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INTENSE RAINFALL AND FLOODING: THE INFLUENCE OF CLIMATE CHANGE

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Background

This factsheet on the influence of climate change on intense rainfall and flooding is a follow up to last week's factsheet on 'Tropical Cyclones and Climate Change' after Tropical Cyclone Debbie hit North Queensland on 28 March.

The devastating effects of this extreme weather event are continuing to be felt across Queensland and northern parts of New South Wales as the deluge flushes downstream after ex-Tropical Cyclone Debbie caused record breaking rain throughout central and north Queensland. Emergency evacuation orders were issued for Chinderah, Kingscliff and Tweed Heads, the Lismore CBD was flooded, major highways were cut off on the Gold Coast, and the low-lying Logan area of Beenleigh, Beaudesert and surrounds (e.g. Rathdowney) were badly affected by flooding. In New South Wales, Ballina, Murwillumbah and other northern areas were also badly affected by intense rainfall and flooding caused by ex-Tropical Cyclone Debbie. Today, Rockhampton is bracing itself for 9 m floodwaters expected to peak on Wednesday, in what could be the highest flood level experienced since 2011.

The influence of climate change on intense rainfall and flooding

Cyclone Debbie is a tragic reminder of how extreme weather events place lives, property and critical infrastructure at risk. Climate change is intensifying many extreme weather events in an atmosphere that is warmer and wetter because of increasing greenhouse gas emissions from human activities, primarily the burning of fossil fuels – coal, oil and gas.

Intense Rainfall

As greenhouse gases increase in the atmosphere, the climate system is warming because these gases are trapping more heat. The oceans are also warming, especially at the surface, and this is driving higher evaporation rates that, in turn, increases the amount of water vapour in the atmosphere (Figure 1). In addition, a warmer atmosphere can hold more water vapour, leading in turn to more intense rainfall. The 1°C temperature rise that has already occurred, together with increasing evaporation, has led to an increase of about 7% in the amount of water vapour in the atmosphere (Hartmann et al. 2013). Globally, it is likely that there have been more land areas with increases in the frequency and intensity of heavy precipitation events than with decreases (IPCC 2013).

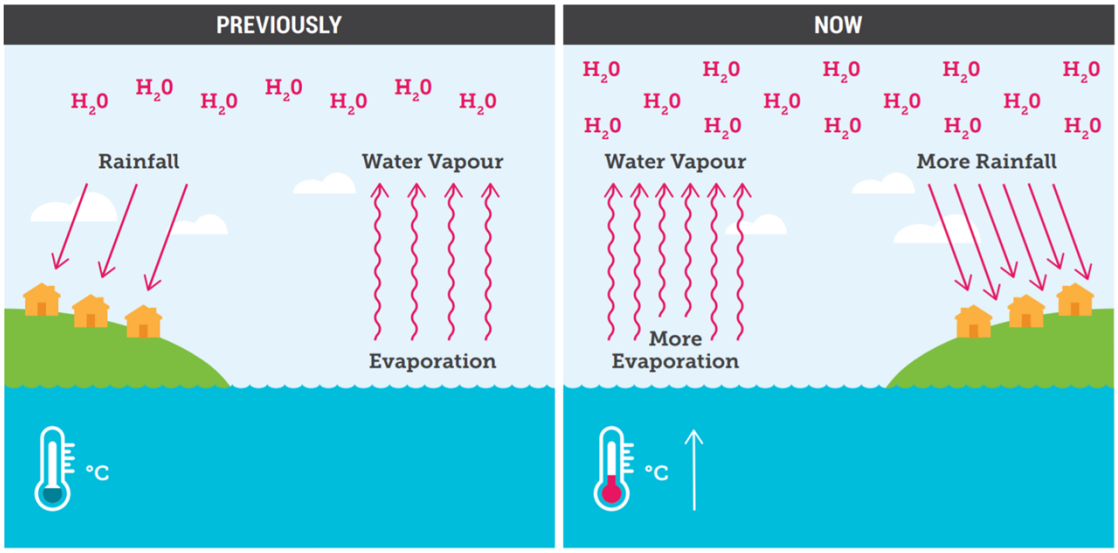

Figure 1: The influence of climate change on the water cycle. Left: The pre-climate change water cycle. Right: The water cycle operating under higher surface and ocean air temperatures, leading to more water vapour (H_2O) in the atmosphere, and in turn, more rainfall (Climate Commission 2013).

As our recent Tropical Cyclone factsheet described, storm surges are becoming more devastating because of climate change and rising sea levels. Many coastal flooding events are associated with simultaneous high sea level events and heavy rainfall events in the catchments inland of coastal settlements. This means that coastal settlements can be inundated by water from both seaward and landward directions – that is, from (i) the combination of storm surge, a high tide and a higher sea level, and (ii) flooding rivers from the catchments behind the settlements. Little research has yet been done to connect these two phenomena and produce an overall change in risk factor for this type of 'double whammy' coastal flooding event. However, the rises in sea level over the 21st century, which are virtually certain, coupled with the projections of an increase in the intensity of heavy rainfall events for most regions of Australia (CSIRO and BoM 2015) suggest that the risk of these 'double whammy' flooding events will increase (Climate Commission 2013).

Recent attribution studies have drawn links between extreme rainfall in Australia and climate change. The warming trend in sea surface temperatures to the north of Australia may have contributed, by up to 20%, to the magnitude of the heavy rainfall of 2010-11 in eastern Australia (Hendon et al. 2014). Another study found that the high sea surface temperatures increased the probability of above average rainfall in eastern Australia in March 2012 by 5-15% (Christidis et al. 2013). However, the results of different attribution studies differ between different regions and for different extreme rainfall definitions (Lewis and Karoly 2014).

The Impacts of Extreme Rainfall

Extreme rainfall has devastating effects on human health and our economy. A few examples are listed below.

Health Impacts

Periods of heavy rainfall can threaten human health and wellbeing. While intermediate levels of rainfall can cause damage to property, heavy rainfall can claim lives. For example, in 2011

intense downpours of 40-50 mm in only 30 minutes falling in already saturated catchments in Toowoomba and the Lockyer Valley led to burst creeks and caused flash flooding of up to 11 m through the Toowoomba city centre (Coates et al. 2012); 23 people drowned in these floods (van den Honert and McAneney 2011). 78% of the state (an area larger than France and Germany combined) was declared a disaster zone. The floods created major health risks, including contamination of drinking water and food, as well as difficulties in accessing health services and treatments. Health impacts of extreme rainfall can also persist days and weeks after the rainfall event has occurred. Large quantities of standing water can lead to the explosion of mosquito populations, which are known to transmit diseases such as dengue fever (Jacups et al. 2015).

Economic Impacts

The economic impacts of heavy rainfall can be devastating. One of the worst flooding events in recent times in Australia as a result of heavy rainfall was the Queensland 2010/2011 floods (Figure 2). Extreme and extended rainfall over large areas of Queensland from a strong La Niña event in the latter part of 2010 led to record breaking and very damaging flooding in Queensland in December 2010 and January 2011. Approximately 2.5 million people were affected and 29,000 homes and businesses experienced some form of flooding. The economic cost of the flooding was estimated to be in excess of $5 billion (QFCI 2012), with 18,000 homes inundated, damage to 28% of the Queensland rail network and damage to 19,000 km of roads and 3 ports (van den Honert and McAneney 2012). Around 300,000 homes and businesses lost power in Brisbane and Ipswich at some stage during the floods (QFCI 2012). Although it is too early to tell, it is likely that the economic costs of Tropical Cyclone Debbie will exceed $1 billion (AFR 2017).

Figure 2: Onlookers survey the levels of the flood waters in inner city Brisbane. Flooding as a result of an exceptionally wet December 2010 and January 2011 caused economic damages of at least $5 billion.

Extreme Rainfall in Australia: General climate projections for the future

A 2°C rise in average global temperatures could result in a 10-30% increase in extreme downpours (Bao et al. 2017). In Australia, extreme rainfall events are projected, with high confidence, to increase in intensity, where extreme events are defined as the wettest day of the year and the wettest day in 20 years (CSIRO and BoM 2015; Bao et al. 2017). The tendency for an increase in intensity may be stronger for the larger, rarer events (current 1-in-20 year events) (Rafter and Abbs 2009) particularly at the sub-daily timescale (Westra et al. 2013).

For Queensland and New South Wales, the two states most badly affected by ex-Tropical Cyclone Debbie, extreme rainfall events are likely to worsen. For example, maximum one-day rainfall is expected to increase by up to 17 and 18% for New South Wales and Queensland respectively, by the end of the century for a high emissions scenario, relative to 1986-2005 climate (CSIRO and BoM 2015).

Insurance in a changing climate

In Australia, flooding along Australia's densely populated coast is a huge societal risk. The most damaging events are likely to arise when inland flooding, storm surges and high tides occur concurrently. Climate change is a significant risk to the sustainability of current insurance practices. Further, the existing challenge of insuring natural catastrophes is made more difficult by climate change intensify extreme weather events, combined with higher concentrations of wealth located in disaster-prone areas (CoastAdapt 2015). In March 2017, Australia's chief financial regulators, the Australian Prudential Regulation Authority, warned that banks and insurers must "rise to the challenge" of climate change.

Climate projections show that an increase is likely in the proportion of the most intense tropical cyclones such as Yasi, those with stronger winds and heavier rainfall, while the total number of tropical cyclones will likely decrease. A greater proportion of tropical cyclones may reach further south along Australia's east and west coastlines (CSIRO and BoM 2015). Modelling by Deloitte and James Cook University estimates that if cyclones do shift further south, tens of billions of dollars worth of infrastructure is at risk (Brisbane Times 2017).

Halting the escalating risks of extreme weather events

Extreme weather events such as heavy rainfall and flooding are very likely to become more intense and destructive over the next couple of decades because of the climate change that is already locked in from past greenhouse gas emissions. But the severity of extreme weather events that our children and grandchildren will face later this century depends on how fast and how deeply greenhouse gas emissions can be reduced now, next year and over the next couple of decades.

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