

## BRÈVE D'ACTUALITÉ

### Les crues de 2010-2011 dans le Queensland (Australie) : observations, premières réflexions et expérience personnelle



Le continent australien a reçu des précipitations importantes sur des étendues considérables durant l'été 2010-2011. L'état du Queensland, dans le nord-est de l'Australie, a été le plus touché, avec des crues couvrant plus de 75% du territoire, correspondant à une surface de l'ordre de  $1,3 \times 10^6$  km<sup>2</sup>. Les crues dans le Queensland ont été à la fois très étendues, et très violentes, causant de nombreux décès. H. Chanson présente ici les circonstances et l'étendue des crues dans le Queensland. Puis il partage son expérience personnelle des crues dans le centre, sud et sud-est de l'état.

#### The 2010-2011 Floods in Queensland (Australia): Observations, First Comments and Personal Experience

Hubert CHANSON

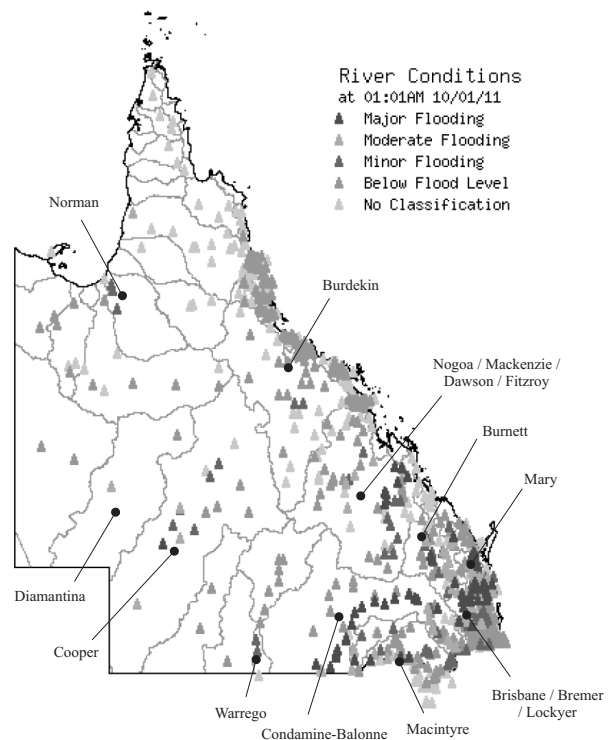
*The University of Queensland, School of Civil Engineering, Brisbane QLD 4072, Australia<sup>1</sup>, Tel. +61 (7) 3365 3516, Fax: 3365 4599, h.chanson@uq.edu.au*

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#### I. INTRODUCTION

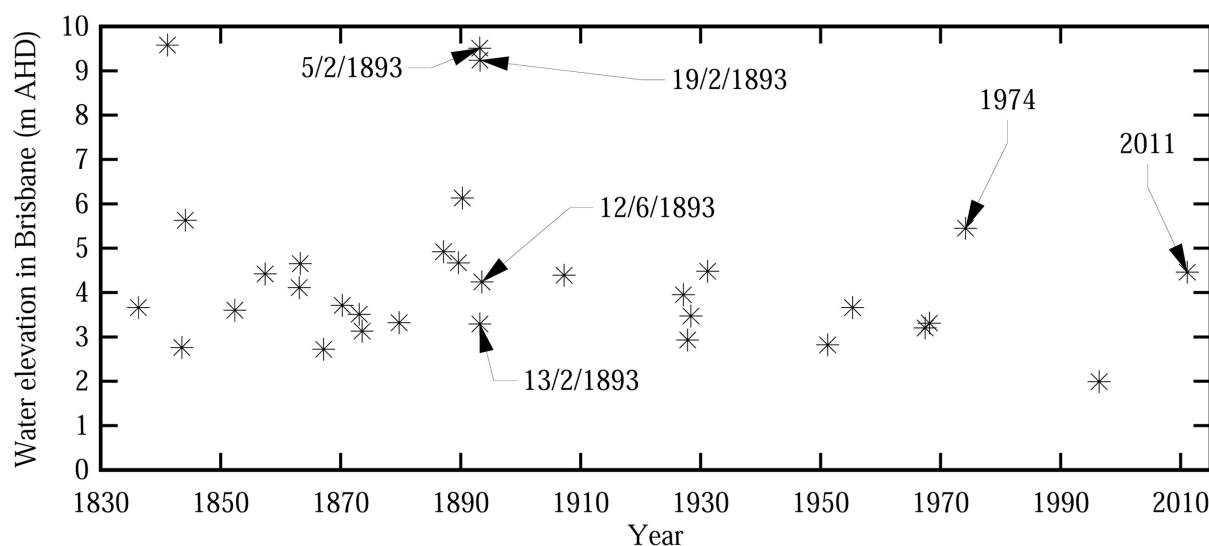
The Australian continent received some unprecedented rainfalls from late November 2010 to mid-January 2011 causing some major flooding in the North-West of Western Australia, in north-west Victoria, northern Tasmania, New South Wales and especially Queensland [7]. The floods in Queensland were unprecedented by the extents of the flooded area and the number of record water levels. Figure 1 illustrates a snapshot of the Queensland river conditions on 10 January 2011: the dark triangles corresponded to some major floods in the relevant catchments. Nearly 75% of the State of Queensland were affected by major flooding representing a surface area comparable to France, Germany, Netherlands, Belgium, Denmark and Norway combined.

