LANDHOLDERS DRIVING CHANGE
BURDEKIN MAJOR INTEGRATED PROJECT

LDC COMMUNITY WATER QUALITY SAMPLING FOR SEDIMENTS AND NUTRIENTS WITHIN THE BOWEN-BROKEN-BOGIE CATCHMENTS

2019-2020 WET SEASON UPDATE

NQ DRY TROPICS

Nine properties in the Bowen, Broken and Bogie (BBB) catchment make up the LDC Community Water Quality Monitoring Group.

This group has been established to better understand the water quality variations throughout the BBB catchment, with a focus on sediment and nutrient concentrations throughout a range of flow events.

Scientists Steve Lewis and Zoe Bainbridge from The Centre for Tropical Water and Aquatic Ecosystem Research (TropWATER), James Cook University, trained landholders on how to collect and store water samples.

The Community Water Quality Monitoring Group data is shared with the Queensland Government modelling team. The results are being used to enhance the Paddock to Reef model and improve confidence in load estimates and results for the BBB catchment.

With monitoring, LDC is learning more about how, when and where sediment (and nutrients attached to sediment) moves. This means graziers can respond better to help reduce sediment flowing out into the Great Barrier Reef lagoon.

This publication outlines the results of the water samples collected by landholders during the 2019-2020 wet season. This publication, and the 2018-2019 wet season booklet, are available on the LDC website.

"The Community Water Monitoring program is a good idea. it gives you a benchmark to work out whether you are going forwards or backwards with your sediment retention."
Glen Rea - Kirknie Station.

PROJECT OVERVIEW

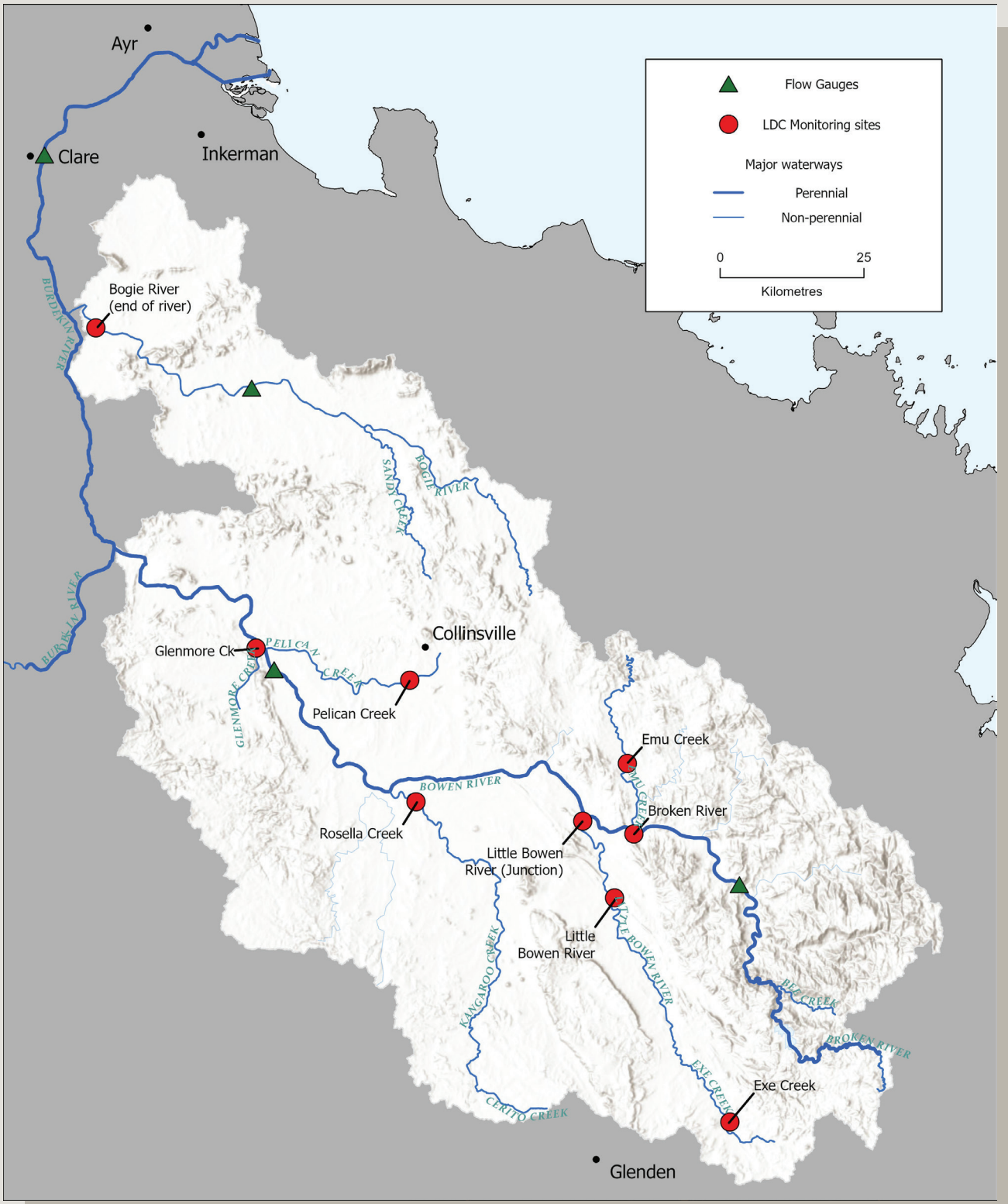
Nine river and creek sites across the Bowen Broken Bogie (BBB) catchment were sampled by landholders during rainfall-generated high flow events in the 2018-2019 and 2019-2020 wet seasons.

Multiple water samples were collected during each flow event to capture changing suspended sediment and nutrient (nitrogen and phosphorus) concentrations over the rising, peak and falling stages of stream flow.

Data collected for this project aims to improve our understanding of loss of soil (and the nutrients attached to this soil) from the land into waterways during high rainfall events, and to quantify differences in the contribution of sediments and nutrients from each of the BBB sub-catchments.

Sub-catchment sediment and nutrient concentration data collected will be used to improve scientific modelling (*Source Catchments*) of our river catchments (that is, provide a validation check against modelled concentrations for these same river and creek locations) and will also act as a baseline dataset to examine trends over time.

The aim is to identify the sub-catchments delivering higher sediment and nutrient loads. This knowledge, coupled with a broader understanding of the landscape (including factors such as slope, soil types, and erosion processes), will improve and refine the process of characterising and prioritising the catchments.


Ayr
Clare
Inkerman
Flow Gauges
LDC Monitoring sites
Major waterways
Perennial
Non-perennial
0
25
Kilometres
Bogie River
(end of river)
BURDEKIN RIVER
SANDY CREEK
BOGIE RIVER
BURDEKIN RIVER
Collinsville
Glenmore Ck
GLENMORE CREEK
PELICAN CREEK
Pelican Creek
Emu Creek
EMU CREEK
BOWEN RIVER
Broken River
Rosella Creek
Little Bowen
River (Junction)
Little
Bowen River
KANGAROO CREEK
LITTLE BOWEN RIVER
BEE CREEK
BROKEN RIVER
EXE CREEK
Exe Creek
CERITO CREEK
Glenden

RAINFALL EVENTS

The 2019-2020 wet season resulted in relatively dry conditions and limited river flows across Queensland. For the Burdekin River, the annual water year discharge (October 2019 to September 2020) was 2.1 million megalitres (ML), and well below the long-term median (4.4 million ML). Much of the flow in the river was derived from the Belyando-Suttor sub-catchment, causing the Burdekin Falls Dam to overflow in a small late-February to early-March event.

Compared to the previous wet season, less rainfall and associated stream flow events occurred across the BBB catchment in the 2019-2020 wet season. Rainfall totals ranged from 221mm at Gatton Vale to 1445mm at Mt William, Dalrymple Heights.

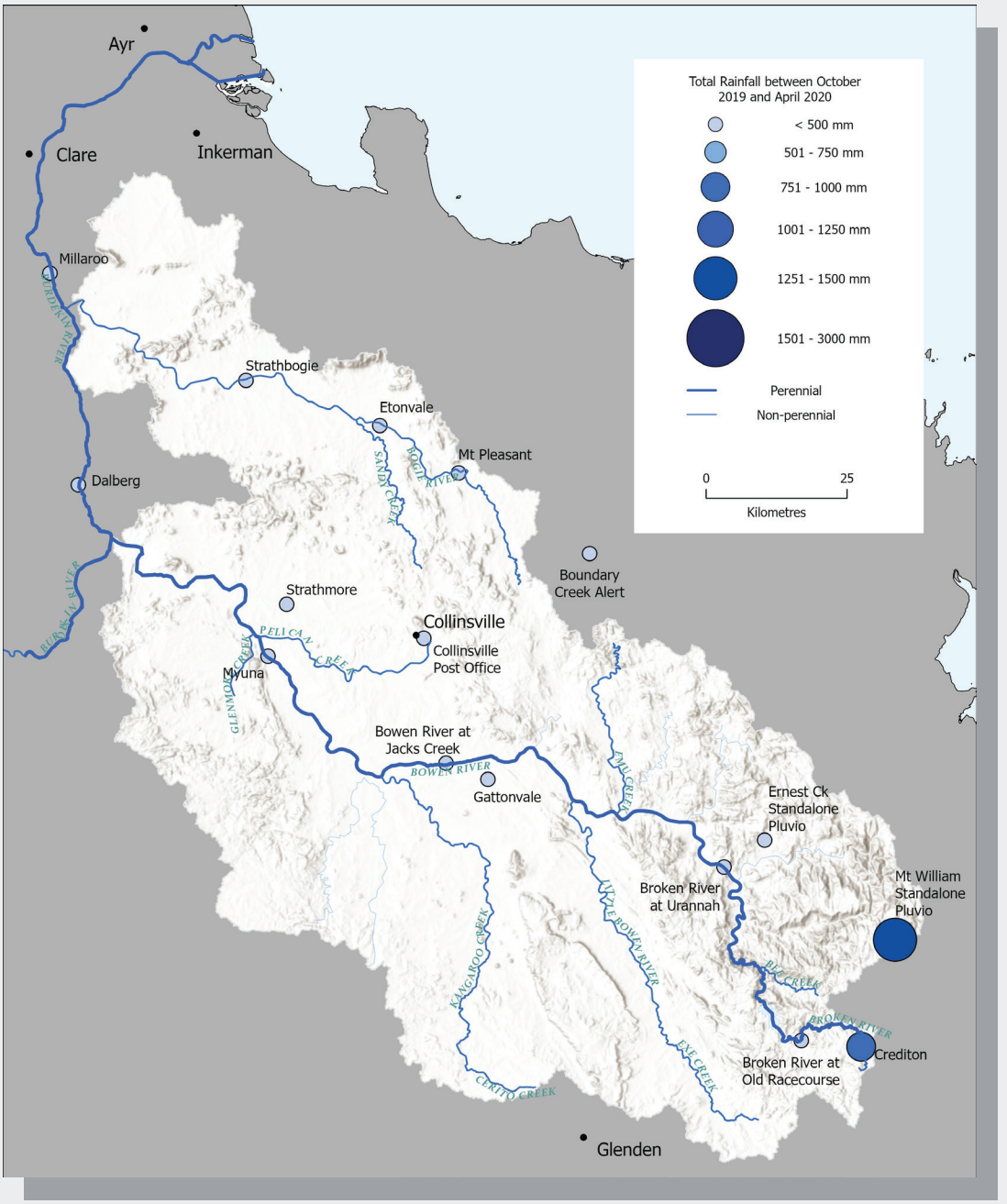
WATER SAMPLE COLLECTION

Thirty-eight water samples were collected this wet season.

Depending where the rain fell, one to three flow events were sampled by landholders at five of our sampling sites:

- January 2020 flows: Broken River, Little Bowen (Junction), Pelican Creek, Bogie River
- February 2020 flows: Broken River, Little Bowen (Junction), Bogie River
- March 2020 flows: Emu Creek, Pelican Creek, Bogie River.

Nine additional water samples were also collected in the 2018-2019 wet season following the reporting period. Combined with this wet season a total of 147 samples have been collected under this project.



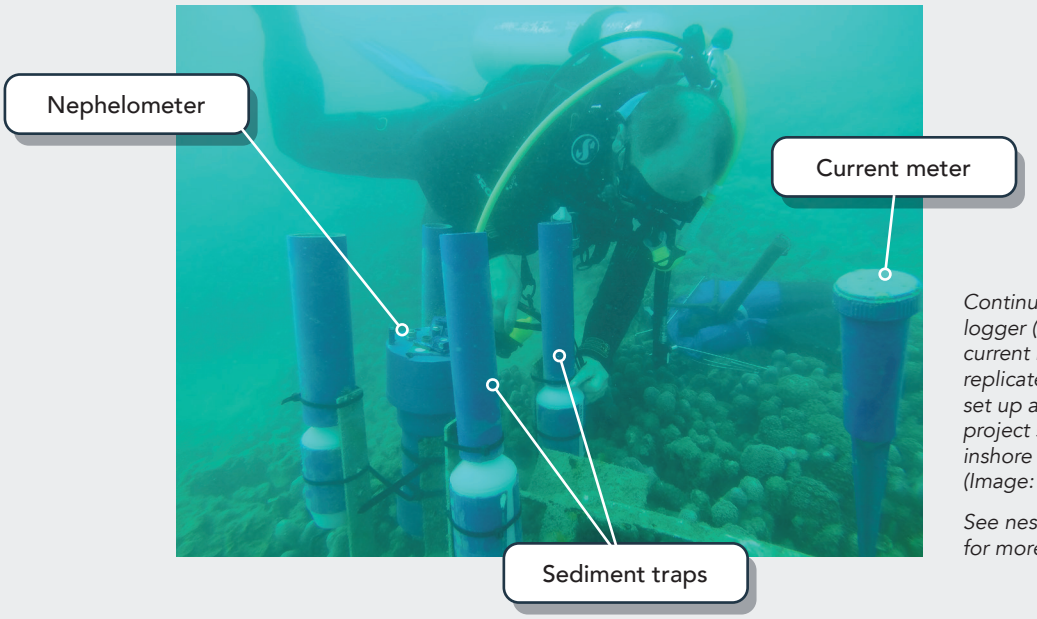
SAMPLING FROM CATCHMENT TO REEF

NATIONAL ENVIRONMENTAL SCIENCE PROGRAM (NESP) PROJECT 5.8

"Our linked NESP Tropical Water Quality Hub Project 5.8 is due to conclude at the end of 2020" says Dr Stephen Lewis.

"We finished our four-year sampling campaign in March 2020 by removing the continuous logger and sediment traps deployed in the inshore region of the Great Barrier Reef (GBR), influenced by the Burdekin River. We also conducted end-of-river sampling of a small Burdekin flow event at Inkerman Bridge to capture sediment from a rare Belyando-Suttor dominated flow source."

The team is working through this large dataset to examine the influence of newly delivered sediment to the inshore GBR, and hopes to identify the sources of this sediment.



Continuous turbidity logger (nephelometer), current meter and replicated sediment trap set up at each NESP project site within the inshore GBR lagoon (Image: Ian McLeod).

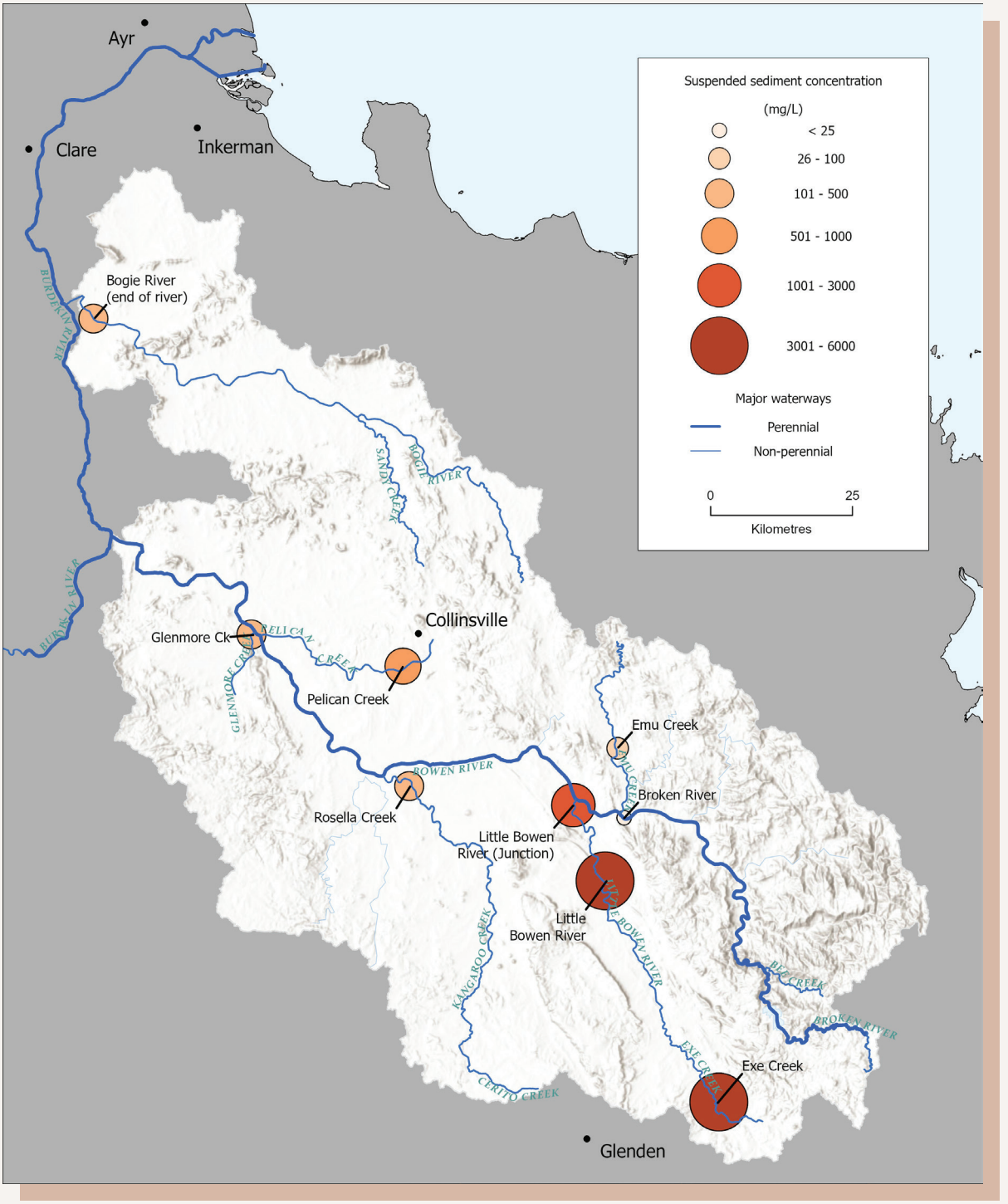
See nesptropical.edu.au for more information

