Flay, Shaun Alexander (2006) ***Climatology of Queensland landfalling tropical cyclones: evaluating instrumental, historical and prehistorical records.*** **PhD thesis, James Cook University.**

Climatology of Queensland Landfalling Tropical Cyclones: Evaluating Instrumental, Historical and Prehistorical Records

Thesis submitted by

Shaun Alexander FLAY

in February 2006

for the degree of Doctor of Philosophy

in the School of Tropical Environmental Studies and Geography

James Cook University

STATEMENT OF SOURCES

DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree of diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

____________________ 1 November 2006

Signature Date

STATEMENT OF ACCESS

I, the undersigned, author of this work, understand that James Cook University will make this thesis available for use within the University Library and, via the Australian Digital Theses network, for use elsewhere.

I understand that, as an unpublished work, a thesis has significant protection under the Copyright Act and;

I do not wish to place any further restrictions on access to this work.

______________________	1 November 2006
Signature	Date

ELECTRONIC COPY

I, the undersigned, the author of this work, declare that the electronic copy of this thesis provided to the James Cook University Library is an accurate copy of the print thesis submitted, within the limits of the technology available.

______________________	1 November 2006
Signature	Date

ABSTRACT

Knowledge of the probability of occurrence of major tropical cyclone events forms an integral part of developing hazard mitigation strategies in regions prone to their impact. Queensland landfalling tropical cyclones are analysed in this study in order to provide a climatology of event frequency and magnitude. The adopted modelling approach differs from previous studies in the region in that it focuses specifically on the incorporation of historical and prehistorical information. The availability of such records offers a means to test whether the satellite-based instrumental record, which encompasses only the last few decades, provides a representative sample with which to characterise extremes of the process.

A methodology based on Bayesian statistical techniques is presented and applied to facilitate the incorporation of historical information. Through this approach, historical observations are specified as prior information for models of seasonal activity and intensity. When combined with reliable information from the instrumental record, subsequent inferences on the landfall climatology can be made with greater precision and confidence. Among the statistical models considered is a Poisson distribution for seasonal counts, a Generalised Linear Model that incorporates an index of ENSO as a predictor for seasonal activity, and a Generalised Pareto Distribution for tropical cyclone minimum central pressures.

The inclusion of historical information is shown to lead to increased certainty in parameter estimates for these models. Furthermore, the incorporation of historical information on storm intensities leads to predictions of the frequency of major

landfall events that are higher than what would be expected from an analysis using only the instrumental record. A further outcome of implementing a Bayesian strategy is the development of predictive distributions showing the probability of specific levels being reached in future periods.

A trend analysis identified the presence of decadal to multi-decadal variability in seasonal storm numbers and in the strength of the relationship between ENSO and tropical cyclone activity. A statistically significant downward trend in landfalling storm intensities over the 20th century was also detected. For Coral Sea region tropical cyclones, there is also evidence of decadal variability in storm numbers. Interestingly, a marginally significant upward trend in peak intensities is found for the Coral Sea region over the period 1960/61-2004/05, which is in contrast to the general downward trend in landfall intensities. No evidence is found to suggest that ENSO has a direct effect on either regional or landfall storm intensities.

A simulation model was then derived from the Coral Sea region satellite record and subsequently applied to generate a series of landfall events. Comparison of the observed landfall record with this simulated series showed close agreement. A further comparison of observed and simulated records with prehistoric data, previously reconstructed from storm ridge sequences found throughout the Great Barrier Reef region, showed some discrepancy. In particular, estimates based on observed and simulated data were tending to underestimate the frequency of major events. Uncertainties inherent in reconstructing storm intensities from the geological record complicate the utility of this comparison, however, suggesting further work is needed to address the use of prehistoric records as an independent data source.

ACKNOWLEDGEMENTS

Foremost I would like to thank my supervisor Professor Jonathan Nott for his continued support during the course this research. Jon provided the catalyst for the project and his invaluable contribution through ongoing discussions on the topic has provided the encouragement necessary to complete this thesis.

I am also indebted to the assistance of Greame Hubbert and Steve Oliver from Global Environmental Modelling Systems (GEMS) for providing several of the physical models used in Chapter 7 as well as technical support on their application.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES