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When floods disrupt freight: modelling supply chain risks under future climates

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Abstract: Recent extreme weather events such as 2022 ex-Tropical Cyclone (TC) Tiffany have demonstrated how flooding can significantly disrupt critical supply chains across Australia. As climate change drives more frequent and severe extreme weather events, understanding the impact of future disruptions to supply chains is critical for resilience planning. This study uses ex-TC Tiffany as a case study to explore the impact of flood-related disruptions on critical freight routes and supply chains under current and projected future climate scenarios. Using the Transport Network Strategic Investment Tool (TraNSIT), we simulate the effects of increasingly severe versions of flood events on supply chains and communities. Results highlight significant increases in freight detour distances and transport costs, especially in regional and remote communities. This work demonstrates the value of scenario-based modelling to investigate resilience of supply chains and freight. This work was completed as part of the National Climate Risk Assessment, which builds the evidence base supporting Australia's National Adaptation Plan.

Keywords: *Supply chain modelling, flood risk, climate modelling*

1. INTRODUCTION

Australia's supply chains are critical to the delivery of food, fuel, medicines, and essential goods across vast urban, regional and remote areas. However, our transport networks have been increasingly disrupted by extreme weather events, damaging key infrastructure and delaying access to critical commodities. These risks are projected to intensify due to climate change-related increases in the severity and frequency of extreme weather events. Understanding how future climate-driven disruptions may impact freight movements and supply chains is essential for effective infrastructure planning, emergency response, and resilience investment.

This study uses Transport Network Strategic Investment Tool (TraNSIT), to simulate freight disruptions under future extreme weather scenarios. TraNSIT is a supply chain modelling tool developed by CSIRO to provide an evidence-based capability to inform infrastructure investments and policy decisions for transport and supply chains (Higgins, et al., 2018). TraNSIT has been extended to promote understanding of the supply chain impacts of weather-related road closures (Higgins, et al 2025a). In this study, TraNSIT is used to quantify the likely costs, detour distances, and sectoral impacts associated more severe versions of recent flood events. This allows us to identify the most vulnerable communities and freight routes.

2. METHODOLOGY AND RESULTS

A scenario-based analysis has been conducted by using TraNSIT to model flood-induced transport disruptions over three time epochs: 2024 (Current), 2050 and 2090 (Higgins, et al 2025b). The analysis focused on two key modelling components:

1. **Future business-as-usual supply chains under population and grain yield changes**: Projected population growth and changes in grain yield (excluding location shifts) for 2050 and 2090 were modelled using TraNSIT to simulate evolving supply chain paths for major commodities. Population growth was modelled at a state/territory level, and existing grain production was modulated by modelling yield changes associated with Global Warming Levels 2 degrees C and + 3 degrees C warming points for 2050 and 2090 respectively. By adjusting input parameters to reflect these changes, TraNSIT was used to simulate potential future versions of business-as-usual supply chain networks.
2. **Future extreme weather scenarios**: Ex-Tropical Cyclone Tiffany (February 2022) was used as a case study of a prominent flood event causing significant supply chain disruptions. TraNSIT was used to model road closure impacts of the event and increasingly severe versions of the event in 2050 and 2090. Increased flood extents were used to model more extreme versions of road closure events for these future

scenarios. These scenarios allowed comparative analysis of freight delays, road closures, rerouting distances, blocked freight, and cost implications across supply chains.

Key results include:

- **Detour distances increase sharply**, especially in remote regions with sparse networks. For example, detours following ex-TC Tiffany in 2090 extend over 3000 km in some cases, overwhelming vehicle fleet capacity and prompting costly modal shifts such as air freight.
- **Freight disruption grows significantly under future scenarios**, with impacted freight and enterprise numbers increasing by over 30% in 2090 compared to 2024 for some events.
- **Regional freight routes become increasingly important** as alternatives when major corridors are closed, especially in western Queensland, the Northern Territory, and South Australia. Without intervention, disruptions to these routes will increasingly affect national supply chains, including links between primary production regions and urban markets.
- **Regional and remote communities face the highest risk**, with prolonged supply disruptions due to both physical isolation and reduced redundancy in freight routes.

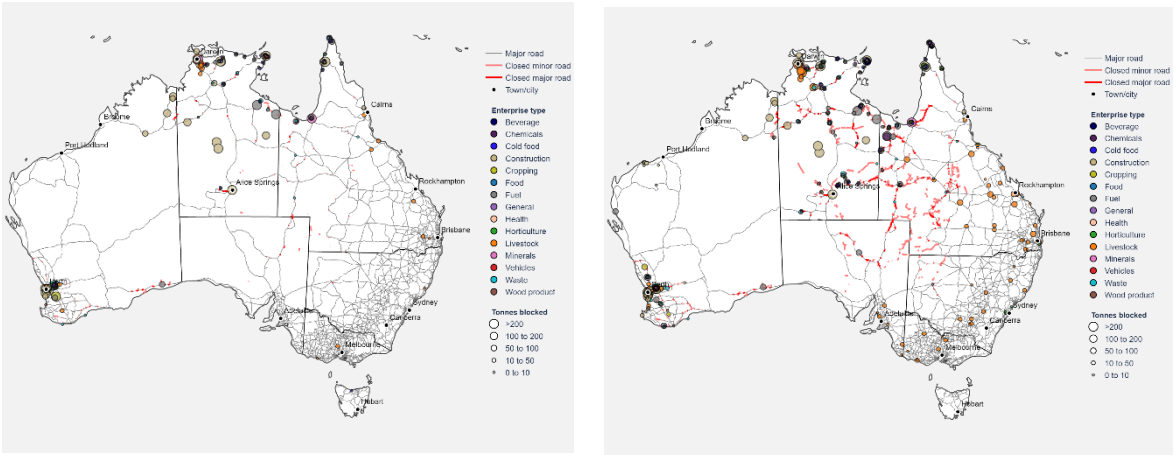

Fig.1 Closed roads and impacted enterprises by sector for 2024 (left) and 2090 (right) scenarios.

3. CONCLUSIONS

TraNSIT provides a powerful platform for evidence-based analysis of how extreme weather can amplify supply chain disruptions. The results reveal increasing reliance on regional freight routes for transporting critical goods to remote communities. By quantifying the impacts of future disruptions, the modelling supports informed decision-making around infrastructure investment, emergency response, and developing a National Adaption Plan for managing climate risks. Targeted interventions can enhance national resilience by strengthening freight networks, supporting vulnerable communities, and ensuring continued access to essential services in a changing climate.

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REFERENCES

Higgins A, McFallan S, Marinoni O, McKeown A, Chilcott C and Pinkard, L (2018) Informing transport infrastructure investments using TraNSIT: A case study for Australian agriculture and forestry. Computers and Electronics in Agriculture 187-203

Higgins, A, McFallan S, Bondarenco A, Tong M, Knapp S, Bruce C. (2025) Transport Network Strategic Investment Tool (TraNSIT): Overview of modelling capability and applications. CSIRO, Australia. https://doi.org/10.25919/rbcf-w133

Higgins, A, Tong M, Islam Z, Marquez L and McFallan S (2025) Supply Chains Technical Report. A technical report prepared for the Australian Climate Service as part of the National Climate Risk Assessment. CSIRO, Australia. https://doi.org/10.25919/0xwr-4s39