SUSPENDED SEDIMENTS

Suspended sediments are a direct measure of the amount of suspended particulate material (organic or inorganic) in the water column. The lab method (total suspended solids) measures all solids in the water sample that can be trapped by a filter, including sand, silts and clays, organic detritus, microbes or plankton.

Soil eroded from the catchment becomes sediment carried to coastal areas by streams as run-off, usually during the wet season when heavy rain and flooding are common.

Most sediment washed to the Great Barrier Reef is very fine and can stay suspended in the water column for a long time, often travelling a great distance away from or along the coast. It causes elevated turbidity (the water loses its transparency and looks murky or muddy), reducing the light available for seagrasses and coral, and can be harmful if concentrations are elevated for extended periods.



Where landholders were able to sample in the 2019-2020 wet season, the additional data provided greater confidence in the average concentrations for those sites. When all data points were combined across the two wet seasons, average suspended sediment (SS) concentration values for each site remained unchanged (see map), with large variations in SS concentrations measured across the BBB river and creek sites.

Water quality measured in rivers and creeks reflects landscape-scale processes of the entire upstream catchment area, and higher SS and nutrient concentrations often relate to highly erodible soil types, the underlying geologies, and areas of steep slopes. Improved knowledge of, and support towards managing these land types is critical in keeping soil in place, and reducing runoff reaching the Great Barrier Reef.

All samples collected at each site over the two wet seasons were pooled to determine an average site concentration, displayed in blue text.

Over the two sampled wet seasons site averages ranged from 20 mg/L (Broken River) to >4800 mg/L across sites in the Little Bowen sub-catchment.

Additional sampling at the Broken River, Pelican Creek and Bogie River sites this wet season have increased the number of individual water samples collected at each of these sites to 49, 24 and 21, respectively. Averages for Broken and Bogie River sites are very consistent across wet seasons, with a slight increase in SS concentrations at the Pelican Creek site in 2019-2020 that increased the site average to 800 mg/L.

The creeks draining into the lower reaches of the Bowen River (Rosella, Pelican and Glenmore) had average SS concentrations ranging from 265 to 800 mg/L. We are still chasing additional flows in these western creeks to improve data confidence, especially at Rosella Creek which has had limited flow over the two wet seasons.

Average SS concentrations were again substantially lower at the Broken River sub-catchment sites (Emu Creek = 85 mg/L, Broken River =20 mg/L). This sub-catchment is often the dominant flow contributor to the Bowen River, draining steep forested and higher rainfall areas in the upper catchment reaches (for example, Eungella).