The floods in eastern Australia are sometimes linked with La Niña events during the El Niño Southern Oscillation (ENSO) cycle, as seen in 1916, 1917, 1950, 1954-1956, 1973-1975 and 2010-2011 [8]. In tropical and sub-tropical Queensland, major floods are a relatively common occurrence as illustrated in Figure 2. Figure 2 shows the major floods of the Brisbane River in the city of Brisbane for the last 180 years and the maximum water levels above the Australian Height Datum (AHD) that corresponds to the Mean Sea Level (MSL). While there have been a smaller number of major floods during the last 50 years, some extreme



**Fig. 1 :** Queensland river conditions on 10 January 2011 at 01:00 (Courtesy of Bureau of Meteorology) - The names of the main catchments in floods were added.

<sup>1</sup>. Corresponding author



**Fig. 2 :** *Historical floods of the Brisbane River in the city of Brisbane and maximum water elevations for the period 1830-2011 (Ref. [2], [3], [4], [6], [10]).*

events were recorded during the 19th century including four major floods for the 1893 year alone [6].

This paper describes the widespread floods in North-East Australia in 2010-2011. It reviews the circumstances and documents the extents of the flooding. Later the author describes his personal experience during this abnormally wet summer season in Queensland.

## II. THE FLOODS IN QUEENSLAND

The State of Queensland in north-eastern Australia occupies 1,727,200 km<sup>2</sup> and is the second largest Australian state. It is bounded on the North and East by the Pacific Ocean, on the South by New South Wales, on the Southwest by South Australia, and on the West by the Northern Territory.

The 2010-2011 floods followed nearly 3 months of wet weather at the end of 2010. Altogether six major rain events took place from late November 2010 to Mid-January 2011. December 2010 was the wettest December on record for Queensland [7]. Many places received more than 6 times the expected average December rainfall, including the city of Brisbane which received 480 mm of rainfall in December. More generally, the 2010 year was wet in Queensland and the township of Babinda, close to Cairns, received more than 7,000 mm of rainfall during 2010 [5]. While the Queensland floods were most notable by their extent and duration, only a limited number of daily rainfall records were set. An analysis of the three-day rainfall totals in the south-east Queensland indicated that the peak rainfalls during the 2010-2011 event were lower than those in 1974, and some historical records suggested that they were significantly lower than during the 1893 event [7]. Figure 3 presents the hydrograph of several Queensland creeks and rivers, including Degibo Creek which is a tributary of the Burnett River in Central Queensland, the Condamine River at Dalby, Lockyer Creek and Flagstone Creek in the Lockyer Valley and the Brisbane River in Brisbane. Note that the scales of the hydrograph axes differ between graphs. Further the Brisbane River in Brisbane is affected by the tidal motion (Fig. 3E).

