This is an Accepted Manuscript of an article published by Taylor & Francis in South African Geographical Journal on 10 April 2023, available at:
https://doi.org/10.1080/03736245.2023.2193758

A new flood chronology for KwaZulu-Natal (1836-2022): The April 2022 Durban floods in historical context

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Abstract

In April 2022, flooding and associated geohazards including landslides and mudslides caused major loss of life and extensive damage in the greater Durban region and large areas of the KwaZulu-Natal (KZN) coastal zone. The heavy rainfall that triggered the flooding and mass movement events was reported in national and international media as having 'smashed weather records', with the floods described by a government minister as 'the worst seen in living memory'. However, no systematic and up-to-date flood record exists for KZN to allow the April 2022 floods to be viewed within their full historical context. To address this issue, this study presents an historical geographic account of flooding in KZN, with a particular focus on the greater Durban region. The flood record expands upon available databases held by the South African Weather Service, drawing on missionary accounts, newspapers and personal diaries to identify all significant flood events in KZN since the mid-nineteenth century. We document 53 significant flood events from 1850-1899 (average ~1.1 per annum) and 210 from 1900-2022 (average ~1.7 per annum). Within the limits of our data, we suggest that the frequency of flooding in Durban has likely doubled over the last century and confirm reports that the city has experienced flooding almost every year during recent decades. Our research confirms that the April 2022 floods were likely the most catastrophic natural disaster yet recorded in KZN, in collective terms of lives lost and overall economic impact. Whether the floods were the worst in living memory is debatable, as flooding in September 1987 affected a larger geographic area and destroyed more homes than the 2022 event. The April 2022 floods do, however, stand out as being associated with the highest ever recorded 24-hr rainfall amount for KZN Province.

Keywords

Flooding; flood hazards; rainfall records; documentary evidence; KwaZulu-Natal, South Africa

1. Introduction

It is widely acknowledged that, in a rapidly warming world, rainfall and flood extremes will increase in many regions (e.g., Woldemeskel and Sharma, 2016; Alfieri et al., 2017; Dottori et al., 2018; He et al., 2022). The Sixth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), for example, identifies that the frequency and intensity of heavy rainfall events have increased over most land areas in recent decades, and that heavy rainfall events are likely to become ever more frequent and intense under continued warming. Essentially this translates, with high confidence, that flooding will increase in frequency and magnitude into the future (IPCC et al., 2021). To this end, many studies have examined the magnitude/frequency of South African floods over the last half century (e.g. Pitman and Midgley, 1967; Farquharson et al., 1992; Kjeldsen et al., 2001, 2002; Alexander, 2002; Ntanganedzeni and Nobert, 2021). In the broader African context, extreme weather events associated with climate change have intensified and become more frequent over the most recent decade (2010-2020) (Dube et al. 2021). Increased flood occurrence is identified for large parts of the continent (Woldemeskel and Sharma, 2016) and for coastal cities in particular (Dube et al., 2021). In South Africa, floods with significant damage occur approximately once every 2 years, while more extensive catastrophic floods happen every 10-15 years (Viljoen and Booysen, 2006); however, we anticipate such flood return periods have increased in the last couple of decades.

On 11-12 April 2022, parts of the KwaZulu-Natal (KZN) coastal zone (including the greater Durban region and south coast; see Figure 1) received more than 300mm of rain in 24 hours (SA Weather Service webpage, 2022) from the slow-moving storm Issa. This led to calamitous flooding – and associated landslides and mudflows – with devastating outcomes. Some 459 people lost their lives, with 88 people still missing at the end of May 2022 (*The South African*, 30 May 2022). Over 4000 homes were destroyed, 40 000 people made homeless (*The South African*, 19 April 2022) and 45 000 left temporarily unemployed, with total infrastructure and business losses estimated at over $US 2 billion (*The South African*, 30 May 2022). Given the magnitude of the natural disaster, loss of life and economic impact, the floods received both national and international media coverage and scientific attention. This reawakened the reality that South Africa not only faces hydrological extremes manifested through drought and water crises as a result of climate change (Brühl and Visser, 2021), but also extreme flooding.

Media coverage of the Durban floods included some notable statements concerning the underlying driver of the event. By 11 April 2022, the World Weather Attribution Group (WWA) had already identified that the extreme rainfall was driven by 'climate change' (*BBC*, 11 April 2022). Shortly thereafter, President Cyril Ramaphosa described the floods as a "catastrophe of enormous proportions" and that it was "telling us that climate change is serious, it is here" (*The Guardian*, 14 April 2022). By 16 May 2022 it had been concluded by the WWA that anthropogenic-induced climate change had made these floods more severe and had doubled the likelihood of such flooding (*Independent Online*, 16 May 2022). Media reports also included statements about the relative magnitude of the natural disaster. On 12 April 2022, *The South African* headlined that the KZN floods had "smashed weather records" with no fewer than eight meteorological stations setting new daily rainfall maxima – most noteworthy was Virginia,

which recorded 351mm over a 24-hour period (*Independent Online*, 12 April 2022). According to the minister in charge of disaster management, Nkosazana Dlamini-Zuma, "These floods [were] the worst floods that [had] ever [been] seen in living memory" (*The South African*, 19 April 2022). A commentary piece in *The Conversation* also noted that Durban has experienced flooding almost every year since 2016 (Magidimisha-Chipungu, 2022).

We do not challenge media commentaries linking the Durban floods to climate change, as these are based on attribution studies of extensive meteorological datasets using peer-reviewed approaches. However, some of the statements concerning the relative magnitude and impact of the floods are neither scientifically nor historically accurate. In part, this stems from the lack of a systematic and up-to-date flood record for KZN Province to position the recent floods and their associated impacts within their full historical context. To this end, we present an historical record of major flooding in KZN, with a particular focus on the greater Durban region. Our aim is to place the 2022 Durban floods in the context of past flood events. To achieve this, we provide a record of all documented significant flood events since the mid-nineteenth century. Having established a record of major floods, we then consider our results in the context of the April 2022 floods and critically engage with some of the media commentaries noted above.

2. Materials and Methods

2.1 Information sources

Establishing a flood chronology for KZN requires the analysis of a wide variety of hard-copy and online historical sources (Table 1). The South African Weather Services (SAWS) CAELUM flood record was used to cover the period 1800-2008. CAELUM was generated by the former South African Weather Bureau from newspaper articles and meteorological publications, and lists, in chronological order, notable weather events in the history of the country. However, this record is incomplete and only contains very brief detail including date, location and, where available, a summary of consequences. CAELUM does not define what constitutes a 'significant' or 'severe' weather event, but in the case of flooding these would have been notable events with impactful consequences. Only events that were reported in selected published sources are included in CAELUM, so a wide variety of additional sources of information were necessary for consultation - we describe these below.

For the nineteenth century, important sources include accounts of floods written by resident and itinerating missionaries (for full details, see Nash et al., 2016). The first Protestant mission stations in present-day KZN were established in 1836 by the American Board of Commissioners for Foreign Missions. Various British, German, and Norwegian missionary societies became active in the region from the early 1840s, such that, by the 1850s, mission stations were widespread. Full collections of missionary correspondence and reports were consulted. The primary source of information for this period, however, is the *Natal Witness* newspaper, first published in Pietermaritzburg in 1846 and continuing today as *The Witness*. The *Natal Witness* reported on floods from across former Natal and Zululand, with particularly detailed coverage for the Pietermaritzburg-Durban area. The full run of nineteenth century issues was scrutinised.

Various other nineteenth century sources, including the *Natal Almanac*, *Natal Blue Books* and miscellaneous diaries and manuscripts, were also consulted. Please refer to Table 1 for further details on data types used and where these were sourced. For the period 1902-1986, all issues of the *Rand Daily Mail* newspaper were analysed. Online searches yielded records of flood events from the 1990s onwards, through a variety of online news channels. A valuable online resource also consulted was 'The International Disaster Database' (https://www.emdat.be). All results were cross-checked against those of Botes (2014), who had previously established a flood history for KZN based on similar but also additional sources. While our record proved considerably more extensive, Botes' chronology was used to fill some data gaps.

Documentary evidence from these sources was used to reconstruct significant flood occurrences over KZN from the mid nineteenth century to end-May 2022. To construct the flood record, flood occurrences and quotations were organised chronologically (please refer to Table 2 for a summary of this chronology). Throughout our analyses, we consider a significant flood event as one where one or more rivers overflowed their banks and/or where one or more of the following consequences are documented: loss of life; infrastructural damage; agricultural and vegetational loss; disruption to communication and travel; necessity to rescue and provide aid. Such floods may also have led to secondary disasters such as soil loss, mud flows and landslides. Reference to 'swollen rivers' or rivers flowing high are not considered to constitute a flood, neither are references to human or livestock deaths by drowning where there is no evidence that the river was in flood. Reports of localised flooded streets in towns and cities owing to high rainfall, but without evidence of major consequences, are not included here as significant flood events.

All information relevant to flooding was extracted from the available sources. The level of detail across sources is, however, highly variable. Typical information extracted included the date (time) of flooding and duration, location and extent of flooding, type of flood (i.e. river, urban, unspecified), consequences (i.e. loss of life, infrastructural damage, agricultural impacts, consequent geohazards such as landslides) and human responses. In some cases, meteorological information was provided (e.g. rainfall amount, rainfall duration) in the documentary sources, but such information becomes increasingly scarce towards earlier years (i.e. 1800s). Contemporaneous flooding across a wide region or at two or more neighbouring locations (e.g. Pietermaritzburg and Durban) is recorded as a single flood event as these would be a product of the same synoptic weather system.

The rainfall quantities associated with flood events described in section 3.4 were either collated from historical sources, or obtained directly from the SAWS. To compare flood occurrences during the contemporary period of accelerated global warming with earlier decades (section 4), we follow guidelines within IPCC et al. (2021) and use 1850-1899 as a pre-industrial reference period. In the following section, floods and significant rainfall events are compared over a variety of temporal windows.

2.2 Methodological challenges

Despite the globally recognized value of documentary-based approaches for climate reconstruction, there are methodological challenges that need to be acknowledged (see, for example, Nicholson, 1979; Brázdil et al., 2006; Grab and Nash, 2010; Nash and Adamson, 2014). In the case of reconstructing a flood history for KZN, perhaps the greatest challenge is finding sufficient information for the early 19th century when the population was relatively sparse and communication from remote areas limited. As a result, information before the late 1840s is incomplete. With the introduction of the first newspapers (i.e. the *Natal Witness* in 1846; *Natal Mercury* in 1852) there is improved reporting, most particularly for the Pietermaritzburg-Durban region, and to a lesser extent outlying regions of KZN. Some underreporting for remote outlying regions is likely for the 19th and early 20th centuries. In contrast, with the advent of internet-based reporting during the most recent few decades, it is likely that all major flood events have been captured. To limit the margin of error, we thus only consider the period 1850-2022 for graphical and statistical representations of flooding. Given the possibility that a few earlier flood events may have gone unrecorded, we anticipate that an unspecified but small margin of error is still possible.

An inherent concern with all forms of flood documentation is potential bias, exaggeration, subjectivity and error. Where possible, we thus use a variety of documentary sources to corroborate information on a given flood event. In many instances this is, however, not possible where only a single source of information is available. Further, it is not logistically feasible to verify the accuracy of published instrumental rainfall and river flow data as this would require detailed metadata on instrument types used, proof of calibration, site details etc, most of which is not available.

3. Results

3.1 Major flood events in KwaZulu-Natal/Durban prior to 1850

Details of all identified significant nineteenth century flood events are recorded in Table 2, along with their primary source(s). The first confirmed flood event we identify for KZN was for the 'Topila' River (we assume this refers to the Tugela River) in late November 1836, in a diary entry by the American missionary, Rev. George Champion (ABCFM Film 467, vol. 2, George Champion's journals – see Table 1 for details of archive abbreviations). In August 1837, the Tugela was again in flood (reported by Rev. F. Owen; p.328 in Bird, 1888, vol. 1). The first reporting of a significant and widespread flood was for September 1843, when apparently the 'whole country' (i.e. Pietermaritzburg and surrounding regions) was flooded, 'rendering the rivers unfordable for many days' (Hon. H. Cloete; p.290 in Bird, 1888, vol. 2). The years 1847 to 1849 all saw floods of exceptional proportion. In October 1847, the Msunduzi (also previously written as 'Umsundusi' or 'Msundusi') flooded, resulting in the 'whole country [being] flooded for the last fortnight' (Rev. Lewis Grout; ABCFM 15.4, vol. 4, Southern Africa, Zulu Mission 1847-59).

The first documented significant flood event to affect 'D'Urban' (modern day Durban) was in April 1848, when the 'Ungenie' River (now Umgeni) 'overflowed its banks [and] came pouring

down a new course', and 'inundated several gardens and plantations' (*Natal Witness*, 14 April 1848). Flooding elsewhere caused destruction and damage to bridges and buildings. In Pietermaritzburg, the Msunduzi River, 'swollen to an extraordinary height', swept the wooden Jargal's Bridge away (*Natal Witness*, 14 April 1848), barely eight months after its construction and built ~1.2m higher than its predecessor (Wills, 1982). Three days of heavy continuous rains over the Durban-Pietermaritzburg region in March 1849 resulted in loss of human life, rivers flooding roads, and damage to infrastructure (*Natal Witness*, 30 March 1849).

3.2 Major flood events in KwaZulu-Natal/Durban during the period 1850-1899

We identify a total of 53 significant flood events over KZN during the period 1850-1899 (av. ~1.1 per annum) (Table 2; Figure 2). Of these, 22 impacted the greater Durban region (av. 0.44 per annum), with the period 1868 to 1875 being particularly flood prone (total = 8 events: 1 per annum). However, this is followed by a lengthy period (1876 to 1890) without any floods reported for Durban. Flood occurrence per decade for KZN was highest for the month of March (2.0), followed by January (1.8) and February/December (1.6 each) (Figure 3). Consequences of such floods regularly included one or more of human and livestock deaths, bridges being washed away, collapsed houses and other infrastructural damage (e.g. to railway lines, roads), destruction of sugar cane plantations and other crops, and impeded travel and communication (e.g. mail services). In towns such as Durban and Pietermaritzburg, blocked gutters and drains were at times responsible for water overflow and flooding in streets. Associated geohazards were also regularly reported, and included agricultural soil being washed away, deposition of sand, collapsed embankments and landslides. We now present some selected examples of severe flood events, with an emphasis on those that impacted Durban.

Over 13-17 April 1856, a major flood (in later years referred to as the 'Great Flood') impacted Durban and Pietermaritzburg. Given the magnitude of this historical event, we provide a detailed description of the flood according to John Colenso, the first Bishop of Natal:

> *Next day, Sunday [13 April], about 10am the rain began, which has made this year memorable in the history of Natal. It continued without cessation till Thursday, and flooded the whole country. The bridges were destroyed, the roads interrupted, and for several days there was no postal communication between Durban and Maritzburg, except by the use of an Indian rubber boat which I had brought with me. Several* [people] *were drowned... The damage done to the crops and buildings in various parts of the country was enormous... For that River [Umgeni], which naturally flowed into the sea at a distance of 2 or 3 miles from the town* [i.e. Durban]*, had now forced itself a second outlet right through the middle of the town into the Inner Bay, and was making a lake of the Market Place.* (USPG D8, Bishop Colenso of Natal, Maritzburg, 31 May 1856).

According to the diary of Pietermaritzburg resident John Fleming (dated 19 April 1856), the town experienced:

> *…the heaviest and strongest continued rain this week of any we have had since we came to the Colony, it commenced on Sunday and continued till yesterday morning [Wednesday]… the Town Bridge was carried away, the water was 5 feet [~1.5m] deep at Anstie's Mill, scarcely a house in town has escaped some damage...* (KCAL 98/65 FLEMING, John. Extracts from John Fleming's Diary, 1850-1891).

The floods extended inland at least as far as Howick, where the Umgeni Bridge was swept away (*Natal Witness*, 25 April 1856). Major rivers in inland regions rose higher than recalled since the first occupation by white colonists in the 1830s, and the Durban region had extensive mudslides and rockfalls (Barnes, 1984). Over a 16km stretch of beach between the mouths of the Umgeni and Umhlanga Rivers (Figure 1), 200 drowned oxen were deposited, together with large quantities of vegetation and other faunal remains (Barnes, 1984). A further report by Bishop Colenso (USPG D8, Bishop Colenso of Natal, Maritzburg, 31 May 1856) speaks of deep gullies having formed in the landscape, with land having been undercut and elsewhere covered in deep layers of sand and mud. In places, the Umgeni River had doubled in width to ~400m, a previous island in the river with trees of 30 to 40 years growth had all but completely disappeared, and the river mouth, which was previously wide and open to the sea, was daily closing due to the quantity of sand deposited from the flood.

In August 1868, major flooding again occurred in the Pietermaritzburg-Durban region, causing infrastructural damage estimated at between £80 000 to £130 000 in Pietermaritzburg alone. For example, the Uys Doorns' iron bridge was carried ~100m downstream (*Natal Witness*, 4 September 1868). A separate article in the same issue of the *Natal Witness* describes how, in Durban, major bridges including the Umgeni Bridge and Queen's Bridge were destroyed, the Springfield Flat extensively flooded, streets in the town centre made impassable, and communication with the KZN Midlands cut off. 'Horses, cattle, timber, boxes, and property of various descriptions, were borne down upon its [the Umgeni River] waters' (*Natal Witness*, 4 September 1868).

Over the period 12-17 April 1872, severe flooding was reported in Pietermaritzburg and Durban. Water levels in the Umgeni were so high that 'the River was washing over the bed plank' of the Queen's Bridge in Durban, and a bridge over the Umhlatuzana River was destroyed (*Natal Witness*, 16 April 1872). A separate article in the same newspaper noted that, in Durban, dwellings collapsed and were damaged, West Street was flooded for several days (apparently, overflowing drains caused urban flooding), stores were converted into ponds (with large-scale damage to goods), communications were impeded, and landslides occurred as associated hazards (*Natal Witness*, 16 April 1872).

In late January 1886, flash-flooding on the Klip River inundated large areas of Ladysmith and led to at least £20 000 of damage to housing and infrastructure (*Natal Witness*, 30 January 1886). The flood swept away livestock and caused extensive damage to 70 properties on and near the floodplain, and was described by a reporter at the time as having "surpassed anything, so far as I know, in the annals of Natal" (*Natal Witness*, 30 January 1886). The flood level was likely accentuated by water backing up behind the supports for the main road bridge across the Klip (*Natal Witness*, 1 February 1886). Sediment deposited from the floodwaters raised the riverbed

by around 1m downstream of the town (*Natal Witness*, 30 January 1886). Records compiled by Bell and Mason (1998) show that the flood was the largest for the Klip in terms of discharge during the period 1884-1994, with an estimated peak flow of 1700 m^3 sec^{-1}.

3.3 Major flood events in KwaZulu-Natal/Durban post-1900

We record a total of 210 significant flood events over KZN during the period 1900-2022 (av. ~1.7 per annum) (Figure 2). Although the greater number of floods per year compared to the period 1850-1899 likely reflects real hydrological changes, under-reporting of flood events is possible for given periods of time. It is plausible, for example, that some significant flooding in areas of KZN away from the main towns and cities (e.g. northernmost Zululand), may have gone unreported during the mid-nineteenth century when information-transfer and communication was less well-established. Since 1980, there have been ~105 significant floods in the province, averaging ~2.44 per annum. Approximately 67 significant floods impacted the greater Durban region during the period 1900-2022 (av. 0.54 per annum), but this almost doubles in frequency to 0.95 per annum since 1980. The period 1993 to 1999 recorded the highest frequency of significant floods in the greater Durban region during the past 173 years (2.29 per annum). Between 1900 and 2022, monthly flood occurrence per decade for KZN was highest for February (3.6), followed by the months of March (2.8), January (2.6), December (1.8) and October (1.7). Although this monthly pattern has remained unchanged since 1980, monthly flood frequency (per decade) has substantially increased as follows: February (4.8), March (4.5), January (3.8), December (2.7) and October (2.7). The consequences of post-1900 floods have at times been catastrophic, and whilst similar in nature to those during the later nineteenth century, have been far greater in terms of reported impact magnitude – this is not surprising given population and developmental growth over time. We now describe some of the most significant flood events impacting KZN since 1900.

On 1 June 1905, a 'terrific storm' lasting almost 24 hours descended upon the greater Durban region and adjoining inland catchments, including those of the Umbilo and Umhlatuzana River valleys (*Rand Daily Mail*, 5 June 1905). Between 3pm on 31 May and 6am on 1 June, 397mm fell in Pinetown (Table 2). As a result, embankments at the Pinetown waterworks 'subsided' and released a catastrophic mass of water down the Umhlatuzana River. Consequences included the deaths of between 200 and 300 people, affecting mostly Indian communities in Chatsworth. Railways lines and many buildings were damaged or destroyed. Amongst these was a famous Hindu Temple located along the Umhlatuzana River, which was wrecked (*Rand Daily Mail*, 5 June 1905). The Durban floods of 28 October 1917 yet again impacted the Indian community most heavily, when a 'large number of Indian shanties had been washed away and the losses of life among the occupants' was feared to have been 'large' (*Rand Daily Mail*, 29 October 1917). According to the SAWS CAELUM record, this flood caused over 100 deaths. The tramway terminus in Durban was ~1.8m under water and rail links with the south coast cut-off, two bridges having been destroyed (*Rand Daily Mail*, 29 October 1917). The floods caused large scale damage to sugar and tea plantations along the coastal belt, and beaches were 'piled high

with cane crash, trees and bushes, with here and there the corpses of cattle' (*Rand Daily Mail*, 20 November 1917).

On 12 February 1923, hundreds of people had to be rescued using rafts from floods in central Ladysmith. Several houses collapsed and the historic cemetery was flooded for the first time. Thousands of acres of agricultural land were flooded, the railway service disrupted, and damage estimated at 'thousands of pounds' (*Rand Daily Mail*, 14 February 1923). Only two years later, during mid-March 1925, a tropical cyclone caused serious flooding over large parts of northern KZN, with damage estimated at over £40 000 (Barnes, 1984). Sugar and cotton plantations were destroyed on a large scale, bridges and railway lines destroyed, and hundreds of head of livestock drowned (*Rand Daily Mail*, 24 March 1925).

The KZN south coast and adjacent interior regions experienced serious floods during mid-May 1959, with at least 51 people estimated to have perished, and houses, railway lines and roads destroyed. Margate and Port Shepstone were particularly hard hit – this also caused considerable water supply problems to communities and holiday makers (*Rand Daily Mail*, 20 May 1959).

Two catastrophic scale floods occurred during the 1980s. The first of these was associated with tropical cyclone Domoina (29 January to 1 February 1984), which impacted several regions of southern Africa including northern KZN. The impact was widespread, with >200 estimated deaths, large scale sugar cane plantation damage, and several major bridges washed away. In Vryheid, over 200 houses were washed away, and the floods left hundreds of people homeless (*Rand Daily Mail*, 3 February 1984; SAWS CAELUM).

This was followed by the devastating 27/28 September 1987 floods, which, at the time, were considered South Africa's worst natural disaster. The entire KZN Province was declared a disaster region, with an estimated R3.3 billion in damages, 388 deaths and over 65 000 people left homeless (*Mail and Guardian*, 2 October 1987; *Independent Online*, 24 October 2018). As was the case with the recent 2022 event, the floods were, at least in part, associated with an intense cut-off low pressure system, yielding >800mm rainfall over 5 consecutive days (Badenhorst et al., 1989; Bell, 1994). In Ladysmith, 3000 homes were damaged or destroyed. The floods caused large scale damage to infrastructure, including roads and bridges (of which 14 were destroyed). Given the extent of associated landscape changes, which included landslides, mudflows, river channel adjustments and sedimentation, the floods were the focus of various scientific reports (e.g. Badenhorst et al., 1989; Bell, 1994).

According to the Associated Press online archives and SAWS CAELUM, an estimated 130 people were swept away by flood waters from their informal homes in Edendale Township (Pietermaritzburg) on Christmas Day 1995, due to flooding of the Msunduzi River. Pietermaritzburg was declared a disaster area, with >1000 people left homeless. Post-2000, two significant floods impacted the Durban region prior to the recent April 2022 event. The first of these was the flood of 14-15 May 2017, when ~100mm of rain fell within 24 hours over Durban, destroying infrastructure and requiring the evacuation of hundreds of people from their homes (*FloodList*, 16 May 2017). Sadly, the famous Vishnu Temple built ~70 years ago was completely destroyed in the recent 2022 flood. This temple was badly damaged during the 2017 flood but

subsequently restored, only to have been impacted by yet another flood on 18 April 2019; one that was associated with the loss of ~67 lives, mudslides, the collapse of buildings and destruction of infrastructure (*Daily Maverick*, 25 April 2019).

3.4 Excessive rainfall quantities associated with flood events

We now consider excessive and record-breaking rainfall events that led to flooding in KZN. Table 3 presents a summary of previously published extreme rainfall quantities and records over given periods of time (days or hours). This table allows a direct comparison between rain records associated with the recent April 2022 Durban flood and those of earlier years, especially during the nineteenth and early twentieth centuries.

According to the *Independent Online* (12 April 2022), Virginia in Durban recorded a record breaking 351mm over 24 hrs in April 2022, more than double the previous record in the city (which had allegedly stood at 165mm from an event in April 2019). Whilst our historical data confirm that the April 2022 event is indeed a new 24-hr rain record for Durban, the previous record dates back to April 1856 when 303mm were measured over a 24-hr period (Table 2; Figure 4). However, if one considers the greater Durban region, then the highest record dates back to June 1905 for Pinetown, when 397mm fell over 15 hrs. The record accumulated rainfall (691mm) for Durban over a period of 2-3 days (66 hrs) is for 14-16 April 1856 (Table 2; Figure 4). Other notable events for the province include the 24-hr rain record (548mm) associated with the 1984 Domoina flood at St Lucia, and that connected with another tropical cyclone in March 1925, when 1187mm fell over 9 days.

Figure 5 presents extreme rainfall quantities over 2- and 3-day periods for KZN for the twentieth century (data provided by Botes, 2014). Although precipitation exceeding 150mm over 2-day extreme rain events has substantially increased from 1.8/decade pre-1950 to 3.2/decade post-1950, the data show no such increase for very extreme rain events >300mm (i.e. 0.8/decade pre- and post-1950). For longer (3-day) extreme rain events, there is a substantial increase in occurrence over time; 3-day precipitation >200mm had a frequency of 3.6/decade pre-1950 and 5.6/decade post-1950, and events >400mm occurred 1.4/decade pre-1950 and 2.0/decade post-1950. Such increases may, at least in part, account for the increased flood frequency over the last century or more.

4. Discussion

The Durban floods of April 2022 were characterised by secondary natural disasters, such as extensive mudflows and landslides, alongside channel changes, sedimentation and soil erosion. In many cases, loss of lives and infrastructure was a consequence of these associated geomorphic hazards. However, such hazards have been known in the region for over 170 years, and could have been anticipated (see for example Thomas and van Schaslkwyk, 1993). Fluvio-geomorphic hazards associated with flooding were reported in KZN as early as April 1848, when the Umgeni River overflowed its banks, such that the channel of water found a new route through the valley

that separates it from Durban (*Natal Witness*, 14 April 1848). According to a report in the *Natal Witness*, the position of the mouth of the Umgeni was 'continually altering' over the following years (*Natal Witness*, 15 November 1864).

During another major flood in late August 1868, the morphology of both the Umlaas (or Umlazi) and Umgeni Rivers is reported to have changed. In the case of the Umgeni, the channel was affected by a combination of channel scour and the deposition of large quantities of sand. The channel became much narrower in some reaches but elsewhere 'greatly increased' in depth (by not less than ~6m). In places, the extent of scour was such that the Umgeni 'apparently flow[ed] directly on its rocky bed' (*Natal Witness*, 8 September 1868). After this flood, tidal influences extended as far upstream as the Queen's Bridge (today near the Connaught interchange), some 5.2km inland of the river mouth (*Natal Witness*, 8 September 1868).

Large-scale sediment deposition and soil erosion associated with flooding were first reported in March 1856 (near the mouth of the Umvoti River; Rev. Aldin Grout, ABCFM 15.4, vol. 4, Southern Africa, Zulu Mission 1847-59) and April 1871 (in the Umgeni River upstream of Durban; *Natal Witness,* 18 April 1871) respectively. Such events caused extensive damage to croplands in particular. We found at least eight accounts of 'landslips' (landslides) associated with heavy rains or floods during the nineteenth century, and in most such cases these impacted travel through the destruction of roads and railways. Such geohazards have been the norm since the nineteenth century, but have also received considerable scientific attention during more recent times (e.g. Badenhorst et al., 1989; Thomas and van Schalkwyk, 1993; Bell, 1994; Bell and Maud, 1996). Given that greater Durban is, in part, underlain by shale and other impermeable lithologies, many areas are naturally susceptible to landslides and mud flows and are thus unsuitable for large scale development (Bell and Maud, 1996). As such, geohazards will continue to be a concern, particularly during heavy rainfall events.

The 2022 Durban floods and associated geohazards, which caused such catastrophic loss of life and damage to housing and infrastructure, can be seen as a consequence of a combination of factors. As discussed in section 3.4, the most immediate was a prolonged extreme rainfall event. However, this rain fell in a region: (i) that has become extensively built-up, with large surface areas impenetrable to water (e.g. roads); (ii) where ponding of water occurred behind infrastructural developments; and (iii) where blockage of human-engineered drainage systems was common. Just like the geohazards described above, these human-induced contributions to flooding are nothing new and have been documented since flood events first started impacting the urban centres of Durban and Pietermaritzburg in the mid-nineteenth century. Nevertheless, it seems likely that floods and other associated geohazards have become more common, as infrastructural development has continued unabated in a geomorphologically unstable region and at a time when heavy rainfall events are becoming more frequent.

Concern has been expressed recently that the absence of effective adaptation and mitigation responses will likely escalate the levels of damage associated with floods and related hazards in South Africa (Van der Bank and Karsten, 2020). Construction and maintenance of drainage systems that can cope with large volumes of water, together with enhanced geotechnical

stabilisation of slopes, are thus essential adaptation measures. Such calls are not new, having first been made as early as 1868 following significant flooding in Durban:

> *While, however, the flood could not have been prevented, it is not affirming too much to say, that much may be learned by which precautions can be taken to avert or diminish the losses that may occur on the return of these periodical phenomena. The usual mildness of the climate, tempts those who erect our buildings or public works, to run them up rapidly, and with too little regard to the tests to which they may be put in extraordinary seasons.* (*Natal Witness*, 4 September 1868)

The first reported adaptive measures to deal with flooding were put in place in central Pietermaritzburg in late 1854, after frequent complaints had been made concerning the flooding of watercourses in the town. A request was made to employ more labourers, as only two men had been working on improving the Town Bridge and draining parts of Church Street over the previous half year. It was further lamented that 'the watercourses [had] not received the attention they required' (*Natal Witness*; 24 November 1854). Two years later, it was complained that the 'Government is in far greater stagnation than the falls of Niagara' with regards to flood response (*Natal Witness*, 13 June 1856). A similar theme emerges in historical accounts from Ladysmith. With rivers again in flood during February 1874, severely impeding transport, apparently 'everybody [was] remarking about the apathy of the government in not even making any commencement towards bridge building' (*Natal Witness*, 21 April 1874).