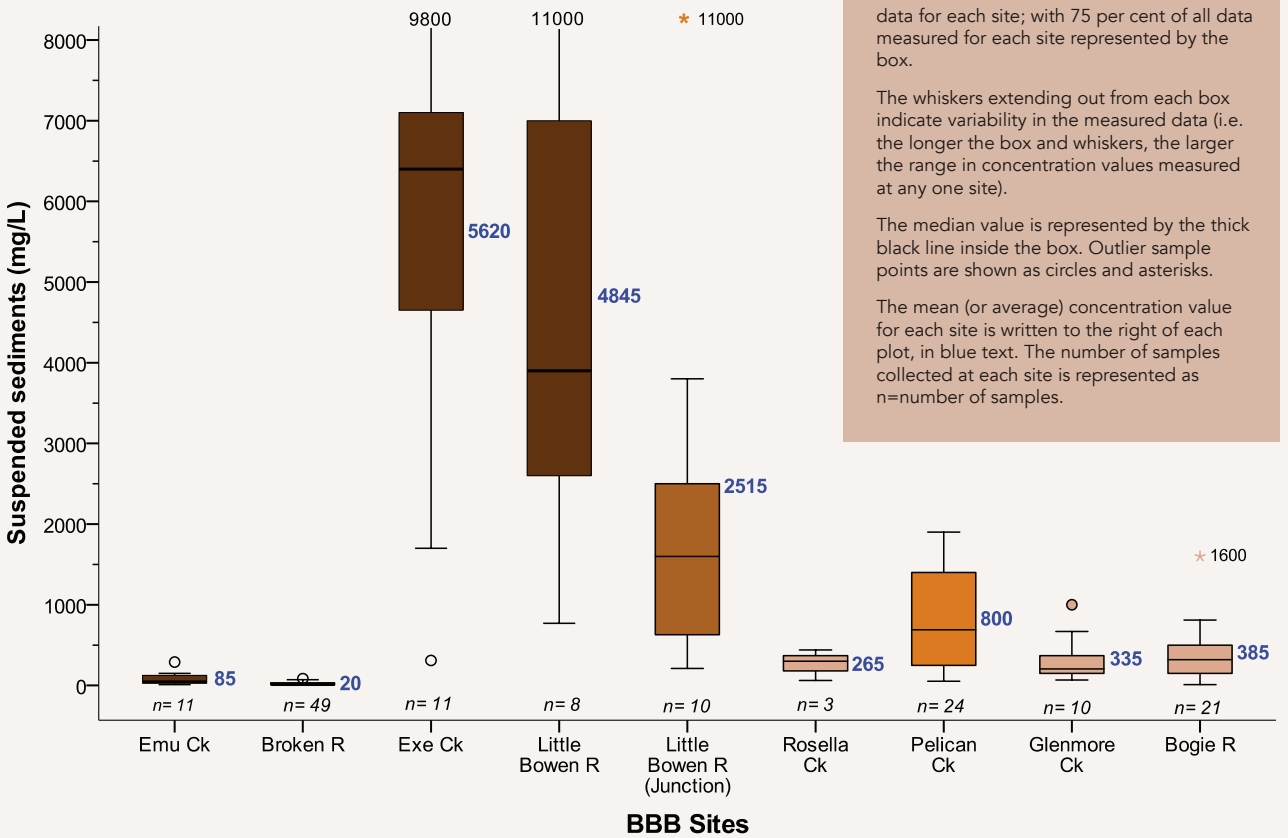
HOW TO READ A BOXPLOT GRAPH

Box and whisker plots (boxplots) show the distribution of the measured concentration data for each site; with 75 per cent of all data measured for each site represented by the box.

The whiskers extending out from each box indicate variability in the measured data (i.e. the longer the box and whiskers, the larger the range in concentration values measured at any one site).

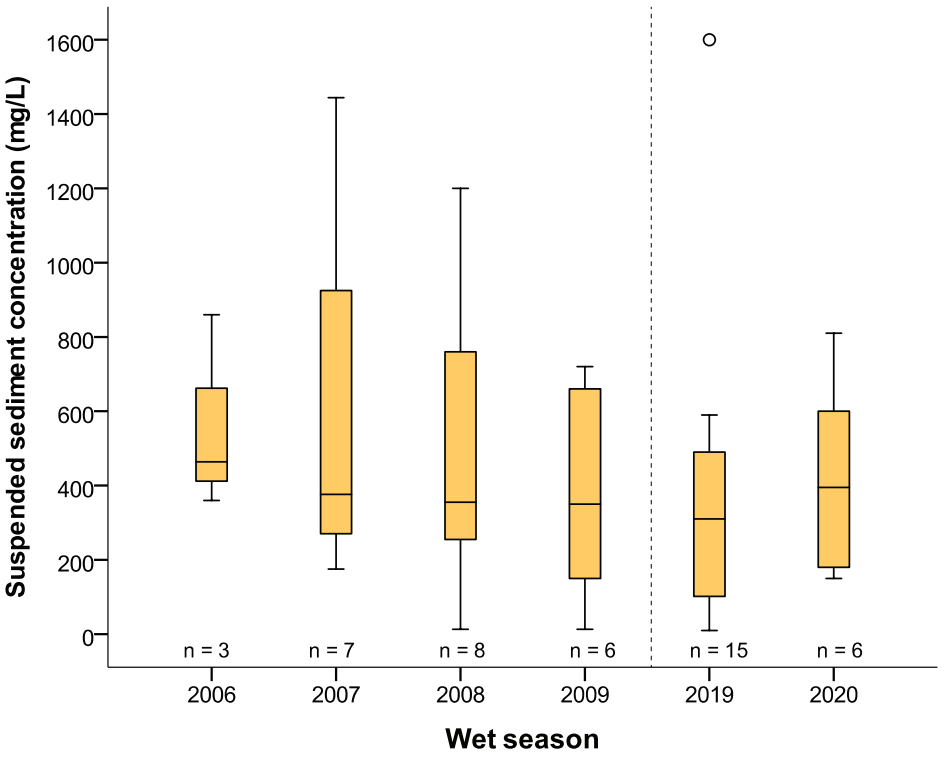
The median value is represented by the thick black line inside the box. Outlier sample points are shown as circles and asterisks.

The mean (or average) concentration value for each site is written to the right of each plot, in blue text. The number of samples collected at each site is represented as n=number of samples.



Graph showing the full range of SS concentrations measured at each sampling site over the two wet seasons.