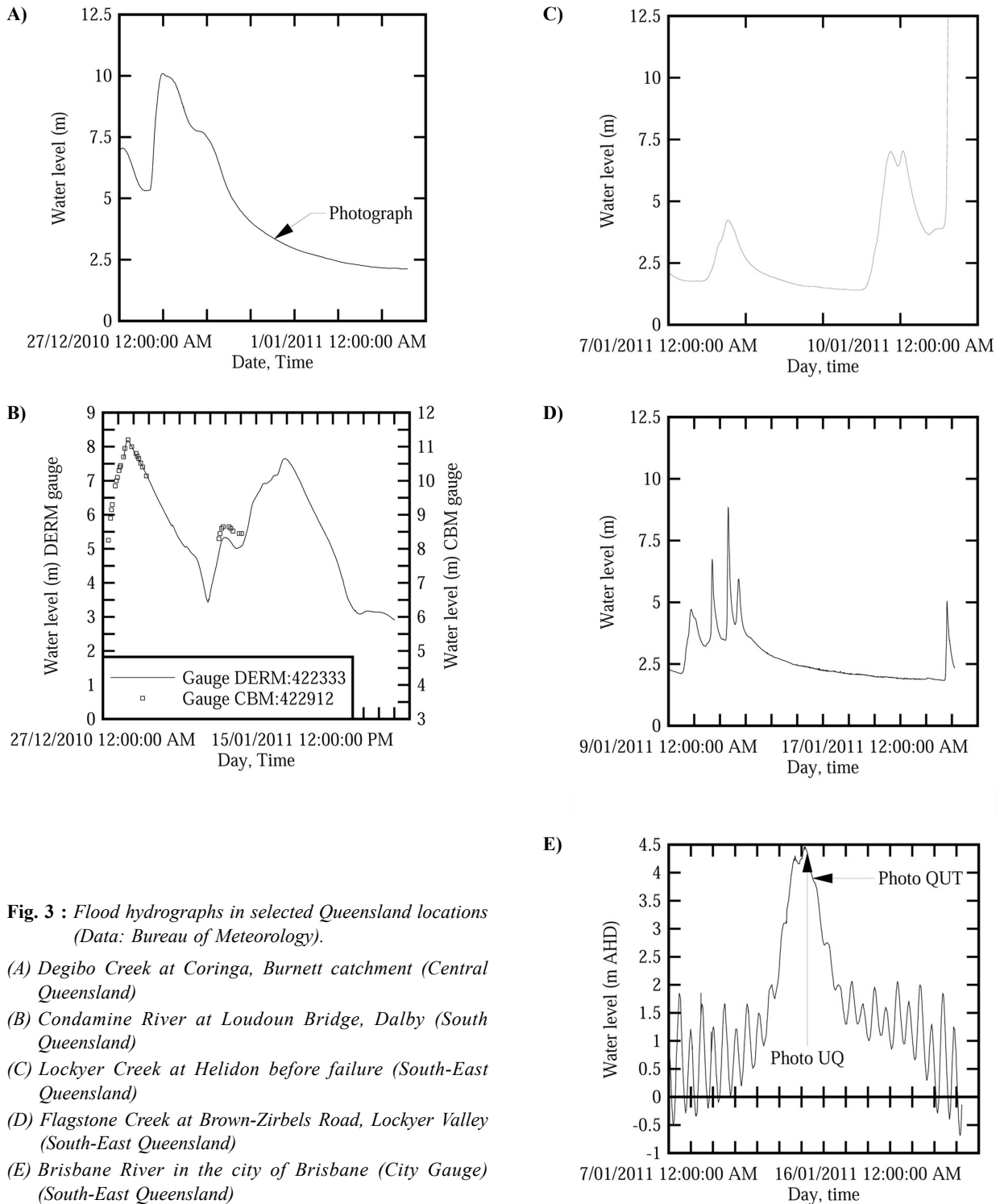
In December 2010, the most extreme flooding occurred in Central and South Queensland, in particular in the Fitzroy

River and Condamine-Balonne River systems (Fig. 1). Figures 3A and 3B show some river hydrographs in both systems. The Fitzroy catchment covers 142,665 km<sup>2</sup> encompassing the Mackenzie, Dawson and Nogoa Rivers which join to form the Fitzroy River with its river mouth next to the city of Rockhampton. Both the Mackenzie, Dawson and Nogoa Rivers experienced some major floods leading to the fifth highest flood level for the last 100 years in Rockhampton [7]. The Balonne River is the continuation of the Condamine River and forms part of the Murray Darling River system which flows into the Great Australian Bight (Indian Ocean) in South Australia. Both the Balonne and Condamine Rivers experienced three major floods between December 2010 and January 2011.

In January 2011, the rainfall and flooding remained widespread throughout Queensland. The most destructive floods took place during the 2nd week of January. Some deadly flash floods occurred over the Toowoomba Range and the upper Lockyer Valley on Monday 10 January late afternoon. The flash flooding caused substantial losses of life. Figure 3C show the hydrograph of Lockyer Creek at Helidon: the last reading recorded 12.7 m above the river bed before the gauge failed. Sixteen kilometres downstream, at Gatton, a record flood level of 18.92 m was measured in the evening before the station failed. Figure 3D presents the hydrograph of Flagstone Creek, about 9 km SW of Helidon. Further some important rainfalls in the catchments of the Brisbane River, Bremer River and Lockyer Creek caused some significant flooding in the upper catchments. In Brisbane, the peak water level reached 4.96 m on Thursday 13 January 2011 (Fig. 3E). This may be compared to the peak levels of 5.45 m in 1974 and 9.5 m in 1893 (Fig. 2), although some aboriginal oral history mentioned a 12 m high flood event in Brisbane [6]. While the flood in Brisbane was spectacular, it lasted a few days only and was less destructive and deadly than other floods in other parts of Queensland.

### II.1. Comments

This series of wet weather events was an illustration of the extreme hydrological and hydraulic conditions in Australia and in Queensland. A few years ago, the state of Queensland



was experiencing a long drought period. In 2007, for example, the combined water supply of the city of Brisbane fell below 17% (Fig. 4A) and the long-term forecasts were dire. On the opposite, Brisbane experienced a large number of major floods during the 19th century (Fig. 2). Following the 1974 flood, the Wivenhoe reservoir was completed with a long-term water supply capacity of  $1.15 \times 10^9 \text{ m}^3$  and an additional flood mitigation volume of  $1.45 \times 10^9 \text{ m}^3$  (Fig. 4). During the 2010-2011, the Wivenhoe reservoir contributed to a shorter flood period and lower flood levels in Brisbane although the reservoir reached about 190% of its nominal capacity on 12 January 2010.

An implication of the widespread extent of the floods was the large number of road closures (e.g. Fig. 5A), isolat-

ing numerous communities and townships for up to several weeks. The township of Theodore in Central Queensland was completely evacuated with the water level of the Dawson River exceeding 14.6 m [9], while the township of Condamine was fully evacuated twice in January 2011. The city of Rockhampton was almost cut off when the airport tarmac went under the Fitzroy River waters.

### III. A PERSONAL NOTE

The author inspected a number of affected catchments in 2010-2011 including the catchments of Little Nerang Creek on 27 December 2010, Burnett River on 30 December 2010



(A) Dry reservoir on 13 June 2007 viewed from the dam right abutment with the secondary spillway intake on the far right - The reservoir capacity was below 16%.



(B) Spillway operation on 17 January 2011 - The reservoir capacity was about 122%.

**Fig. 4 :** Wivenhoe Reservoir on the Brisbane River in South East Queensland - Completed in 1984, the reservoir has a dual purpose: flood mitigation and long-term water supply (it is the largest water supply for the city of Brisbane) - Note that the Bremer River and Lockyer Creek join the Brisbane River downstream of Wivenhoe dam.

and Condamine River on 5 January 2011, the Upper Brisbane Valley on 21 and 30 December 2010, and the lower Brisbane Valley on numerous occasions between 9 and 25 January 2011. For nearly 4 weeks in December and early January 2011, the author had some field inspection equipment in his car to respond rapidly to any new flooding situations, and he drove altogether more than 3,500 km across Queensland. A brief summary of his personal experience in January 2011 follows.

Some heavy rainfalls were experienced in South East Queensland on 7-9 January 2011. Following further heavy rainfalls on Monday 10 January 2011, and the catastrophic flash floods in Toowoomba and the upper Lockyer Valley, the author inspected some areas of the Lower Brisbane Valley on Tuesday 11 January 2011 afternoon, including

Kenmore, Brookfield, Fernvale and Marburg. In the early afternoon, Moggill Road was closed at Rafting Ground. The road to Fernvale was closed when Black Snake Creek overtopped the road (Fig. 5C). The Warrego Highway was closed between Marburg and Minden. The flooded township of Marburg was devastated (Fig. 5B). (Note that Figures 5B and 5C show some photographs during and after the flood.) During the return trip to Brisbane, the author's car was one of the last vehicles to drive the eastbound Ipswich motorway past Goodna, as the motorway was closed shortly after and later submerged.

On 12-13 January 2011, he inspected the Brisbane River flooding in Brisbane (Fig. 5D & 5E). A key feature was the rise of the water levels in Brisbane on Wednesday 12 January 2011. The rapid rise of the Brisbane River on 12 January





**Fig. 5 : Floods in Queensland.**

(A) Degibo Creek at Coringa, Burnett catchment (Central Queensland) on 30 December 2010 (see hydrograph in Figure 3A).

(B) Black Snake Creek Marburg about 60 km West of Brisbane, looking downstream - Note the footpath concrete slabs jammed into the road rails on both photographs.

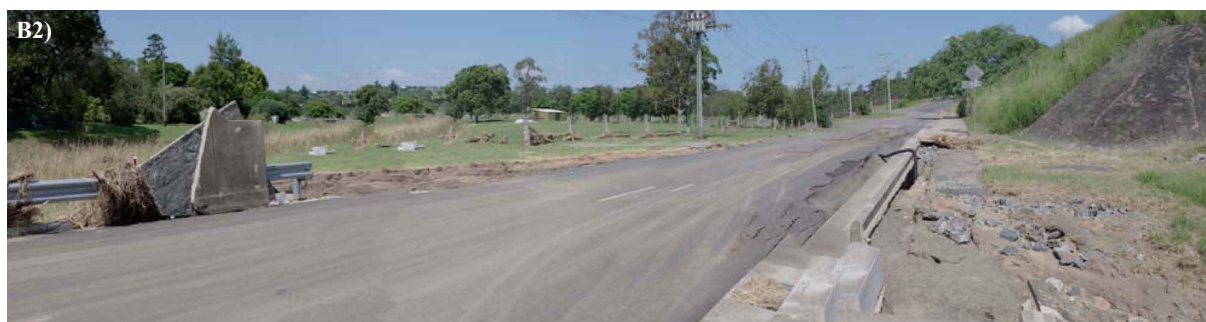
(B1) On Tuesday 11 January 2011 at 16:31 - The tip of the concrete slabs is visible above the water surface in centre of the photograph.

(B2) On Monday 17 January 2011 at 14:26.

(C) Brisbane Valley Highway at Black Snake Creek (also called Fairnie Brook) 3 km SSW of Fernvale - View from the southern end of road.

(C1) On Tuesday 11 January 2011 at 15:52.

(C2) On Monday 17 January 2011 at 12:04.





(D) Submerged campus of the University of Queensland in Brisbane on Wednesday 13 January 2011 morning at 06:25 - The main channel of the Brisbane River is in the right background behind the trees (see hydrograph in Figure 3E).



(E) Submerged campus of Q.U.T. in the city centre on Wednesday 13 January 2011 morning at 11:40 - Looking upstream at the flood flow between the South-East Freeway (left) and C Block (right) with the main channel of the Brisbane River on the far left (see hydrograph in Figure 3E).

**Fig. 5 : Floods in Queensland.**

2011 took many people by surprise despite the long-lasting wet weather during the summer, although thankfully the peak water level was nearly 1 m below the official predictions. A simple trip from the University to the city, that took normally 10 minutes, required over 50 minutes because the two main arterial roads (Coronation Drive and Milton Road) were under water. Many communities in western Brisbane, such as Bellbowrie, Moggill, Anstead, Karana Downs, were completely isolated for a few days. At the author's home, the electricity power supply was cut in the afternoon when the local substation was inundated until Thursday afternoon. On Thursday 13 January 2011, he participated to some field measurements in the flooded QUT Gardens Point campus with an academic colleague, Dr Richard Brown (Fig. 5E) [1]. From the mid-morning onwards, a rapid decrease of the water level of the Brisbane River was observed and a further water level drop was clearly seen on Friday (Fig. 3E).

Between 15 and 25 January, the author inspected the flood damage in the Brisbane Valley and lower Lockyer Valley. A feature of the clean-up was the large amount of mud left after the flood receded, although some coarse sandy deposits were observed in some parts of the river banks. Numerous

large debris were also seen in many places when the flood receded.

The observations of the maximum water levels in Brisbane's UQ St Lucia campus, Toowong and city centre indicated that the water levels were about 1 m below the 1974 maximum water level, although there were some (unconfirmed) reports that the maximum water levels differed in some areas. There were also indications that the flooding in the Upper Brisbane Valley and at Fernvale, downstream of confluence of Lockyer Creek and Brisbane Valley, was higher than during the 1974 flood.

#### IV. ACKNOWLEDGMENTS

The author dedicates this contribution to the victims of the 2010-2011 floods in Australia.

He acknowledges all the people who assisted in the site inspections, including Dr Richard Brown, Ms Ya-Hui Chou and André, Nicole and Bernard Chanson, and Dr Alex Scheuermann.

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