In light of this discussion, articles such as the one published in the *Independent Online* (19 April 2022) – '*Government's slow response to KZN floods slammed as death toll rises to 450' –* merely repeat the concerns voiced by flood-impacted citizens since earliest colonial times. Perhaps the overriding message from our flood record is that, in contrast to views expressed in the aftermath of the 2022 Durban floods, significant and damaging floods in KZN are not new. The role of governments and non-governmental organisations in providing aid to flood victims, including those affected by the 2022 floods, is well established and important in southern Africa. In KZN, non-governmental initiatives to support flood victims can be traced back to at least as early as January 1886, when subscriptions were raised from the people of Pietermaritzburg 'towards the relief of sufferers' following catastrophic flash-flooding in Ladysmith' (*Natal Witness*, 30 January 1886; see section 3.2). However, given the scale of the 2022 floods, and the likelihood of equivalent or greater magnitude events occurring in the future as a result of climate change, such reactive responses must now be complemented by proactive planning.

5. Conclusion

The April 2022 floods in Durban received much immediate media attention – appropriately so, given the catastrophic nature of the event – climatologically, hydrologically and in terms of human and economic consequences. The challenge, however, is for the media to provide accurate reporting of scientific facts. In most instances, this requires consultation with the scientific community, who themselves require sufficient time to understand the dynamics of the given event. To this end, we have provided an historical geographic account of past floods and

associated extreme rainfall events for the province of KZN, and particularly for the greater Durban region. As Francois Engelbrecht and colleagues have recently noted: "South Africa lacks collective memory about disasters since it doesn't have a reliable disaster loss and damage database" (Engelbrecht et al., 2022). We hope that this study goes some way towards building that memory.

Our record enables us to test some of the statements made concerning the recent floods. In doing so, we can confirm that the April 2022 floods were likely the most catastrophic natural disaster yet recorded in KZN, in collective terms of lives lost, homes and infrastructure damaged or destroyed, and overall economic impact. Our data also confirm reports that Durban experienced flooding almost every year during recent decades. Within the limits of our data, we suggest that the frequency of flooding has likely doubled in the city over the last century. Meteorologically, the 2022 event also stands out as having recorded the highest ever 24-hr rainfall amount. However, there are some aspects of reporting that require more critical thought and careful wording. Whether, for example, the 2022 floods were the worst "in living memory" (*The South African*, 19 April 2022) is debatable – the September 1987 floods affected a larger geographic area of KZN and destroyed more homes than the 2022 event.

Catastrophic scale rainfall and significant flooding has occurred repeatedly over KZN and Durban during the full period of our historical investigation. However – potential under-reporting during some periods of time notwithstanding – our data suggest that the frequency of extreme rainfall events and flood occurrence has increased over the last century or more. It is highly likely that recent anthropogenically-induced global climate warming has contributed to such trends and may continue to do so during the foreseeable future, for which society must be prepared. According to Pinto et al. (2022), the extreme rainfall event that led to the 2022 floods had a return period of ~20 years in today's climate – an event of this magnitude would have had a return period of ~40 years in a 1.2°C cooler world.

Without understating the important role of nature in flood-related disasters, we support the recent call made by Raju et al. (2022, p.1) — that it is imperative to recognise "a discourse in which the role of human activity in disasters is clearly communicated, as opposed to blaming Nature or the Climate". As these authors argue, this "will be more conducive to a proactive, equitable and ultimately successful approach" to reducing flood impacts.

Acknowledgements

The research that underpinned the identification of nineteenth century flood events in KwaZulu-Natal was funded by Leverhulme Trust Research Project Grant number F/00 504/D. Thanks to our colleagues Georgina Endfield, Jørgen Klein and Kathleen Pribyl who worked on American, Norwegian and German mission sources, respectively, as part of this project. We thank the two anonymous reviewers who provided constructive inputs.

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Table 1. Details of major manuscript, print-copy and online collections used in this study, together with abbreviations used in the text.

Source	Consulted at	Code	Period consulted
General storm and flood data			
CAELUM flood record	South African Weather Service (SAWS)	n/a	19th century to 2008
Botes (2014) Appendix IV (pp.255-264)	Available at: https://researchspace.ukzn.ac.za/handle/10413/12455	n/a	1848 to 2000
Missionary sources			
American Board of Commissioners for Foreign Missions papers	Houghton Library, Harvard University, USA	ABCFM	1836 to 1900
Norwegian Mission Society materials	Norwegian Mission Society archive, Stavanger, Norway	NMS	1846 to 1900
Society for the Propagation of the Gospel materials	Bodleian Library, University of Oxford, UK	USPG	1856 to 1900
Hermannsburg Missionary Society materials	Evangelisch-lutherisches Missionswerk Niedersachsen, Archiv, Hermannsburg, Germany	ELM	1860 to 1929
Other 19th century sources			
Natal Witness newspaper, *Natal Almanac*	Msunduzi Municipal Library, Pietermaritzburg, South Africa	n/a	1846-1900
The Natal Mercury and Advertiser (now: *The Mercury*)	Available at: https://dds.crl.edu/crldelivery/25470	n/a	1852 to present
19th century diaries and other manuscripts, *Natal Blue Books*	Killie Campbell Africana Library, University of KwaZulu-Natal, Durban, South Africa	KCAL	19th century
20th- and 21st- century sources			
Rand Daily Mail newspaper	Available at: https://infoweb.newsbank.com	n/a	1902 to 1986
The International Disaster Database	Available at: https://www.emdat.be	n/a	1900 to present
Mail and Guardian newspaper	Available at: https://mg.co.za	n/a	1985 to present (online 1994-)
The Guardian newspaper	Available at: https://theguardian.com	n/a	1995 to present
The South African newspaper	Available at: https://www.thesouthafrican.com	n/a	2003 to present
Independent Online newspaper (IOL)	Available at: https://www.iol.co.za	n/a	2007 to present
Daily Maverick newspaper	Available at: https://www.dailymaverick.co.za	n/a	2009 to present
The Conversation news website	Available at: https://www.theconversation.com	n/a	2011 to present
FloodList	Available at: https://floodlist.com	n/a	2013 to present

Table 2. Significant nineteenth century flood events in KwaZulu-Natal. Abbreviations for archive sources: ABCFM – American Board of Commissioners for Foreign Missions; ELM – Evangelisch-lutherisches Missionswerk Niedersachsen; KCAL – Killie Campbell Africana Library; NMS – Norwegian Mission Society; USPG – United Society for the Propagation of the Gospel. See Table 1 for archive locations.

Year	Month	Impacted regions, towns and rivers mentioned in sources	Main source(s)
1836	November	'Topila' (possibly Tugela) R.	ABCFM Film 467 Vol. 2, George Champion's journals
1837	August	Tugela R.	Bird (1888), Vol. 1, p.328
1843	September	'Whole country' [KZN region] flooded	Bird (1888), Vol. 2, p.290; and KCAL 18619-18620. Cloete, Hendrik. Holograph, watermarked 1849, Mr Cloete's Journey to Panda 1843.
1843	December	'Many rivers' flooded	Bird (1888), Vol. 2, p.330
1847	October	'Umsundusi' [Msunduzi] R.; 'whole country' [KZN region] flooded	ABCFM 15.4, Vol. 4, Southern Africa, Zulu Mission 1847-1859 (letter from Mr L. Grout)
1848	February	'Umgani' [Umgeni] R.	*Natal Witness*, 24 February 1848
1848	April	Durban, Ilovo, 'Ungenie' [Umgeni] R.	*Natal Witness*, 14 April 1848
1848	May	Inanda	ABCFM 15.4, Vol. 4, Southern Africa, Zulu Mission 1847-1859 (letter from Mr L. Grout)
1849	March-April	Ifafa, Pietermaritzburg	ABCFM 15.4, Vol. 4, Southern Africa, Zulu Mission 1847-1859 (letter from Mr D. Rood); *Natal Witness*, 30 March 1849; and *Natal Witness*, 13 April 1849
1854	February	Pietermaritzburg	*Natal Witness*, 17 February 1854
1854	November	Pietermaritzburg-Durban region	KCAL 98/65 Fleming, John. Extracts from John Fleming's Diary, 1850-1891; and *Natal Witness*, 17 November 1854
1854	December	Durban, rivers generally in flood	KCAL 98/65 Fleming, John. Extracts from John Fleming's Diary, 1850-1891
1855	September	Durban, rivers generally in flood	KCAL 98/65 Fleming, John. Extracts from John Fleming's Diary, 1850-1891
1856	March	Durban; 'Umvoti' [Mvoti] R.	ABCFM 15.4, Vol. 4, Southern Africa, Zulu Mission 1847-1859 (letter from Mr A. Grout)
1856	April	Howick-Pietermaritzburg-Durban; many rivers in flood	USPG D8, Bishop Colenso of Natal, Maritzburg, 31 May 1856; J. Fleming; KCAL 98/65 Fleming, John. Extracts from John Fleming's Diary, 1850-1891; *Natal Witness*, 18 April 1856; and *Natal Witness*, 25 April 1856
1856	November	Ladysmith; Klip R.	*Natal Witness*, 7 November 1856
1857	March	Rivers generally in flood	*Natal Witness*, 6 March 1857