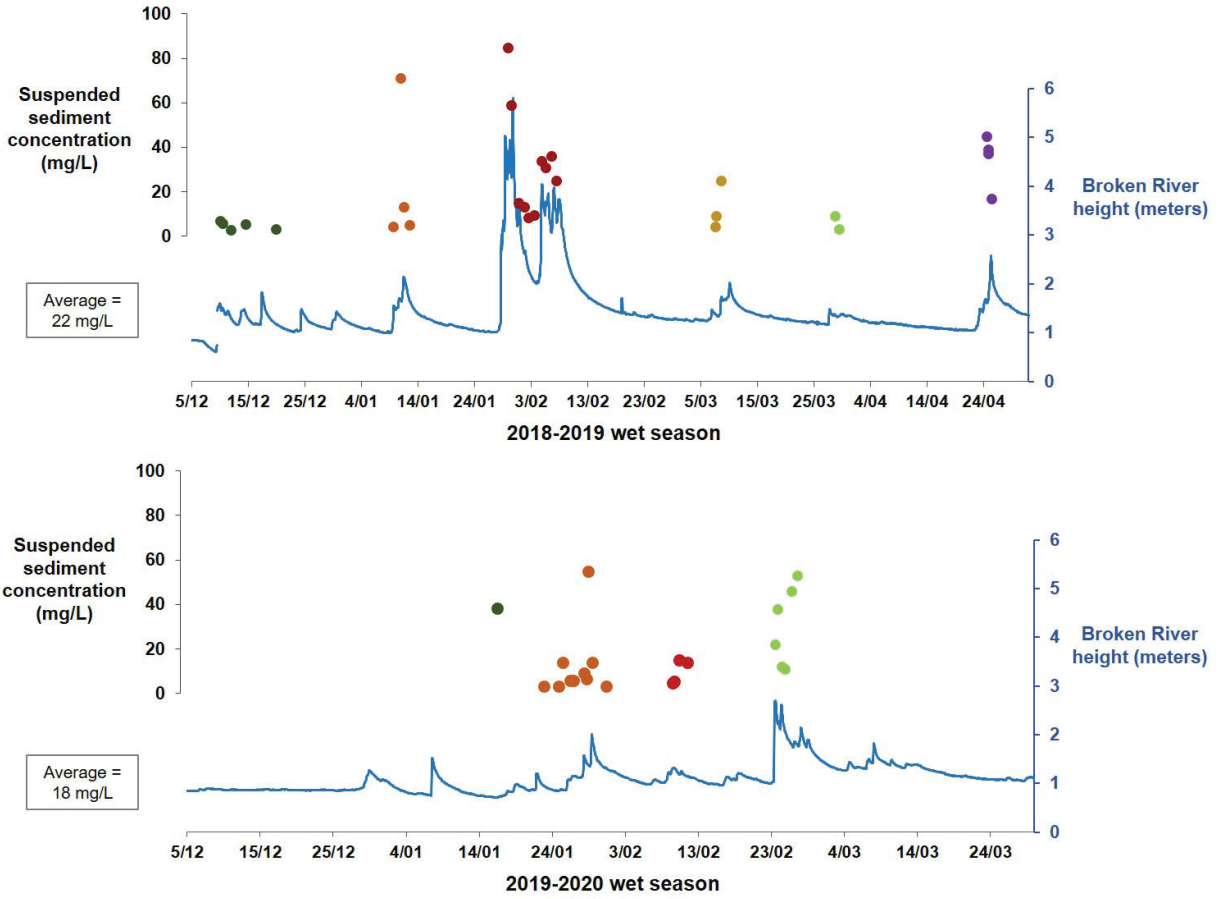
CASE STUDY
MULTI WET SEASON SAMPLING OF THE BOGIE RIVER



Graph showing the range of SS concentrations measured at the Bogie River site across six sampled wet seasons.

- The Bogie River (end-of-catchment) site has now been sampled over six wet seasons: two under this project and four additional water years from 2006 to 2009 as part of the earlier Burdekin-wide community-based sampling project TropWATER ran with NQ Dry Tropics. A total of 45 samples have now been collected at this site.
- All suspended sediment concentration data is presented in the graph above, showing the range of concentrations measured within each wet season. This sampling highlights the value in collecting a dataset over multiple discharge events and water years, for examining trends, and to provide increased confidence in data collected.
- Despite sampling occurring over drought-breaking flood events (2006, 2007), extreme flood years (2008, 2009) and two wet seasons a decade later, the median concentration for each of these wet seasons - depicted by horizontal line within each box - is fairly consistent, ranging from 310 to 465 mg/L.

CASE STUDY
EXTENSIVE SAMPLING OF THE BROKEN RIVER



*Samples plotted up to -5hrs from time of collection for each event to account for sampling site ~25km downstream of flow gauge (120207A gauge flow data: © State of Queensland 2020)

Broken River hydrographs for the 2018-2019 (top) and 2019-2020 (bottom) wet seasons. Sediment concentrations for each water sample collected across the hydrographs are displayed as circles relating to the left axis. The different colours represent each flow event sampled.

