Editorial

An East Coast Low caused significant damage to the Hunter coast near Newcastle in New South Wales in June 2007, resulting in nine deaths, insurance claims of $1.6 billion and the grounding of the 40 000 tonne Pasha Bulka bulk carrier. Notwithstanding the significant damage and loss of life caused by East Coast Lows (ECLs), these intense low-pressure systems occurring off the Australian east coast contribute significantly to urban water security within the eastern seaboard of Australia. This region is home to almost nine million people and has billions of dollars of public and private infrastructure. In this special issue Vernon-Kidd et al. describes the nature and impacts of the Pasha Bulker storm, reflects on lessons learned and subsequent adaptation strategies employed, and highlights some of the knowledge gaps driving ECL research.

After the Pasha Bulka storm the New South Wales Government established a research collaboration—the Eastern Seaboard Climate Change Initiative (ESCCI)—to better understand the impacts of climate change along the eastern seaboard of Australia (ESA). Under this initiative, the NSW Government collaborated with the Australian Bureau of Meteorology, the University of New South Wales, Macquarie University and Newcastle University to design and deliver the Eastern Seaboard Climate Change Initiative – East Coast Lows (ESCCI-ECL) research program to better understand past, recent and future ECLs and their influence on rainfall, coastal processes and water security. This research program which ran from 2010–2016 comprised a suite of interrelated projects focusing on four principal themes: (i) understanding of the historical and pre-historical (paleo) climate variability of ECLs; (ii) understanding of how the long-term multi-decadal variability of ECLs influences coastal processes and streamflows; (iii) high resolution modelling of projected ECL frequency and intensity in response to climate change; and (iv) integrated understanding of the impacts of ECLs on coastal and water resources and potential changes to these impacts in response to climate change. The program was funded by the project partners, the NSW Environmental Trust, NSW Department of Finance and Services, Hunter Water and the Australian Research Council.

Before the ESCCI-ECL program information on past ECLs and the severe wind, wave and rainfall events they produce along the ESA was largely unavailable to people outside of the research sector. As part of this program the Australian Bureau of Meteorology linked historical ECLs with their impacts on the ESA within an online interactive tool named Maps and Tables of Climate Hazards on the Eastern Seaboard (MATCHES). In this issue Pepler et al. discusses the development of this online tool and shows how it enables ECLs tracks to be displayed and information on associated rain, wind and wave impacts extracted. The current version of the tool, which is accessible publicly through the Bureau of Meteorology's Registered Users website and contains information on ECLs for the 1950 to 2008 period, has supported ECL research and addressed the needs of some stakeholders. Further development and support for the ongoing maintenance and enhancement of MATCHES would substantially improve its usefulness for a range of stakeholders, including emergency managers, water managers, researchers and the insurance sector.

The climate of the ESA is highly variable and we need to extend our knowledge beyond historical weather records to pre-settlement climate and risks posed by large and rare storm events. During the ESCCI-ECL program Macquarie University constructed a long-term history of ECLs and their impacts on the NSW coastal environment and characterised coastal hazards due to extreme ECL storm waves. In publications elsewhere, Browning and Goodwin (2015), Goodwin et al. (2015, 2016) describe the use of innovative paleoclimatology techniques to investigate the variability in clustering and intensity of ECLs over a 1200 year period, and how a 500 year storm wave climate was reconstructed to assess the effects of ECL activity on the coastal landform along the eastern seaboard. A major conclusion from this research is that risk analysis for coastal planning purposes should consider past periods which experienced significantly higher and more persistent ECL storm activity than the 20th century.

In this issue Browning and Goodwin examine how ECL activity, as objectively determined for the period 1851–2014, is influenced by synoptic patterns, notably the latitude of blocking in the Tasman

Sea, and large scale drivers focusing on the Pacific decadal variability. From season to season the probability of ECLs occurring increases under certain combinations of regional climate drivers. Improved understanding of large-scale ocean-atmospheric circulation patterns that lead to high frequency storm seasons may help to improve ECL forecasts.

Understanding future changes in ECLs requires the use of climate modelling. ECLs have relatively small spatial scales and short lifetimes with global climate models (GCMs) having been found to significantly under-predict their occurrence and residence time near the coast. In this issue Di Luca et al. evaluate the performance of a 15-member ensemble of regional climate model (RCM) simulations to model ECLs, with the RCM ensemble performance also compared to results from GCM simulations. This study demonstrates the value of using an ensemble of RCM simulations to obtain reliable projections of possible future changes to ECL activity.

Based on recent research it is evident that there are several different types of ECL, each form differently and have different characteristics in terms of rainfall patterns and when, where and how they impact the ESA. In this issue Kiem et al. show that regional water security over the east coast of NSW is significantly affected by ECL activity, with ECL types determining the timing, location and severity of the effects and accounting in part for the unique hydroclimatology of the region.

Spatial and temporal hydroclimatic variability caused by ECLs are important inputs into the hydrological models used to determine current and future urban water security in the eastern seaboard of Australia. In this issue, Parana Manage et al. discuss aspects of long term and seasonal rainfall correlations that are important for reservoir dynamics, and Lockart et al. investigates the usefulness and limitations of using RCM projections for water security assessments based on case studies from the Lower Hunter urban water supply system. These studies highlight the need for further work to produce climate-informed stochastic daily rainfall simulations that realistically preserve the statistics important for catchment scale hydrology, such as clustering of extreme events, long-term persistence and the occurrence of wet and dry spells.

The ESCCI-ECL program has enhanced our understanding of the behaviour and impacts of ECLs and has paved the way for more robust projections of future ECL activity and water resource modelling for the ESA. ECLs are highly variable from year to year and decade to decade, and there is the potential for more intense and frequent storms than the eastern seaboard has experienced in the recent past. Collaborative research into ECLs will continue as a component of NSW Government's Climate Change Impacts and Extreme Climate Events research programs. The data, information and knowledge delivered from these programs will continue to be made publically available and support emergency management planning, water resource and coastal planning, and natural ecosystem assessments, enhancing the adaptive capacity and resilience of the NSW community and all communities of the ESA.

Yvonne Scorgie and Matthew Riley
Climate and Atmospheric Science Branch
New South Wales Office of Environment and Heritage

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