WILLIAMS, K. 2006. Floodplain renewal research in coastal lowlands adjacent to the Great Barrier Reef, Australia. *Proceeding of the 2<sup>nd</sup> International Conference on Estuaries and Coasts*, Guangzhou, China 28-30 November 2006. Vol 2, 662-669.

### **Problems and/or Opportunities**

Professor Angela Arthington has been appointed to the **Environmental Water Scientific Advisory Committee** (DEWHA) to provide advice to the Commonwealth Environmental Water holder on how to manage the Commonwealth's water holdings to protect and restore the environmental assets of the Murray-Darling Basin and other Australian rivers.