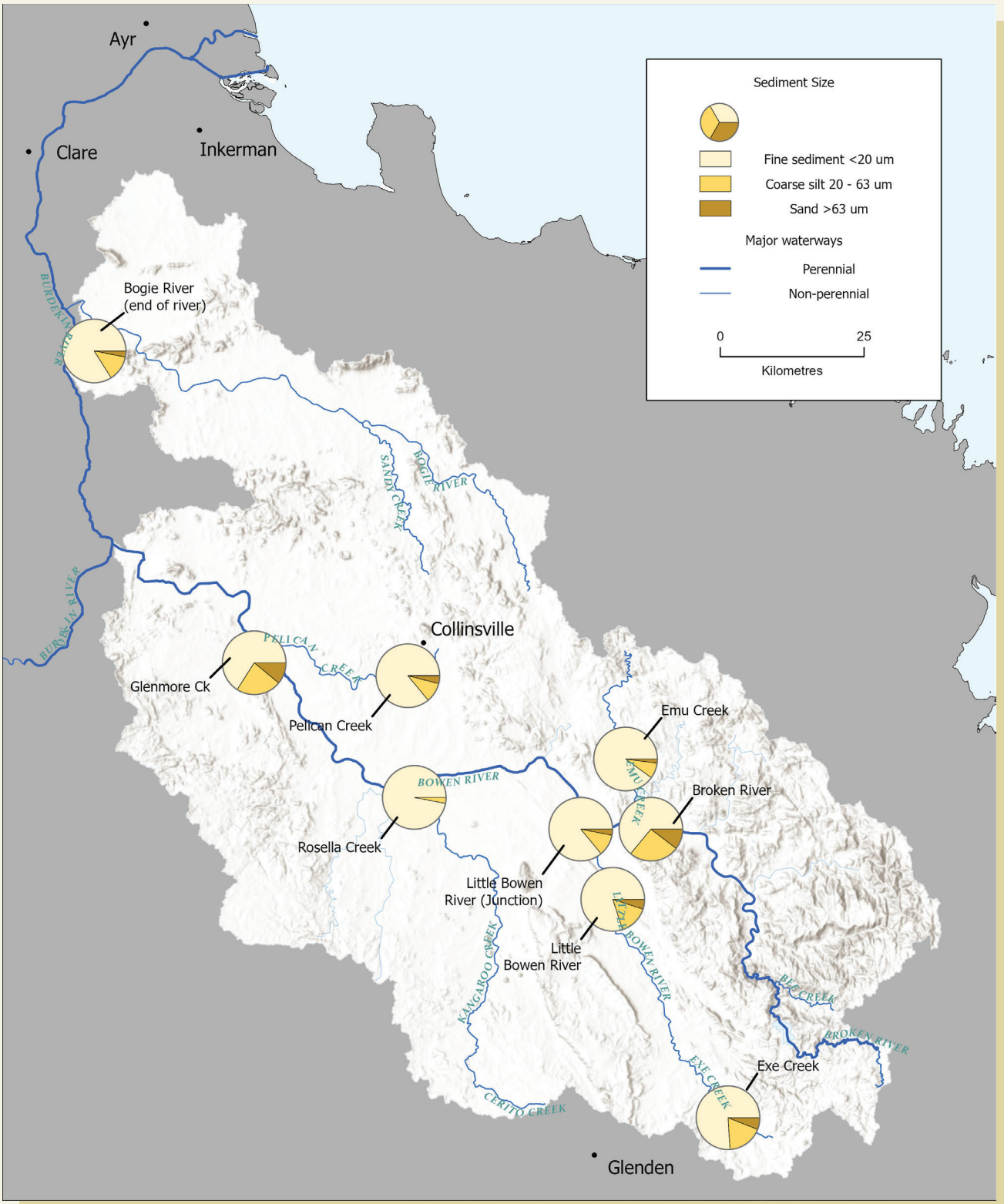
- The Broken River hydrographs (above) covering the 2018-2019 and 2019-2020 wet seasons highlight the extensive sampling efforts at this site. Water samples have been collected across all stages of the flow hydrograph (rise, peak, falling stages) and capture multiple flow events each wet season. Similarly to our other sites, the highest suspended sediment concentrations are typically measured on the rising stages of streamflow, and during larger events.
- The range of SS concentrations were similar in the 2019-2020 wet season despite the smaller flow events (refer to the river heights), with a consistent average SS concentration measured across the two wet seasons (22 and 18 mg/L, respectively).

SEDIMENT GRAIN SIZE

To identify which sediment size fractions are being transported through the BBB rivers and creeks, a sub-set of collected water samples (selected from the rising and peak stages of sampled events) was measured to determine the proportion of fine sediment (clay and very fine silt sized particles), coarse silt and larger sand grains.

Fine sediment was the dominant grain size in all water samples measured (64-96 per cent of all grain sizes), and this size fraction has the highest delivery ratio to the end of catchment i.e. most likely to be transported from its source (for example, hillslope or gully) downstream to the Burdekin River and into the GBR lagoon.

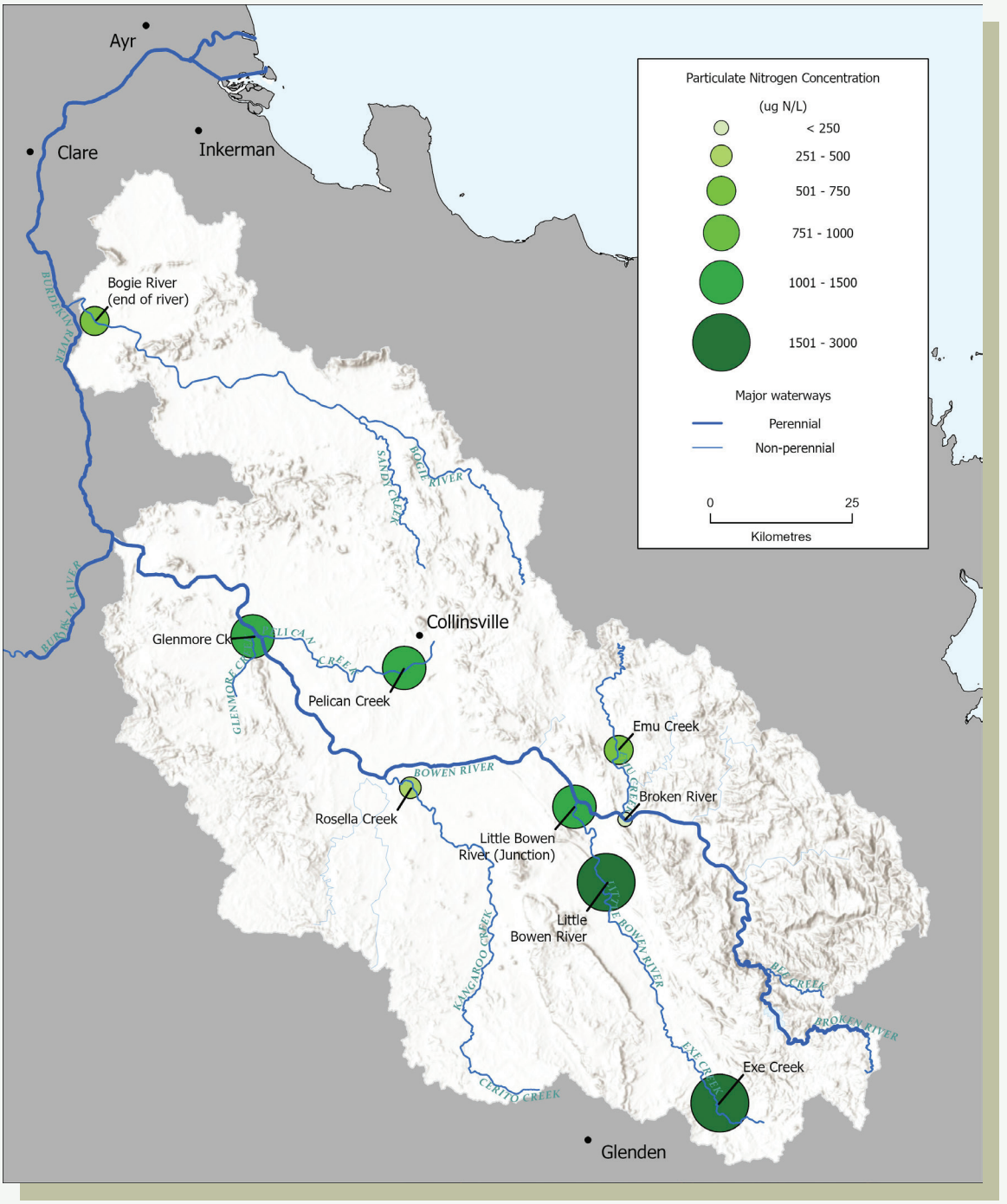
Sand comprised only 1-11 per cent of all grain sizes measured, and was highest in water samples collected at Glenmore Creek and from the headwaters of the Little Bowen sub-catchment, at Exe Creek. These coarser sized grains are most likely to settle out of suspension during downstream transport, onto river beds and channel bars.