1860	November	Pietermaritzburg-Durban region; Umlazi; Springvale	USPG E7, H. Callaway, Springvale, Journal from 1 October to 31 December 1860; USPG E7, C.S. Grubb, Umlazi, Durban, 3 January 1861; *Natal Witness*, 30 November 1860; and *Natal Witness*, 7 December 1860
1863	August	Pietermaritzburg-Durban region	South African Weather Service (CAELUM flood record)
1864	January	Rivers generally in flood (e.g. Umhloti)	USPG E15, W.A. Elder, Verulam, 30 January 1864
1864	February	Durban, Tugela R.; Umgeni R.	USPG E15, J.M. Samuelson, Kwamagwaza, 31 March 1864; and *Natal Witness*, 23 February 1864
1864	March	Durban	*Natal Witness*, 8 March 1864
1868	March	Coastal rivers in flood	*Natal Witness*, 6 March 1868
1868	August-September	Greytown-Pietermaritzburg-Durban-Umphumulo	*Natal Witness*, 1 September 1868; *Natal Witness*, 4 September 1868; *Natal Witness*, 8 September 1868; and NMS A1045-131-9, T. Udland, 30 September 1868
1868	December	Durban	USPG D37, H. Callaway, Springvale, 21 December 1868
1869	January	Ladysmith; Klip R.	*Natal Witness*, 16 February 1869
1870	November	Pietermaritzburg-Durban; Mahlabatini; Umbilo R.	*Natal Witness*, 25 November 1870; and NMS A1045-132-5, H.C. Leisegang, 5 January 1871
1871	January	Pietermaritzburg; Ladysmith; Klip R.	*Natal Witness*, 31 January 1871
1871	April	Durban	*Natal Witness*, 18 April 1871
1872	April	Pietermaritzburg-Durban region; Msunduzi R.	*Natal Witness*, 16 April 1872
1872	December	Southern KwaZulu-Natal	*Natal Witness*, 17 December 1872
1874	February	Durban; Verulam; Tugela and other rivers	KCAL 98/75/3/5 Groom, Thomas, File 3. Diaries 1870-1875; USPG D37, T. Jenkinson, Maritzburg, 25 March 1874; and *Natal Witness*, 24 February 1874
1874	March	Widespread across KwaZulu-Natal	*Natal Witness*, 10 March 1874; and *Natal Witness*, 13 March 1874
1874	April	Ladysmith; Klip R.	*Natal Witness*, 21 April 1874
1874	December	Durban; Ladysmith; Newcastle; many rivers	*Natal Witness*, 11 December 1874; *Natal Witness*, 15 December 1874; and *Natal Witness*, 12 January 1875
1875	November	Greytown to Durban region; Umgeni R.	*Natal Witness*, 23 November 1875; NMS A1045-133-10, G. Gundersen, 29 May 1876
1875	December	Pietermaritzburg; Msunduzi R.	*Natal Witness*, 17 December 1875; and *Natal Witness*, 31 December 1875
1880	February	Pietermaritzburg; Eshowe; Umgeni R.	*Natal Witness*, 19 February 1880; and NMS A1045-135a-6, O. Oftebro, 22 March 1880
1880	March	Estcourt; Mooi R.; Bushman's R.	*Natal Witness*, 9 March 1880

1882	not specified	General and widespread flooding	ELM, ASA 41, 58, Chronik der Station Entombe/Natal (Jahresbericht), 1878, 1981, Missionare 1860-1947 (entry by Ch. Wagner)
1882	November	Pietermaritzburg	*Natal Witness*, 30 November 1882
1883	March	Pietermaritzburg; widespread; Umgeni R.	*Natal Witness*, 10 March 1883 (Supplement)
1884	January	Howick; Umgeni R.	*Natal Witness*, 2 February 1884
1886	January	Ladysmith; Klip R.	*Natal Witness*, 29 January 1886; *Natal Witness*, 30 January 1886; and *Natal Witness*, 1 February 1886
1886	March	Pietermaritzburg	*Natal Witness*, 9 March 1886; and *Natal Witness*, 10 March 1886
1889	November	Ladysmith; Klip R.	*Natal Witness*, 7 December 1889
1890	February	Port St Johns; Howick	*Natal Witness*, 14 February 1890
1890	October	Pietermaritzburg; KwaMagwaza	USPG E45b, J.M. Samuelson, St Paul's, Zululand, 30 December 1890; and *Natal Witness*, 25 October 1890
1891	January-February	Widespread across midlands region	*Natal Witness*, 15 January 1891; *Natal Witness*, 17 January 1891; *Natal Witness*, 9 February 1891; and *Natal Witness*, 12 February 1891
1891	March	Durban; Umbilo flats; widespread across KwaZulu-Natal	*Natal Witness*, 17 March 1891; *Natal Witness*, 18 March 1891; *Natal Witness*, 19 March 1891; and *Natal Witness*, 17 April 1891;
1891	December	Widespread across KwaZulu-Natal	*Natal Witness*, 22 December 1891; and *Natal Witness*, 7 January 1892
1892	January	Widespread across KwaZulu-Natal	*Natal Witness*, 22 January 1892
1893	January	Durban; Ladysmith; Estcourt; Tugela R.	van Bladeren (1992); *Natal Witness*, 17 January 1893
1893	March	Ladysmith; Klip R.	*Natal Witness*, 11 March 1893
1893	September	Pietermaritzburg; southern KwaZulu-Natal	*Natal Witness*, 2 October 1893; and *Natal Witness*, 5 October 1893
1893	October	Durban; Umgeni R.	*Natal Witness*, 10 October 1893
1894	January	Pietermaritzburg	*Natal Witness*, 1 February 1894
1894	February	Newcastle-Ladysmith region	*Natal Witness*, 6 February 1894
1895	February	Newcastle	*Natal Witness*, 23 February 1895
1895	May	Durban	van Bladeren (1992); South African Weather Service (CAELUM flood record)
1895	December	Pietermaritzburg; Lydgetton; many rivers	*Natal Witness*, 21 December 1895; and *Natal Witness*, 25 December 1895
1896	September	Durban	*Natal Witness*, 3 October 1896

Table 3. The most extreme recorded rainfall events in KwaZulu-Natal.

