Solving Australia's transport and supply chain challenges

Improving costs, efficiency and resilience

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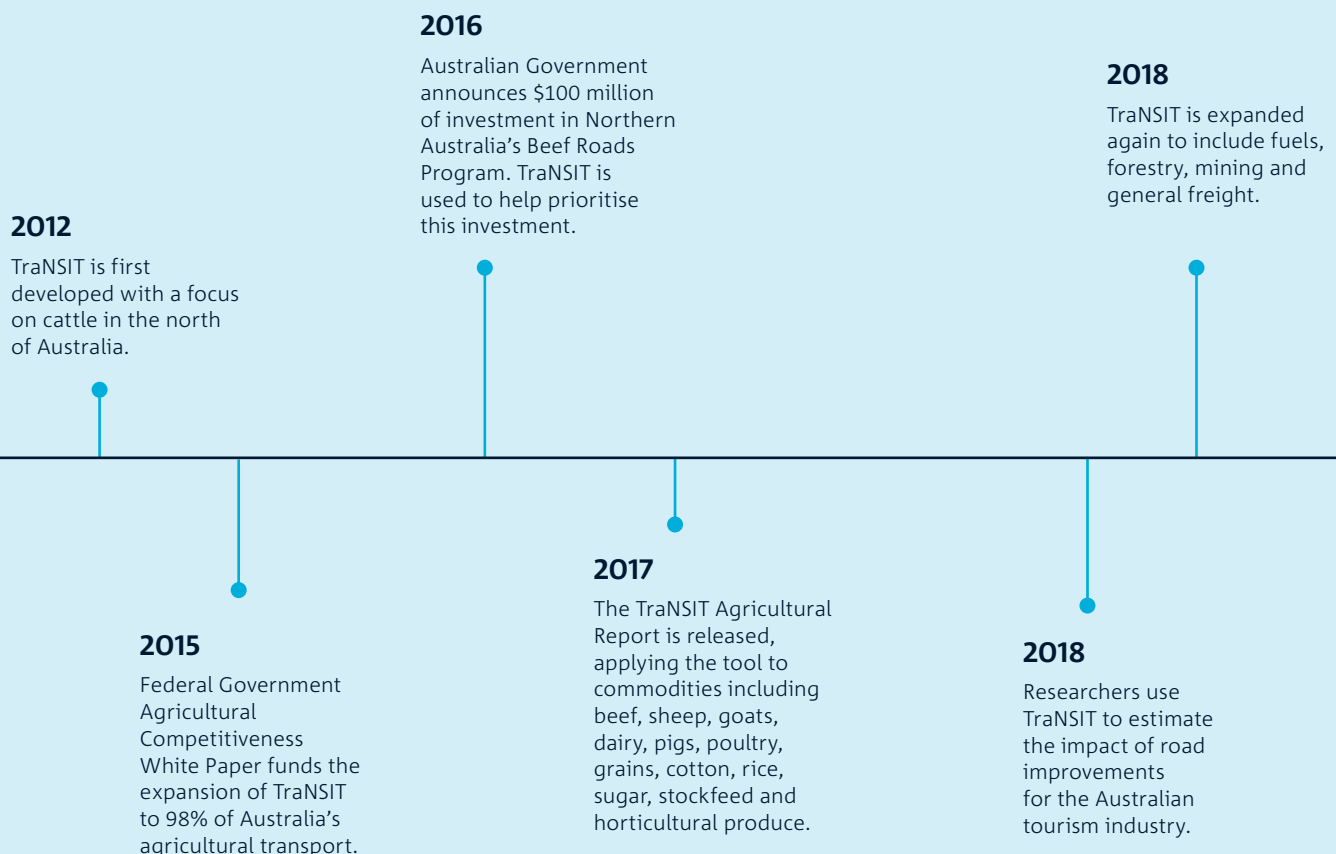# How CSIRO's transport mapping tool helps governments, industry and communities

In a country as large as Australia, reliable transport infrastructure is essential. More than 1.5 billion tonnes of freight are moved around the country each year. Commodities including food and forest products, fuels, minerals, construction materials and general freight often travel complex routes of 1000km or more before reaching the market. This can be hugely expensive for producers and manufacturers.

