A HYDROGEOMORPHIC STUDY OF MOORES CREEK IN CENTRAL QUEENSLAND, AUSTRALIA

Jordan Maultby | jordan.maultby@cqumail.com

Supervisors: Dr Ben Taylor (CQU) | Monishaa Prasad (RRC) | Ben McMaster (AECOM) | Richard Corbett (AECOM)

INTRODUCTION

Hydrogeomorphology is defined as 'an interdisciplinary science that includes the linkages among various hydrologic and geomorphic processes' (Sidle & Onda 2004) and enables us to better understand surrounding watercourses and their catchments.

Moores Creek is a dynamic system with a stream length of about 17km which collects runoff from the 30.6km^2 catchment. The majority of the catchment falls within Mt Archer National Park with the lower segment of the creek meandering through the suburbs of Norman Gardens, Frenchville, Park Avenue and Berserker, eventually discharging into the Fitzroy River.

Local catchments within Rockhampton have recently endured several notable flood events, with the most memorable recent events being generated by Ex-TC Oswald (2013), TC Marcia (2015) and Ex-TC Debbie (2017). Whilst ecologic, hydrologic and hydraulic studies have been completed for Moores Creek over recent years...

"...the geomorphic response of the system to recent events is currently unknown and unquantified."

As such, this study is placed to bridge this knowledge gap.

METHODOLOGY

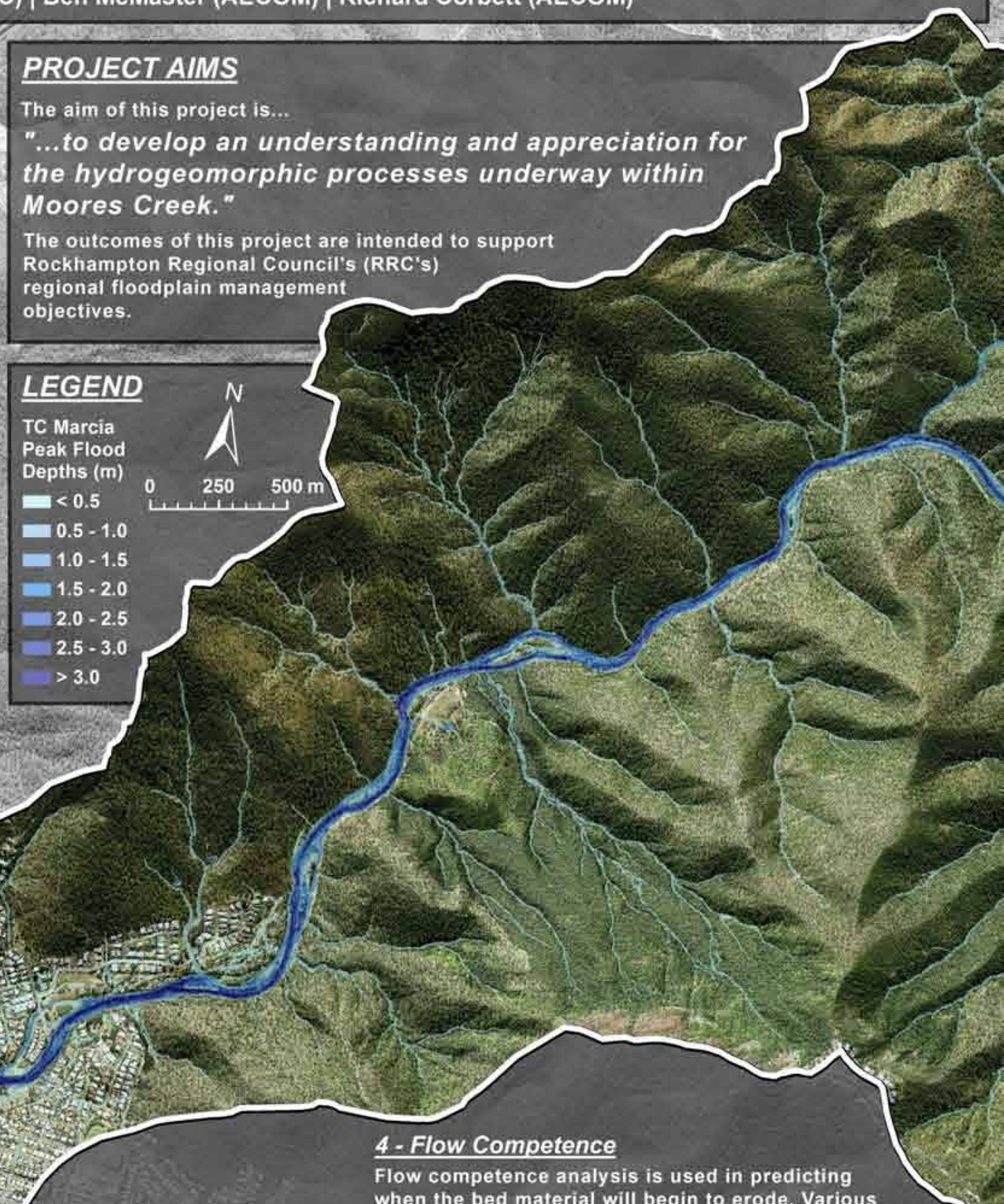
1. Retrieve, develop and collate data required to support analysis.
2. Identify historic change within Moores Creek channel.
3. Establish relationships between hydrologic and geomorphic components.
4. Test & evaluate flow competence models.
5. Quantify geomorphic effectiveness of Ex-TC Oswald and TC Marcia events.