Year	Month	Location	Days	Hours	Rainfall (mm)	Source
1856	14-16 Apr	Durban		66	691.0	*The Natal Mercury*, 18 April 1856
	14 Apr	Durban	1		189.5	
	15 Apr	Durban	1		303.0	
	16 Apr	Durban	1		198.6	
1868	29-30 Aug	Durban	2		420.0	South African Weather Service, 2008
			1		255.0	
1905	01 Jun	Pinetown		15	397.0	*Rand Daily Mail*, 5 June 1905
1908	17-19 Apr	KZN coast	3		577.0	South African Weather Service, 2008
1909	19-21 Jan	KZN northern coast	3		634.0	South African Weather Service, 2008
1925	March	KZN northern coast	9		1187.2	*Natal Advertiser*, 13 June 1935
				11	320.0	
2019	April	Virginia (Durban)	1		165.0	*Independent Online*, 12 April 2022
2022	April	Virginia (Durban)	1		351.0	*Independent Online*, 12 April 2022
Highest 24-hr rainfall recorded = 548mm at St Lucia in 1984 (Source: Kovács, 1988)						
Highest 1-hr rainfall recorded = 211mm at Ulundi in 2004 (Source: Fashuyi et al., 2006)						

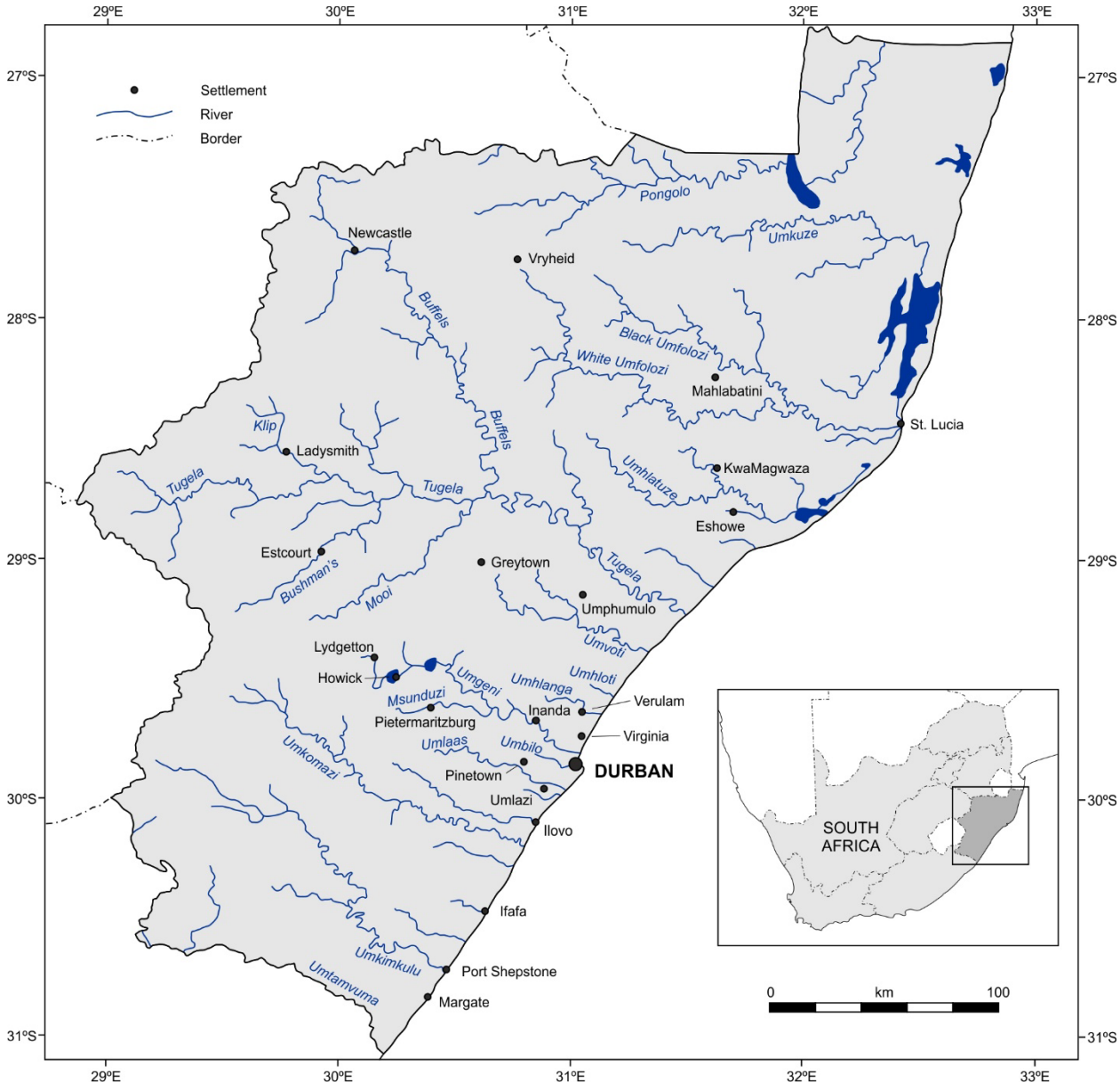

Figure 1. Major rivers and drainage features in KwaZulu-Natal, together with locations of places mentioned in the text.

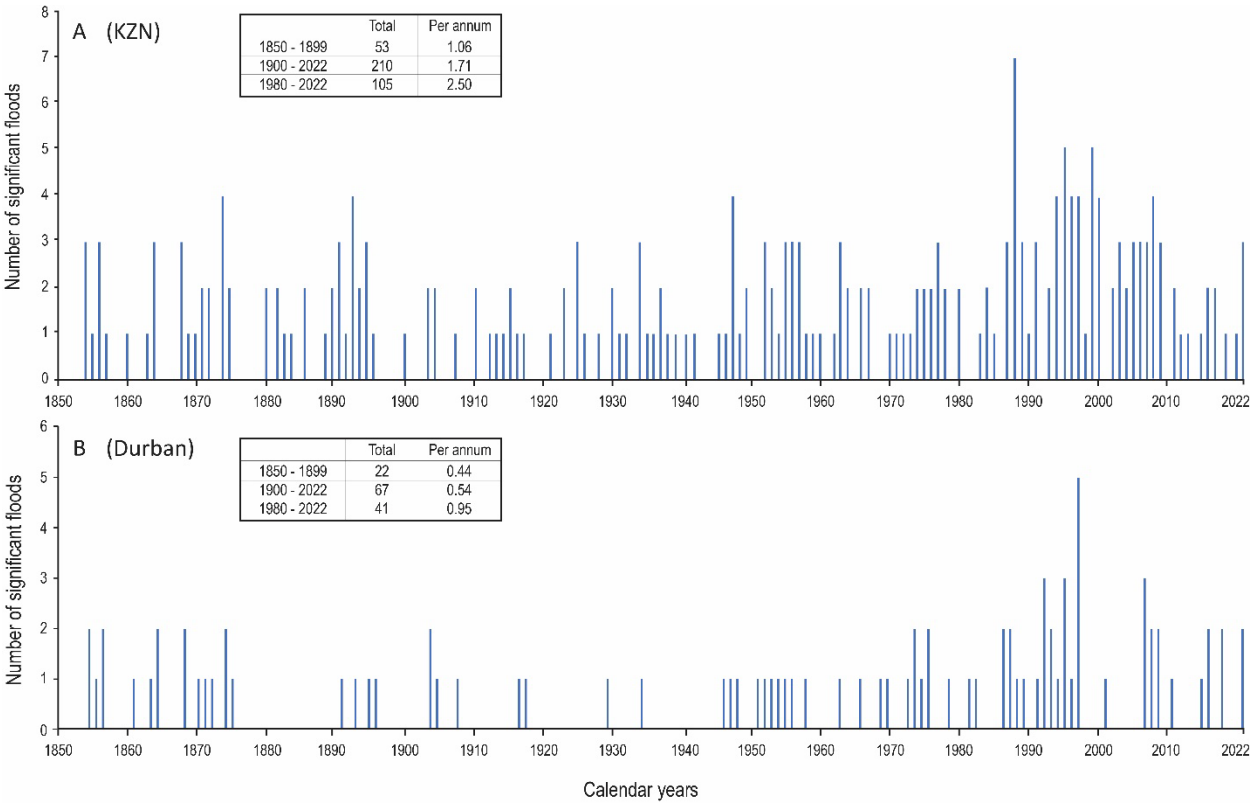

Figure 2. Significant floods in (A) KwaZulu-Natal as a whole and (B) Durban only over the period 1850-2022.

