Tropical Water Quality Hub

National Environmental Science Programme



The Torres Strait and mining runoff from the Fly River: 30 years on from the Torres Strait Baseline Study

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Cover photographs: (front) Landsat 5 satellite image showing a flood plume from the Fly River, Papua New Guinea in February 2009 © Eric Lawrey, NASA. (back) Herbert Warusam, Mura Buway Ranger, Saibai Island collecting sediment cores with the gravity sediment corer. Image: Jane Mellors

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The issue

Copper mining began at the Ok Tedi mine located in the headwaters of the Fly River in Papua New Guinea (PNG) in the 1980s. The plan was to store the waste products (tailings) from the mine in a dam. However, in 1984 there was a landslide and the dam was destroyed. Since then, around 40 million tonnes of copper mining waste has gone into the Fly River every year. The amount of mining waste increased in 1990 when the Porgera gold mine also opened. Before mining began, around 85 million tonnes of mud and sediment reached the mouth of the Fly River each year. Now, with the waste from both mines, the amount of mud and sediment that is discharged has increased to around 130 million tonnes every year.

The mine waste also contains a range of trace metals including copper from the mine processing. Small amounts of copper are required by all living organisms to sustain life however large amounts of copper can be harmful to animals and plants that live in the water. Fortunately, copper is not very toxic to humans and that is why drinking water pipes are often made of this metal. Large amounts of mud and sediment can also make the water cloudy, which is bad for animals and plants. In the late 1980s, people were concerned that the mining waste from the Fly River might reach the Torres Strait. They wanted to know if people, animals, and environments in the Torres Strait could be affected. This led to the Torres Strait Baseline Study which ran from 1991-1993. The study measured the amount of sediment and trace metals (metals normally present in small but measurable amounts in animal and plant cells and tissues) in the Torres Strait. This was an important study because it provided a baseline that could be used as a comparison in future studies.

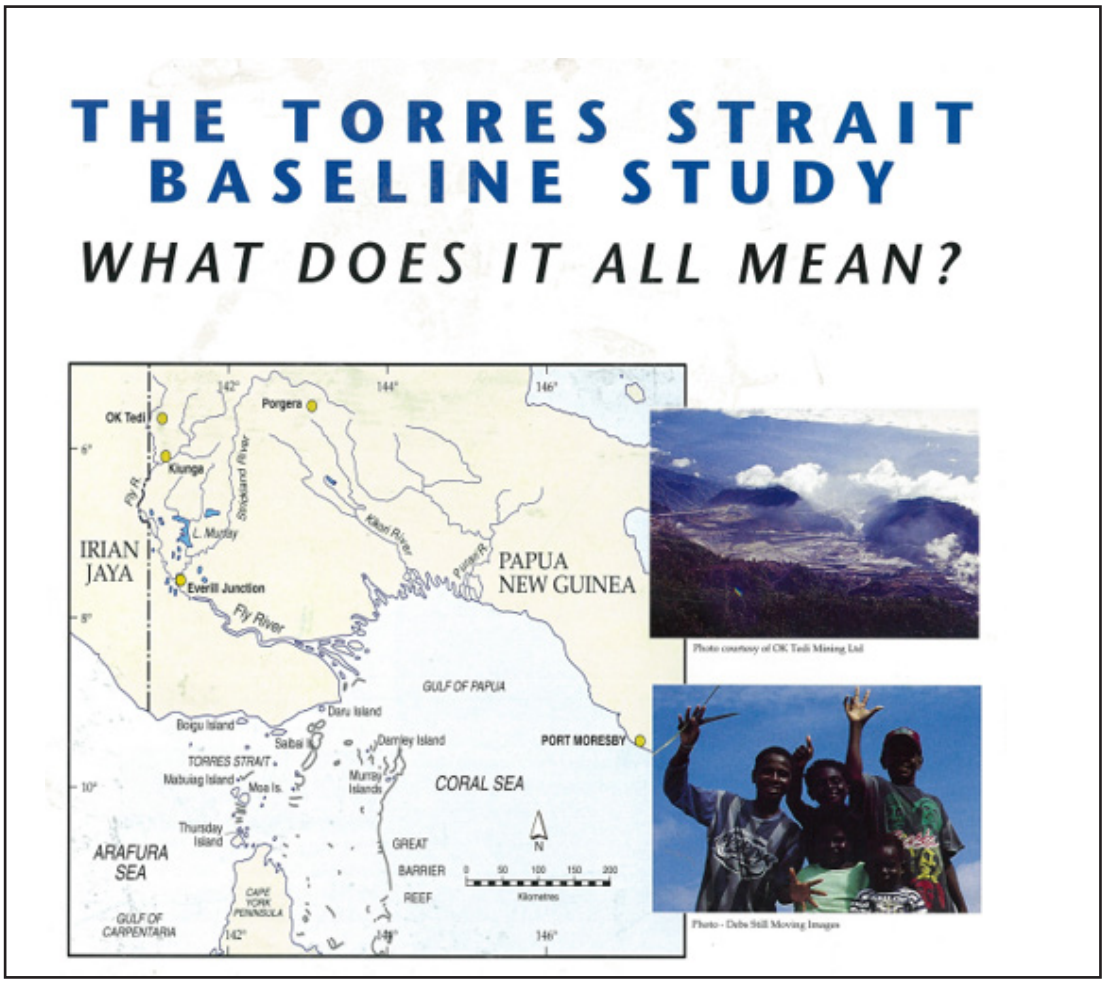


Figure 1: *Front cover of the 1993 Torres Strait Baseline Study.*

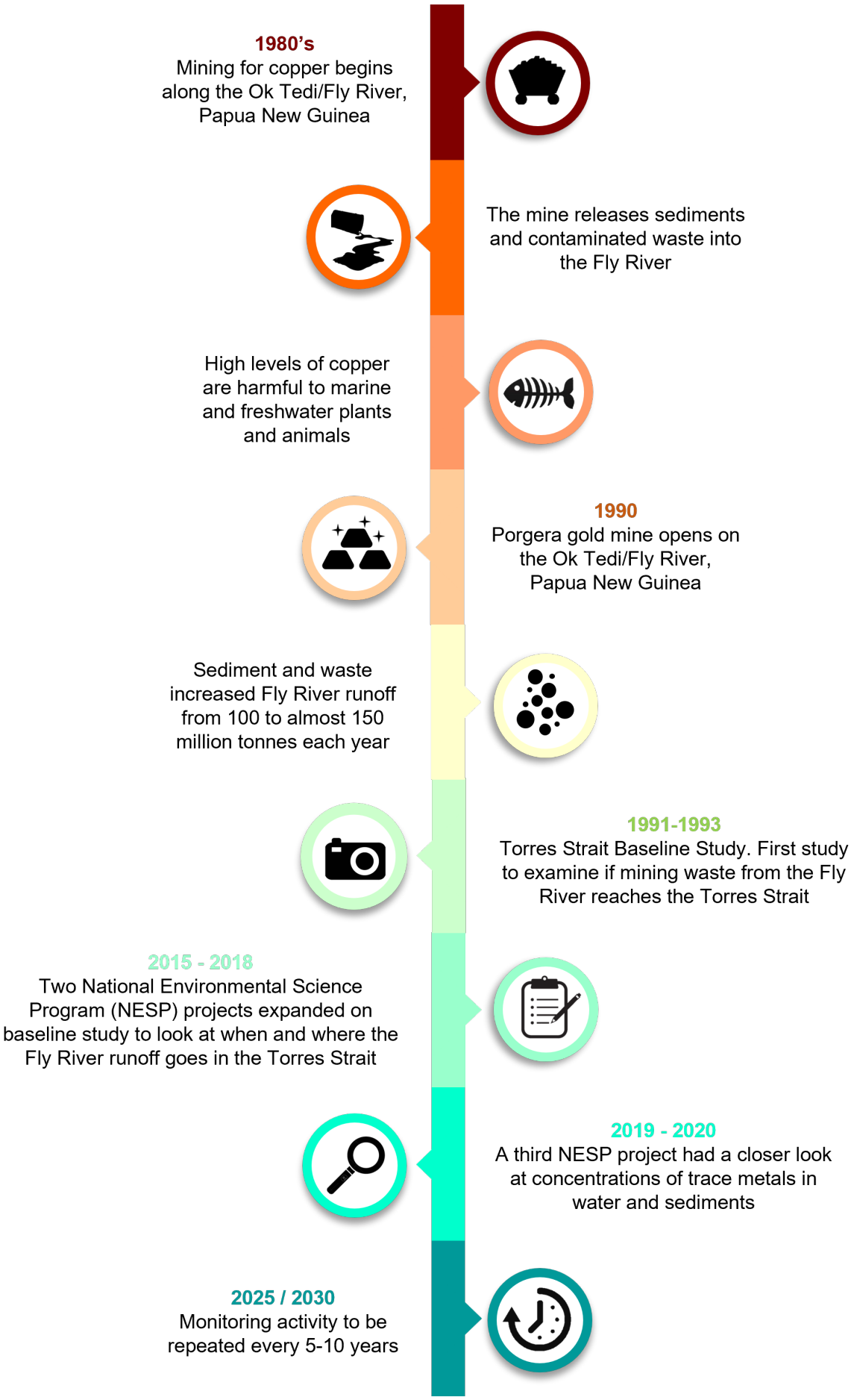


Figure 2: *Timeline of mining activity on the Fly River, Papua New Guinea and the research projects in the Torres Strait.*

What did the current research do?

The National Environmental Science Program (NESP) was funded by the Australian Government from 2015 to 2021. The Tropical Water Quality (TWQ) Hub was part of NESP and looked at how activities on land could affect water quality in the sea.

The funding provided a great opportunity to revisit the Torres Strait Baseline Study and see if there have been any changes over time. There were three NESP TWQ Torres Strait projects that looked at:

- where the Fly River water goes.
- how the water movement changes at different times of the year.
- how much sediment is in the water.
- how much and which trace metals are in seagrasses, sediments, and waters in the Torres Strait.



Figure 3: *Map of the Fly River and the Torres Strait region showing the location of coral reefs and seagrasses. Source: Waterhouse et al. 2021*

The process

Because almost 30 years had passed since the Torres Strait Baseline Study, the new projects were able to use lots of new tools and technology to find out more about the Fly River runoff and its impacts on the Torres Strait.

The work involved people from many different organisations including James Cook University (JCU), the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Institute of Marine Science (AIMS), the Torres Strait Regional Authority (TSRA) and the Reef and Rainforest Research Centre (RRRC).

Rangers from the TSRA played an important role in the projects, from collecting samples to liaising with their local communities about the projects. From 2017, TSRA Rangers have been regularly measuring the salinity of water samples. Because freshwater has a lower salinity than seawater, this work helped to show if fresh-water runoff from rivers on the Papua New Guinea mainland was likely to reach islands and certain marine habitats of the Torres Strait.

Seagrass, sediment, and water samples were collected from around the islands in the northern, central, and southern areas of the Torres Strait, as well as Maizab Kaur (Bramble Cay) and Warrior Reef. Historic coral cores were also used to look at freshwater patterns at Maizab Kaur and Erub over hundreds of years (from 1781 to 1993). The amounts of trace metals, including copper, were measured in the seagrass, sediment, and water samples.

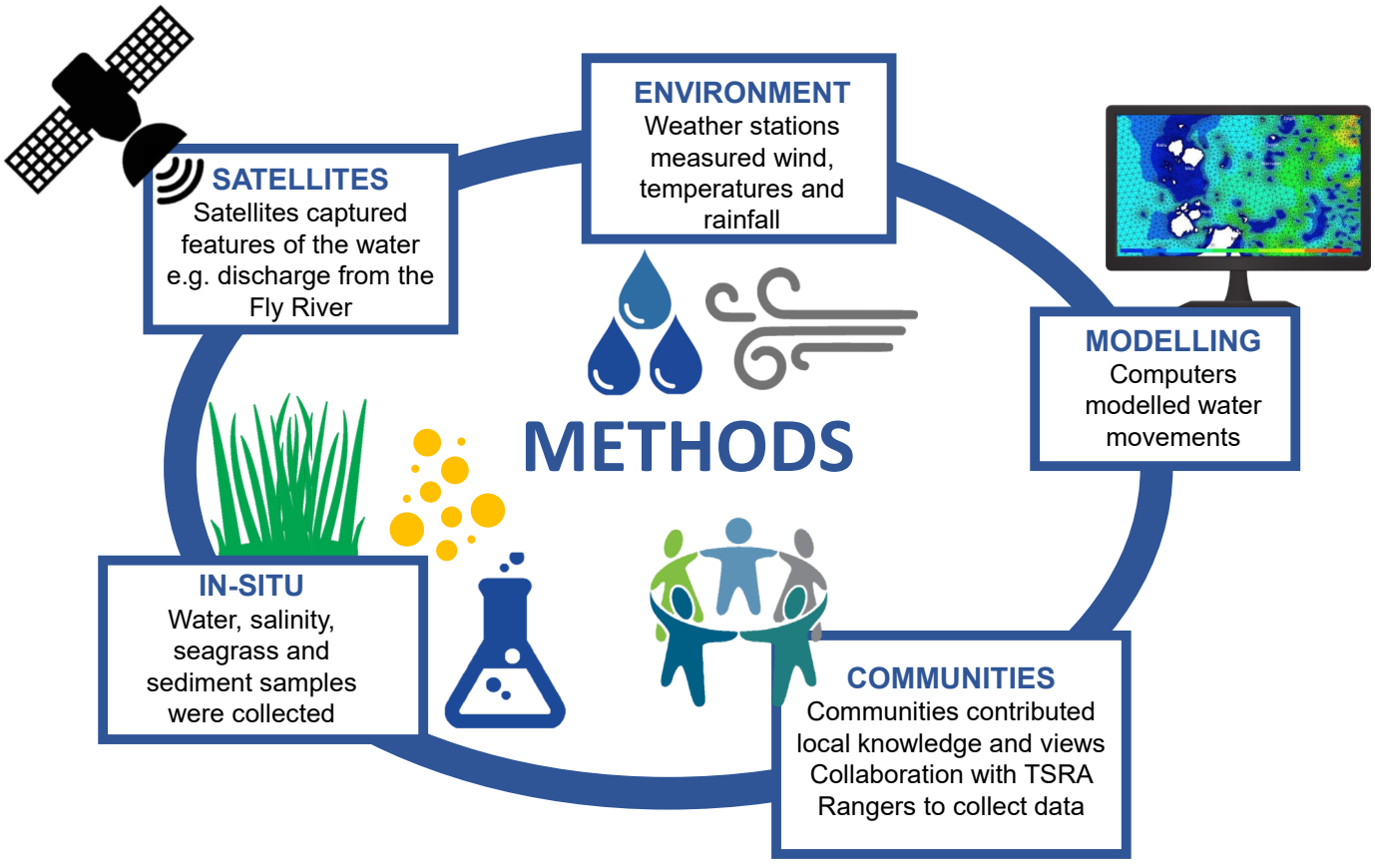


Figure 4: *Some of the methods used to understand how the Fly River runoff affects the Torres Strait.*



Figure 5: *The junction between the Ok Tedi and Fly Rivers, Papua New Guinea (Credit: Simon Apte, CSIRO).*

The projects used weather stations around the Torres Strait to measure weather conditions such as wind, rain, and temperature.

Scientists also used satellite images and computer models to look at where the Fly River water goes. Satellite images from 2008-2019 were used to map the cloudiness (turbidity) and colour of the water at different distances from the Fly River and PNG coast. Higher turbidity means there is more suspended solids, including sediments and mud, in the water and the water often looks very brown. This usually reduces the amount of light that is available for coral reefs and seagrass systems, and reduced light can affect their health. Computer models were used to simulate where Fly River plume waters and sediments travel when they leave the Fly River.

The findings from these different tools were combined to make an overall assessment for each location in the Torres Strait.

Where possible, this information was compared to the Torres Strait Baseline Study to see if there have been changes over time. The results were also compared to other parts of the world to understand what the findings might mean for the Torres Strait.







Figure 6: *Training TSRA Rangers to measure salinity (Credit: TropWATER JCU), Middle: Weather stations recorded wind, rain and temperatures around the Torres Strait (Credit: AIMS), Bottom: TSRA Rangers collecting sediment samples (Credit: TropWATER JCU).*

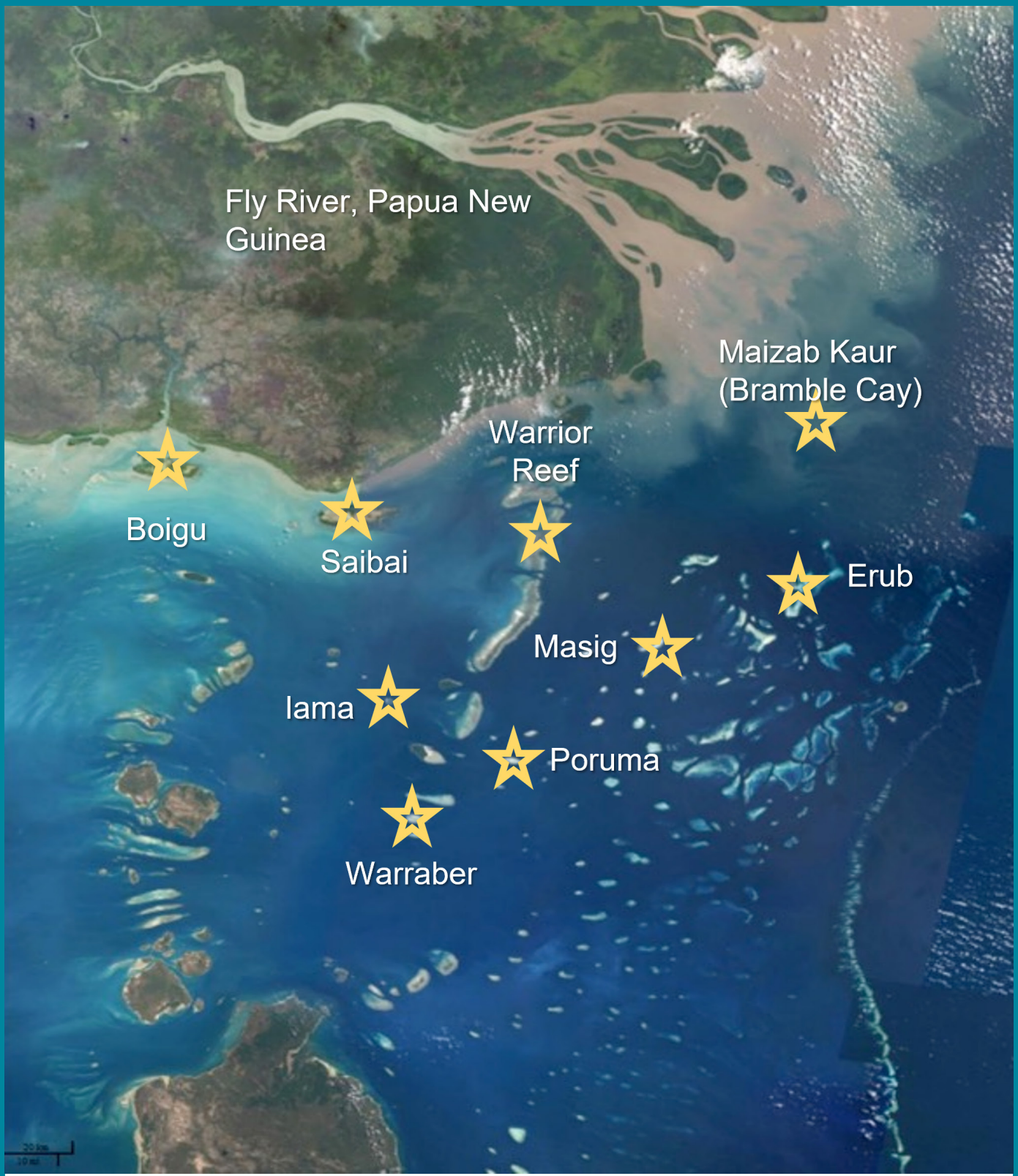


Figure 7: *Main sampling locations in the Torres Strait during the three NESP projects that ran from 2015 to 2020.*

What do the results show?

Overall, the water quality in the Torres Strait is good. Coral reefs and seagrasses are relatively healthy across much of the Torres Strait but are starting to be more affected by other pressures such as coral bleaching. However, there were some differences in the results depending on the location in the Torres Strait.

The northern, particularly the north east region of the Torres Strait is most often affected by water from the Fly River. This area includes Maizab Kaur (Bramble Cay), Warrior Reef, Boigu and Saibai. However, it seems likely that other rivers like the Wassi Kussa and Mai Kussa rivers near Boigu also have an influence. Salinity levels are lower and turbidity is higher in the north compared to the central and southern regions of the Torres Strait. Information from coral cores from 1781-1993 shows that there has always been some influence from PNG's rivers in the northern Torres Strait even before mining began.

The time of year also affected the results with strong seasonal differences. During Sagar (south east trade wind season), more water from the Fly River goes into the Torres Strait. During Kuki (monsoon season), water from the Fly River travels east into the Gulf of Papua.

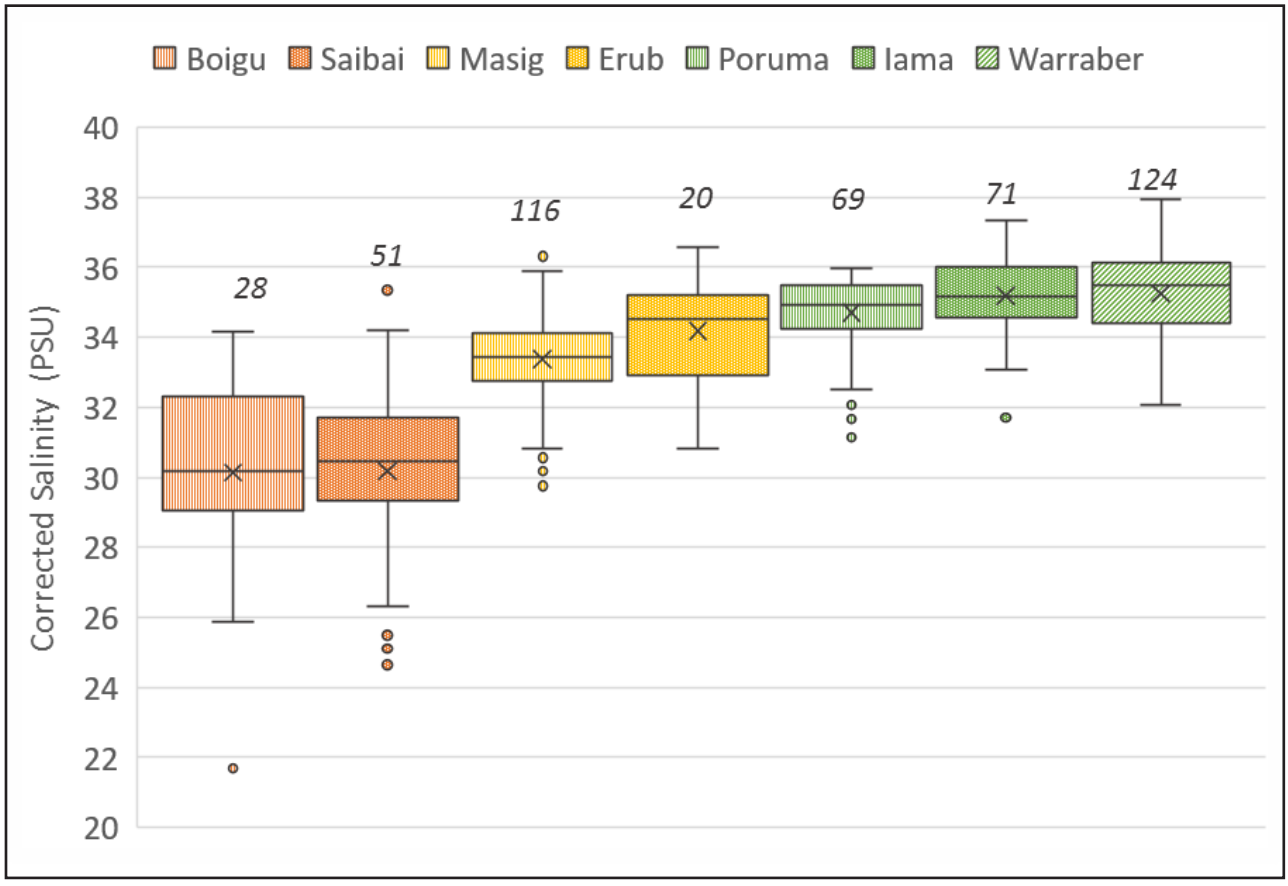


Figure 8: *Salinity measurements around the Torres Strait. Islands and reefs closer to the PNG mainland have lower salinity levels because they are closer to PNG rivers and more influenced by freshwater runoff.*

Results continued...

Several trace metals were also higher in water samples in the northern region of the Torres Strait. However, the levels were much lower than in the Fly River. Generally, trace metals were found in the expected amounts for an unpolluted environment. Copper is the main trace metal that can be linked to the mining waste. There were higher amounts of copper in the waters around Boigu and Saibai, as well as Maizab Kaur, and while these amounts were higher than unpolluted or 'pristine' environments, the amount of dissolved copper was not recorded in amounts that can damage corals or seagrasses. In addition, sediment samples from the northern regions did not show high amounts of copper suggesting that mine waste does not regularly settle in these areas.

Importantly, the computer modelling work that simulated how sediment is transported from the Fly River into the ocean identified valuable information about the movement of the Fly River water which might be important for long term impacts. In particular, the modelling showed that Daru and Bristow Islands act as sediment barriers. These islands reduce the movement of water out of the Fly River to the west, which causes some sediment to drop out of the water and settle around the islands. This is important because it means that these islands stop a large amount of the sediment (and therefore mining waste) leaving the Fly River and potentially going further into some parts of the Torres Strait.

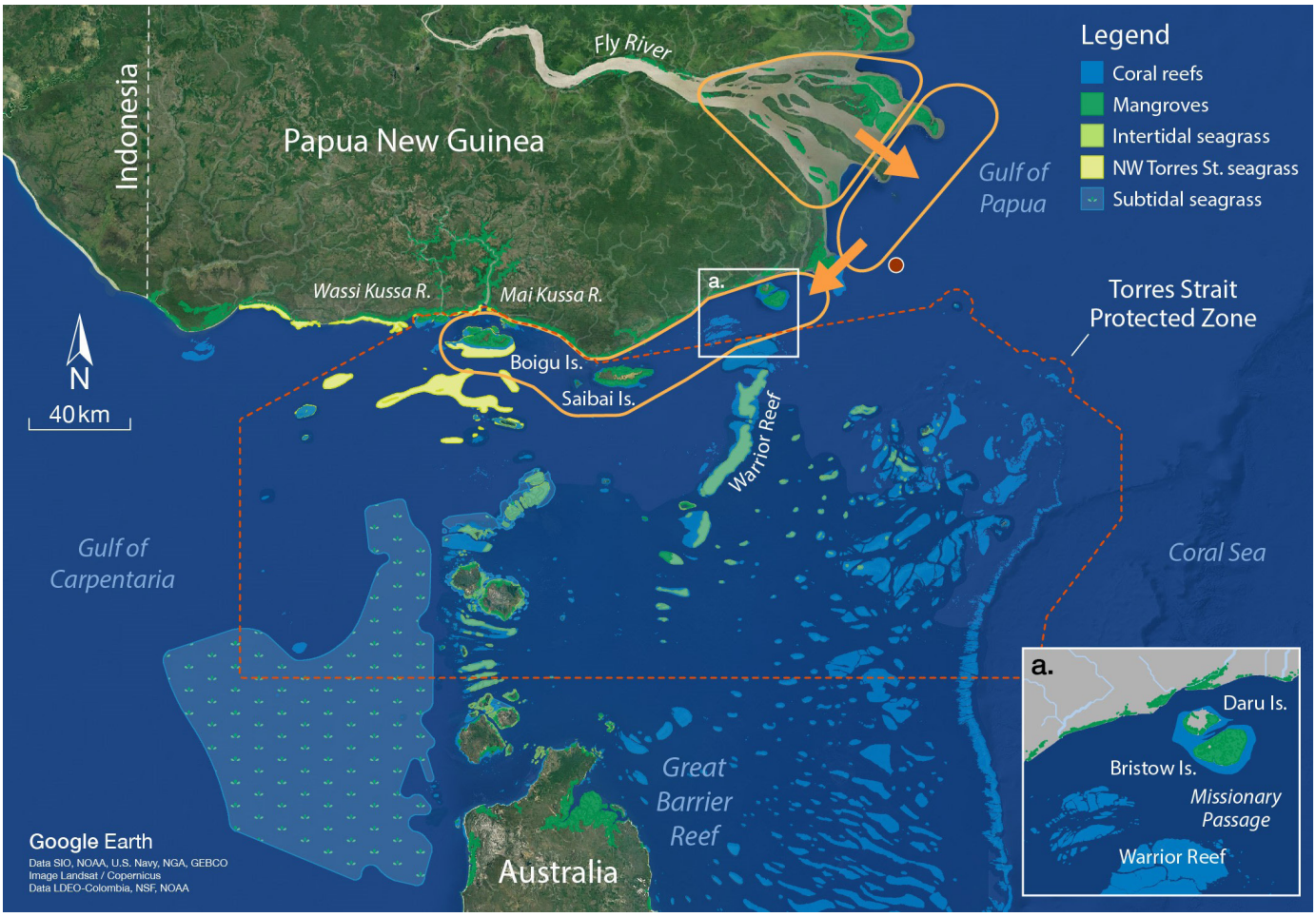
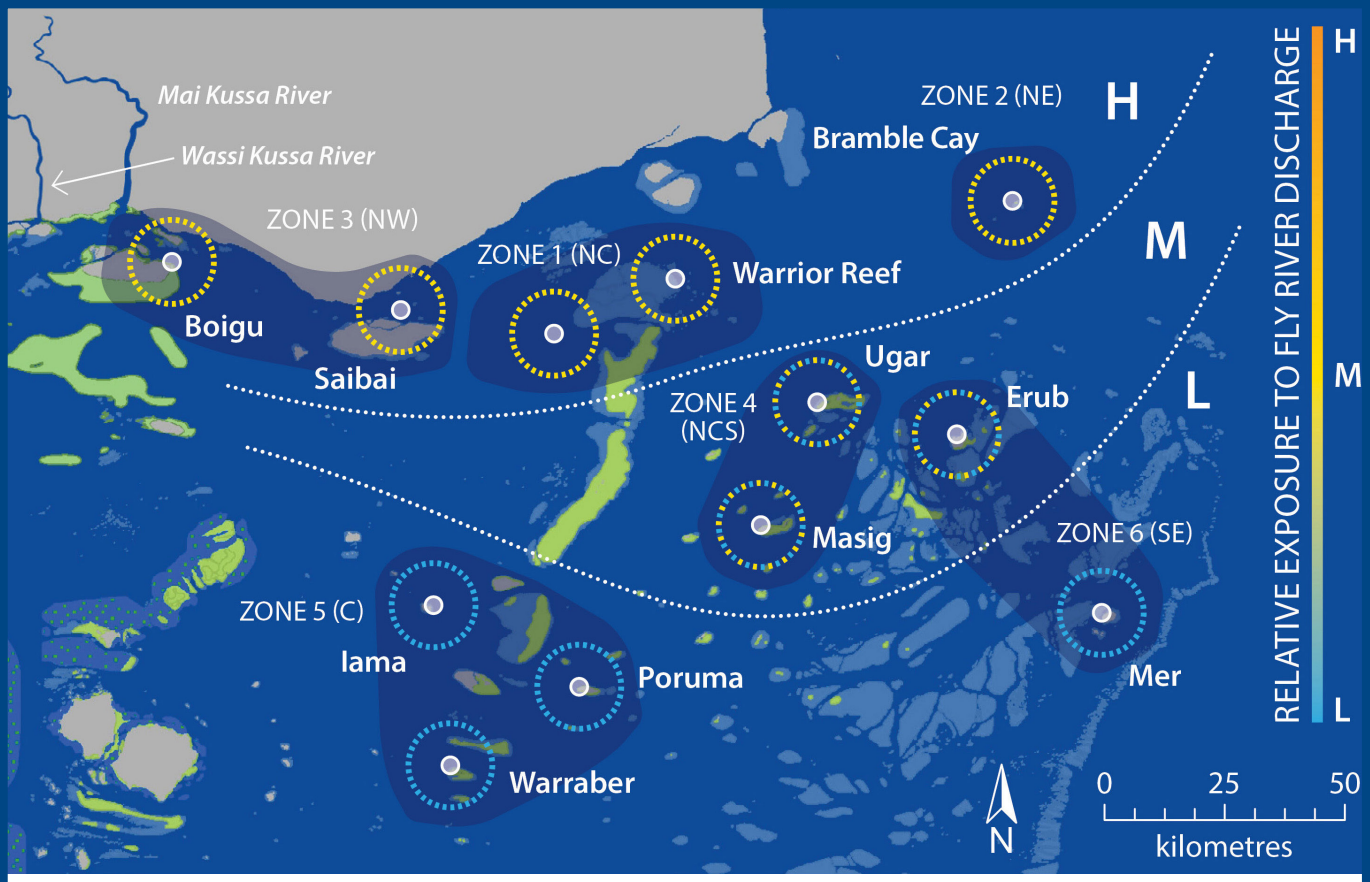