PROJECT AIMS

The aim of this project is...

"...to develop an understanding and appreciation for the hydrogeomorphic processes underway within Moores Creek."

The outcomes of this project are intended to support Rockhampton Regional Council's (RRC's) regional floodplain management objectives.



RESULTS

The structure of the results aligns with the project methodology steps presented above. The number included in each subheading correlates to the relevant step in the methodology.

1 - Data Collection

Aerial imagery and LiDAR were available for 2009 and 2016.

Soil profile data was not available. This resulted in key grain sizes being estimated from planimetric analysis (photosieving).

Factors of 1.05 or less were used to correct data derived from photographs.

1 - Model Development

The existing Moores Creek TUFLOW model was developed to utilise GPU hardware to improve simulation speeds.

The revised model was re-calibrated to the TC Marcia flood event and validated to the Ex-TC Debbie flood event. The final calibration resulted in an average difference of +60mm during TC Marcia and -20mm during Ex-TC Debbie.

Figure 1 - TC Marcia Results

2 - Sediment Flux

Sediment flux is the analysis of change in volume over time using multi-temporal LiDAR. Across Ex-TC Oswald (2013) and TC Marcia (2015), the system had a net loss of over -80,000m^3. More than 60% occurred within the urban segment, which eroded 4.5x faster than upstream segments. Largest change correlated with areas of high weed intrusion and velocity.

"The urban segment had a loss rate of 7.2m^3/m (4.5x the upstream section)."

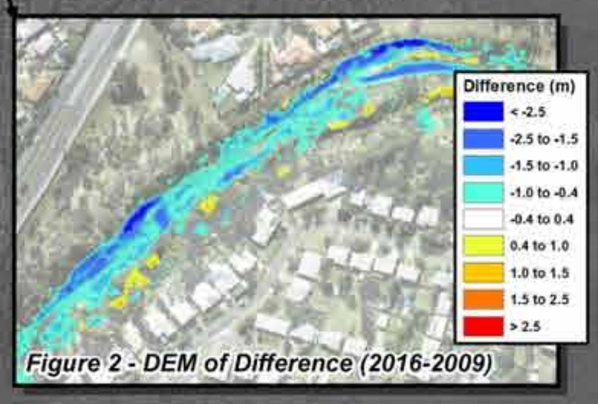


Figure 2 - DEM of Difference (2016-2009)

3 - Connectivity Plots

The figure below describes the variation of channel area and can be used to identify revegetation opportunities.

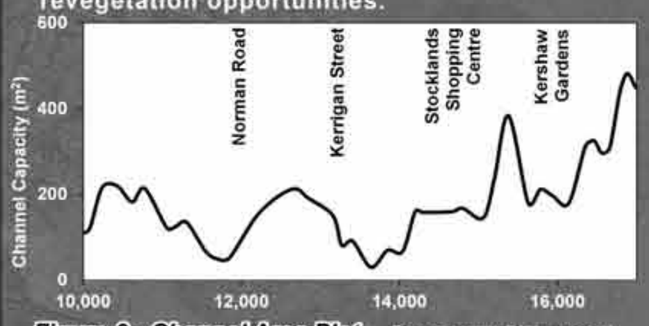


Figure 3 - Channel Area Plot

4 - Flow Competence

Flow competence analysis is used in predicting when the bed material will begin to erode. Various methods (e.g. velocity, stream power) are utilised for this analysis; this study tested the applicability of eight models. Of these models, bed shear stress (by Parker et al. 2010) was shown to be the most appropriate model with a precision of 81% in the worst instance. Other models achieved a precision of 65% or lower.