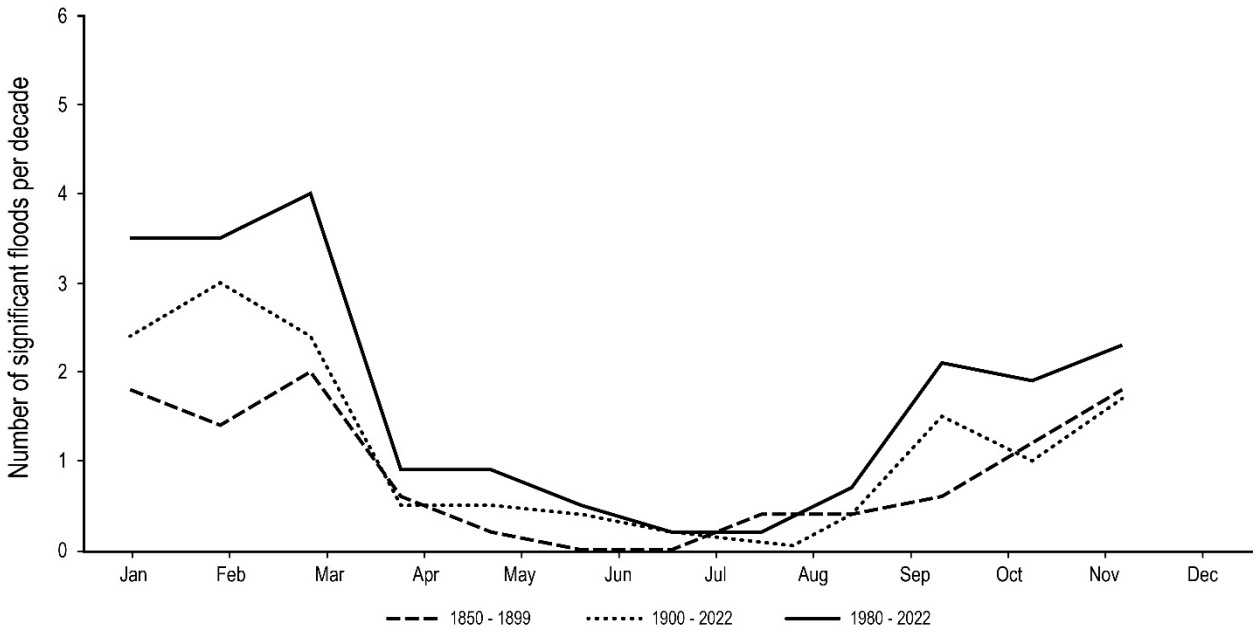

Figure 3. Mean number of significant floods per decade in given months and for given periods of time in KwaZulu-Natal.

The Natal Mercury,
AND ADVERTISER.
VOL. IV.] FRIDAY, APRIL 18, 1856. [No. 179.

METEOROLOGICAL REGISTER,

FOR THE WEEK ENDING APRIL 15TH, 1856,

Kept at the Observatory, in the Gardens of the Agricultural and Horticultural Society of Durban, Natal, by Mr. Plant, Curator.

Hour.	Day of the week.	Day of the month.	Barometer.	Attached Thermometer.	Dry Bulb Thermometer.	Wet Bulb Thermometer.	Direction of Wind.	Force of Wind 0-6.	Amount of Clouds, 0-10.
9 a.m. local time	W	9	30.140	91	73	67			
	Th	10	30:	68	77	72	E.	1	s ci 3
	F	11	30.076	92	77	72			ci 3
	S	12	29.948	84	75	71			cu 5
	S	13	29.924	76	72	69			cu 10
	M	14	30.164	62	62	62	S.E.	2	cu 10
	Tu	15	30.122	66	67	66	E.	3	cu 10
3 p.m. local time	W	9	30.05	72	70	67	E.	1	s ci 2
	Th	10	29.972	97	81	77	E.	1	ci 2
	F	11	29.950	80	78	73	E.	1	ci 2
	S	12	29.788	92	82	76	E	2	s cu 5
	S	13	29.983	70	66	66	S.W.	1	cu 10
	M	14	30.165	64	61	64	S.W.	3	cu 10
	Tu	15	29.924	67	67	66	E.	1	cu 10
9 p.m. local time	W	9	30.	62	62	61	E.	1	ci 2
	Th	10	30.	64	61	63			ci 3
	F	11	29.644	67	66	63	S.W.	1	
	S	12	29.926	67	67	66	E.	1	cu 8
	S	13	30.024	52	51	51	E.	2	cu 10
	M	14	30.108	65	64	64	E.	2	cu 10
	Tu	15	30.050	67	67	66	E.	3	cu 10

		Self-Registering Thermometer.				Moisture.	
Hour.	Day of Week.	Day of Month.	Minimum in Grass.	Minimum in Shade.	Maximum in Shade.	Rain in inches	Evaporation.
9 p.m. local time	W	9	51	38	73		.140
	Th	10	55	62	89		.186
	F	11	55	62	85		.188
	S	12	58	65	82		.160
	S	13	57	62	86	.140	.191
	M	14	56	62	79	7.460	
	Tu	15	55	62	73	11.930	

REMARKS.

April 11. Single halo round the moon.

April 12. Thunder-storm from westward in the evening.

13. Rain in afternoon, commencing about 4 p.m., and continuing without cessation, till Wednesday 9 p.m. During this time 27.330 inches was registered here.

Figure 4. Meteorological tables depicting the extreme weather conditions in April 1856 that led to catastrophic flooding in the Durban and adjacent interior regions. The measurements were taken at the Observatory, Gardens of the Agricultural and Horticultural Society, Durban. The remarks section reads as follows: April 11. Single halo round the moon. April 12. Thunder-storm from westward in the evening. 13. Rain in the afternoon, commencing about 4 p.m., and continuing without cessation, till Wednesday 9 p.m. During this time 27.330 inches was registered here. Source: *The Natal Mercury and Advertiser*, Fri 18 April 1856, vol IV, No179.

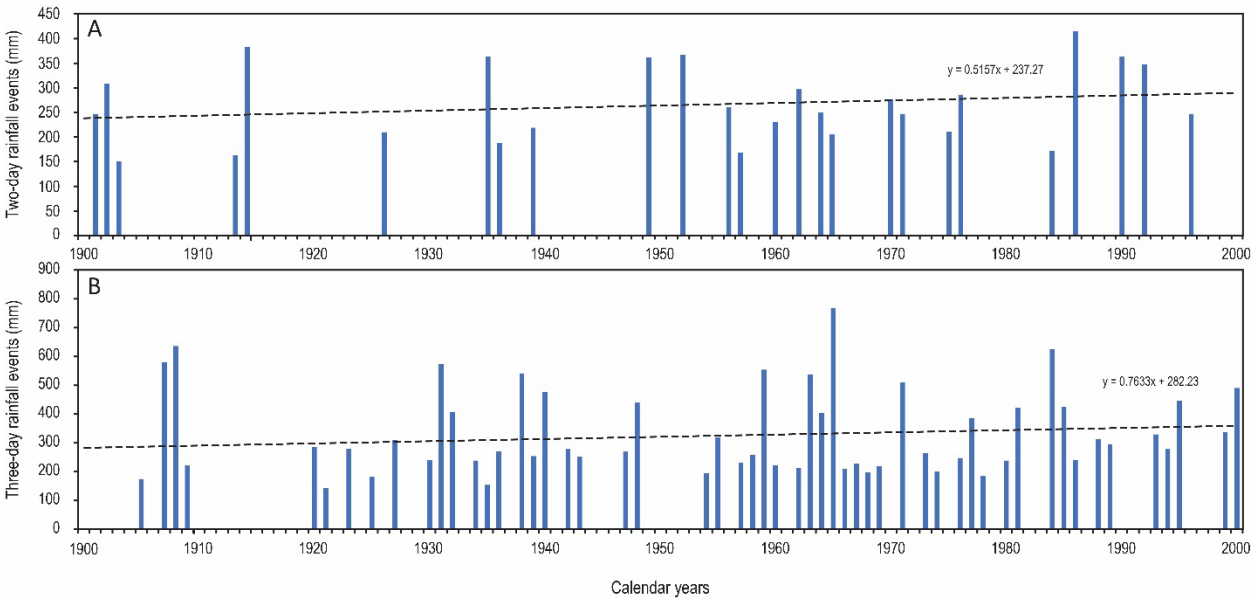

Figure 5. (A) Two- and (B) three-day extreme rainfall events (total precipitation in mm) and trends in KwaZulu-Natal over the period 1900-2000 (raw data from Botes, 2014).