Figure 9: *Map of the Torres Strait region showing the major rivers, islands and habitats. The orange areas and arrows show the movement of mud and sediment from the Fly River into the Torres Strait. Enlarged area (a) shows the role of Daru and Bristow Islands as barriers to the flow of mud and sediment into the Torres Strait. Source: Modified from Waterhouse et al. (2021).*

Overall assessment

The overall assessment from the three projects found that no locations in the Torres Strait were at serious risk of sustaining impacts from mining wastes. For all locations in the Torres Strait, the risk of mining waste impacting the environment was assessed as being relatively low to moderate.



Relative exposure categories

There were no places in this higher risk category
Exposure to Fly River discharge, elevated trace metals, ecological risk likely

Zone 1 (Warrior Reef), Zone 2 (Bramble Cay) and Zone 3 (Boigu and Saibai)
Exposure to diluted Fly River discharge, slightly elevated trace metals, low ecological risk

Zone 4 (Ugar, Erub and Masig)
Occasional exposure to Fly River waters during the SE trade wind (Sagar) season, relatively low trace metals, low ecological risk

Zone 5 (Iama, Poruma and Warraber) and Zone 6 (Erub and Mer)
Low exposure, low trace metals, low ecological risk

Figure 10: *Assessment of the relative exposure to Fly River discharge on different areas of the Torres Strait including consideration of sediment exposure, trace metal measurements and ecological significance of each region. Refer to Waterhouse et al. (2021) for more information.*

How do these results compare to the Torres Strait Baseline Study?

The findings from the three NESP TWQ Hub projects show that not much has changed since the Torres Strait Baseline Study.

There have not been any measurable increases in trace metal concentrations in the Torres Strait sediments over the last 30 years. Similarly, the amount of freshwater from PNG rivers reaching the Torres Strait does not appear to have changed. It is more difficult to show whether the amount of sediment and mud delivered to the region has changed over this timeframe, but the satellite imagery did not indicate any major changes in patterns over the last 12 years which is a good indication of a relatively stable condition.

Being able to compare the current findings with the baseline study tells us that any influence from the mines will happen very slowly.

What does this mean for the Torres Strait and its communities?

The results show that generally runoff from the mining activity on the Fly River is not having a big impact on the Torres Strait. Importantly, this has not changed very much over the last 30 years.

Therefore, we are unlikely to see any rapid changes to the environmental conditions in the Torres Strait because of the runoff. This is good news for the Torres Strait which is home to many important animals, like turtles and dugong, and valuable habitats like coral reefs and seagrasses, and for the local communities that depend on Torres Strait marine resources for food, livelihoods and cultural activities. The northern region of the Torres Strait is more exposed to the Fly River and other rivers along the PNG coast but this has happened for many years, even before the mines.



Figure 11: *TSRA Rangers and Jon Brodie (Credit: TropWATER JCU).*

What were the recommendations arising as a result of these projects?

- The Torres Strait Regional Authority (TSRA) Rangers were very important for the success of this project. Rangers should be involved in future monitoring work and given opportunities to learn new skills.
- The northern Torres Strait, particularly Maizab Kaur and the Warrior Reef complex, should be the focus of any shorter-term future monitoring efforts. That is because these highly valued and sensitive locations showed some influence from runoff from the Fly River but there was limited data collection to confirm the potential impacts. In particular, it would be useful to establish how much and how often the turbid water from the Fly River is reaching the Warrior Reefs and potentially influencing critical seagrass habitats.
- Changes to mining activity, or other activities (e.g. logging, palm oil plantations) on the PNG mainland, could result in changes to water quality and environmental conditions, particularly in the northern Torres Strait. In the longer term (e.g. 5 to 10 years) it would be useful to repeat the monitoring of sediments and trace metals to identify any potential changes to the risks to the Torres Strait from these sources. The inputs of metals and sediments from different rivers on the PNG mainland in addition to the Fly River should be investigated to better understand where trace metals, sediments and potentially other pollutants such as pesticides might originate, and from what activities (e.g. mining, agriculture, natural etc.). This would identify if there are likely to be changes to these threats, and if they are manageable, what to target for future protection of Torres Strait ecosystems.

Conclusions

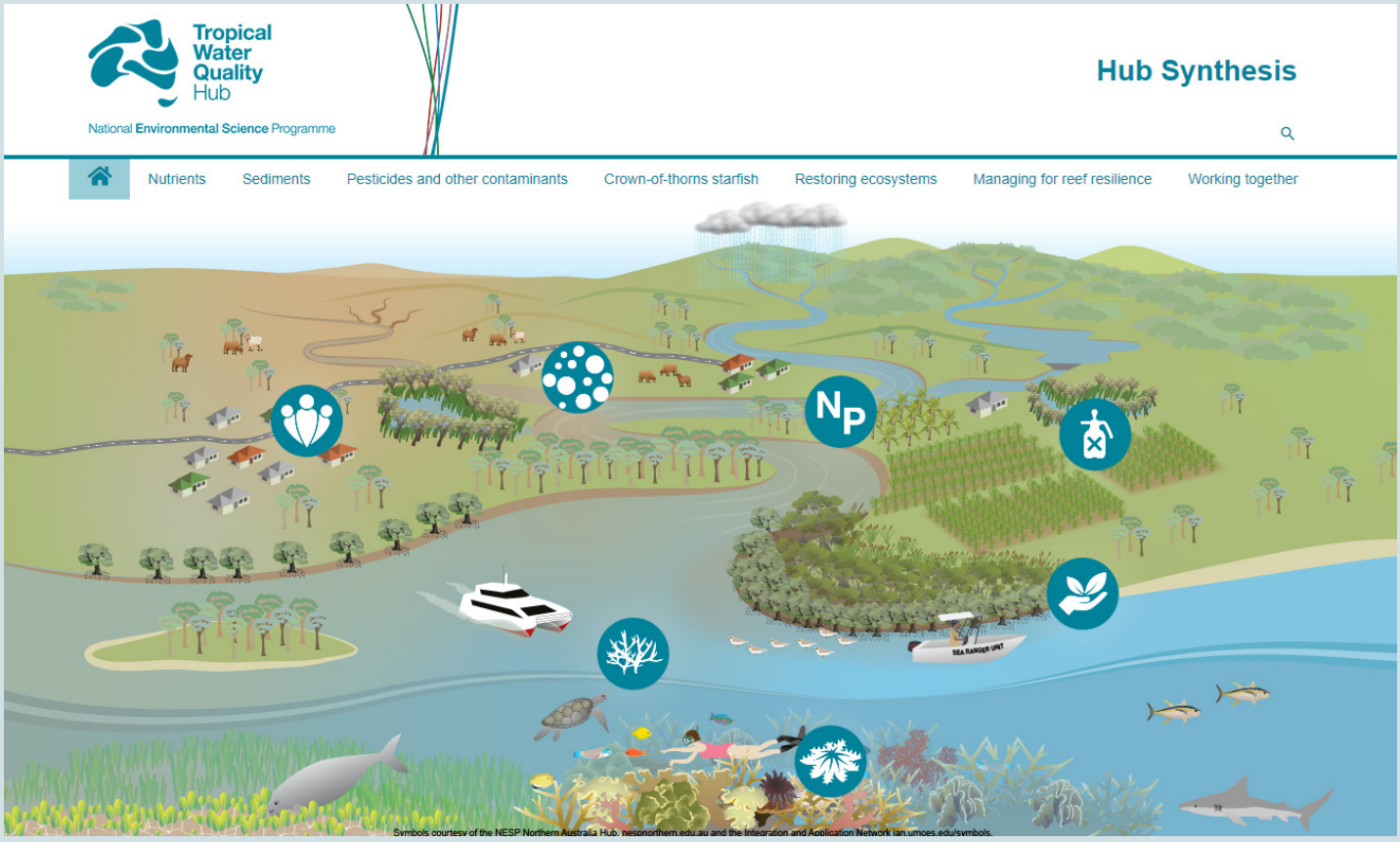
The NESP TWQ projects support the findings from the Torres Strait Baseline Study. Very little runoff from the Fly River goes into the broader Torres Strait region. Any influence of the Fly River is mainly found in the northern Torres Strait, as far west as Saibai Island and as far east as Maizab Kaur, and typically during Sagar (south east trade wind season). The projects show that using different scientific tools can help build a more complete picture of what is happening in the waters of the Torres Strait. Monitoring every 5 to 10 years would be good to check for any environmental changes.



Figure 12: *TSRA Rangers played an important role in the projects from collecting data to talking with local communities about the projects (Credit: TropWATER JCU).*

Further reading

More detailed reports and summaries for groups of islands in the Torres Strait are available from the NESP Synthesis website: www.synthesis.nesptropical.edu.au/



Apte, S.C., Angel, B.M., Hunter, C., Jarolimek, C.V., Chariton, A.A., King J. and Murphy, N. (2019) Impacts of mine derived contaminants on Torres Strait environments and communities. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (126 pp.).

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Waterhouse, J., Petus, C., Brodie, J., Bainbridge, S., Wolanski, E., Dafforn, K.A., Birrer, S.C., Lough, J., Tracey, D., Johnson, J.E., Chariton, A.C., Johnston, E.L., Li, Y., Martins, F. and O'Brien, D. (2018) Identifying water quality and ecosystem health threats to the Torres Strait and Far Northern GBR from runoff of the Fly River. Report to the National Environmental Science Program. Reef and Rainforest Research Centre Limited, Cairns (162pp.).

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