Flow competence thresholds were tested at 26 locations throughout the creek, revealing that in the vast majority of instances, event magintudes as frequent as 1 in 10 years are able to mobilise the entire bedload fraction.

5 - Geomorphic Effectiveness

Establishing the geomorphic effectiveness of an event provides insight into its ability to modify the channel form. Costa and O'Connor (1995) identified that the total energy along with the average stream power serves as a tool for evaluating an event's geomorphic effectiveness.

Specific stream power trends calculated by the TUFLOW model were integrated over time above the widely-adopted alluvial erosion threshold of 300W/m^2. Assessment of the Ex-TC Oswald and TC Marcia flood events revealed the longer, Ex-TC Oswald event had 20MJ more energy available to effect geomorphic change despite TC Marcia having the highest recorded flood heights and a higher average stream power. As such, Ex-TC Oswald was more than likely responsible for the majority of sediment flux in Moores Creek between 2009 and 2016.

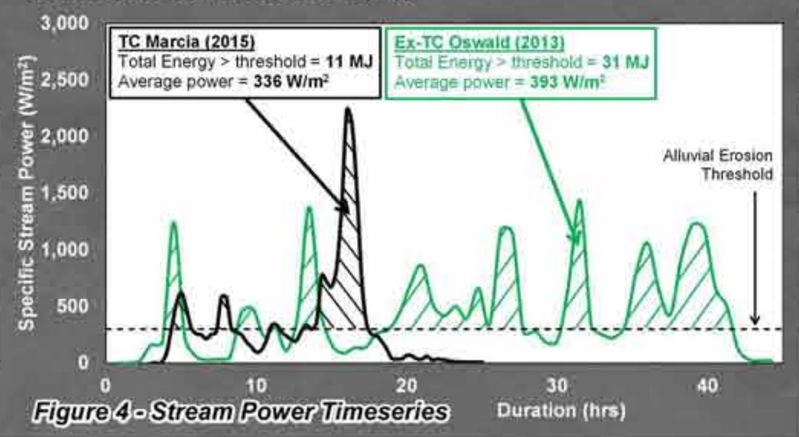


Figure 4 - Stream Power Timeseries

KEY OUTCOMES

Key outcomes from the study include:

- *Practical, inexpensive means of maintaining ongoing data collection.*
- *Risk identification of erosion issues affecting infrastructure (bridges, pipelines etc.) and the community (i.e. landholders).*
- *Areas with revegetation potential. (Connectivity Plots)*
- *A predictive tool to assess an event's potential to change (erosion / deposition) the channel form. (Flow Competence + Geomorphic Effectiveness)*

CONCLUSION

As a result of the study, the following points can be established:

- *Ongoing, practical data collection is possible and of significant value.*
- *Over only 7 years (2 notable flood events), over 80,000m^3 was eroded into the Fitzroy River channel.*
- *60% of erosion occurred within the urban segment.*
- *Events as frequent as 1 in 10 years are able to mobilise most of the channel bed.*
- *Despite TC Marcia having a higher flood extent, Ex-TC Oswald was likely responsible for the majority of change in Moores Creek between 2009 and 2016.*

RECOMMENDATIONS

1. Communicate findings to key stakeholders.
2. Use findings for ongoing corridor management.
3. Apply to other catchments and wider Fitzroy Basin.

REFERENCES

Costa, J & O'Connor, J 1995, 'Geomorphically effective floods', Natural and Antropogenic Influences in Fluvial Geomorphology, vol. 89, pp. 45-56.

Parker, C, Clifford, N & Thorne, C 2011, 'Understanding the influence of slope on the threshold of coarse grain motion', Geomorphology, vol. 52, pp. 51-65.

Sidle, RC & Onda, Y 2004, 'Hydrogeomorphology: overview of an emerging science', Hydrological Processes, vol. 18, pp. 597-602.