Ayr
Clare
Inkerman
Collinsville
Glenden
Sediment Size
Fine sediment <20 um
Coarse silt 20 - 63 um
Sand >63 um
Major waterways
Perennial
Non-perennial
0
25
Kilometres
Bogie River
(end of river)
Glenmore Ck
Pelican Creek
Rosella Creek
Emu Creek
Broken River
Little Bowen
River (Junction)
Little
Bowen River
Exe Creek
BURDEKIN RIVER
BURK-IN RIVER
SANDY CREEK
BOGIE RIVER
PELICAN CREEK
BOWEN RIVER
EMU CREEK
LITTLE BOWEN RIVER
KANGAROO CREEK
BEE CREEK
BROKEN RIVER
EXE CREEK
CERITO CREEK

PARTICULATE NITROGEN (PN)

Why do we measure for nutrients?

All living organisms require nutrients (e.g. carbon, oxygen, nitrogen and phosphorus) to supply energy and support growth. However, when nutrients are increased beyond natural levels there can be ecological effects. During high-flow events, nutrient loads accumulate downstream and head into the Great Barrier Reef (GBR) lagoon where excess nutrients encourage the growth of algae on inshore reefs. They also feed plankton whose remains bind with sediment to form 'marine snow', reducing light and smothering the juvenile corals that renew inshore reefs.



TropWATER also measured nitrogen and phosphorus concentrations in all water samples collected. Average particulate nitrogen (PN) concentrations for each site are shown in map to the left. Nitrogen in the particulate form (PN) is associated with organic matter and is commonly attached to soil particles, and thus often elevated in runoff with higher sediment concentrations. Hence in most circumstances, the PN values closely match the SS concentrations, which was the case over both wet seasons sampled.

Over the two wet seasons, the highest concentrations of PN were measured at the high sediment-contributing Little Bowen sub-catchment sites, with average concentrations of 2750, 1865 and 1295 µg N/L at Exe Ck, Little Bowen and Little Bowen Junction sites, respectively.

Average concentrations were also elevated in Pelican and Glenmore Creeks draining into the lower reaches of the Bowen River (1150 and 1020 µg N/L, respectively).

The Broken River site had the lowest PN concentrations (195 µg N/L) due to the relatively low SS concentrations measured at this site.

HOW WILL THIS DATA BE USED OUTSIDE OF THE LDC PROJECT AND FUTURE SAMPLING?

Suspended sediment and nutrient concentration data collected at each site has been provided to the Source Catchment's modelling team, which is working with the data to improve the model's representation of water quality contributions from many of the BBB's major creeks and rivers.

Prior to this project, only limited water quality data has been collected during high flows across the BBB creeks and rivers, except for the long-running Bowen River at Myuna flow gauge site (active since 2003).

Remaining sediment from water samples collected in this project has also been recovered to help build the sediment source tracing dataset within TropWATER's related related NESP project 5.8 (see nesptropical.edu.au).

TropWATER hopes this landholder-based sampling program can be continued into future wet seasons, to build on the valuable dataset already collected, allow for trend identification over time and document the water quality improvements achieved due to the LDC project.

Landholders Driving Change is a Burdekin Major Integrated project funded by the Queensland Government through the Queensland Reef Water Quality Program.

Queensland Government

NQ DRY TROPICS

LANDHOLDERS DRIVING CHANGE
BURDEKIN MAJOR INTEGRATED PROJECT

TropWATER

JAMES COOK UNIVERSITY AUSTRALIA

This publication is a joint initiative of NQ Dry Tropics' Landholders Driving Change project and TropWATER, James Cook University.

Prepared by Zoe Bainbridge and Stephen Lewis, TropWATER, James Cook University for the Landholders Driving Change BMIP. The LDC's Barb Colls, Rodger Walker and Adrienne Hall are gratefully acknowledged for supporting this collaborative project. This project is also supported by Zoe Bainbridge's Advance Queensland Research Fellowship.

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For further information on water sample results, contact Zoe Bainbridge (TropWATER) via email: zoe.bainbridge@jcu.edu.au

Copies of the cited journal publications (Bainbridge et al. 2014, 2016) can also be shared on request.