Since 2012, CSIRO's Transport Network Strategic Investment Tool (TraNSIT) has been used across multiple sectors - nationally and internationally - to improve supply chain efficiency and help identify options for investment.

Originally developed to reduce the cost of transporting cattle from farms in northern Australia to their domestic and international markets, TraNSIT is a spatial computer model that creates incredibly detailed maps of Australia's supply chains, freight movements and costings.

For each supply chain path, TraNSIT is able to select the most cost-effective route that accounts for travel distance and time, vehicle configuration, road conditions, driver fatigue regulations and vehicle decoupling costs.

A decade of transport network improvements

2012
TraNSIT is first developed with a focus on cattle in the north of Australia.

2015
Federal Government Agricultural Competitiveness White Paper funds the expansion of TraNSIT to 98% of Australia's agricultural transport.

2016
Australian Government announces $100 million of investment in Northern Australia's Beef Roads Program. TraNSIT is used to help prioritise this investment.

2017
The TraNSIT Agricultural Report is released, applying the tool to commodities including beef, sheep, goats, dairy, pigs, poultry, grains, cotton, rice, sugar, stockfeed and horticultural produce.

2018
TraNSIT is expanded again to include fuels, forestry, mining and general freight.

2018
Researchers use TraNSIT to estimate the impact of road improvements for the Australian tourism industry.

As well as reducing costs of transport and logistics across the supply chain, the models generated by TraNSIT enable the national and local governments to direct road and rail investment to the areas where it will have most impact.

More than 10 years on from its initial development, TraNSIT now accommodates over 185 commodities, representing more than 25 million vehicle trips and 200,000 rail trips per annum. It incorporates information and expert knowledge from over 400 agencies and organisations across Australia.

The tool has been adapted for a range of other applications, including biosecurity, climate and disaster resilience, tourism, and infrastructure planning and investment. Its use has also expanded internationally to Indonesia and Vietnam.

CSIRO's approach to research is a collaborative one, and the success of TraNSIT demonstrates how much can be achieved when researchers, industry and government work closely together. The TraNSIT team remains committed to this approach and looks forward to further expansion of the tool's capabilities in coming years in order to meet Australia's needs.

2019
The TraNSIT tool is first adapted for use in Vietnam and Indonesia.

2020
CSIRO partner with the Australian Government looking at the transport cost benefits of Inland Rail

2021
CSIRO develops and launches the Supply Chain Benchmarking Dashboard - an accessible online interactive tool which builds on TraNSIT capabilities. It allows government and industry users to develop a shared understanding of supply chain performance.

2021
TraNSIT is applied through a partnership with the Australian Climate Service (ACS) to help improve the national response to extreme weather events.

2022
CSIRO's Gas Industry Social and Environmental Research Alliance (GISERA) uses TraNSIT to analyse the transport impacts across a range of hypothetical gas development scenarios in the Beetaloo Sub-basin.

2022
Ten-year anniversary of TraNSIT's development.

2023
Extension to modelling, measuring and monitoring Australia's supply chain resilience

Beef Roads

More efficient transport for Australian cattle farmers

A major operational and economic challenge for farmers in Australia's north is long transport distances between production and markets.

Cattle from the Northern Territory travel an average of almost 1000km and sometimes as much as 2500km to east coast abattoirs. Travel often takes place along a sparse rural road network that is largely unsealed and can be disrupted by seasonal flooding.

The $100 million Beef Roads Program was a Federal Government initiative to benefit the beef industry in northern Australia by making targeted upgrades to reduce transport costs.

In 2016, work by TraNSIT was used to inform investment under the program.

The Australian Government asked stakeholders in the beef and transport industries, as well as state, territory and local governments, to submit proposals for road upgrades across Queensland, Western Australia and the Northern Territory.

More than 60 submissions were received, with a total construction cost exceeding $3 billion. The proposals included new bridges, sealing road surfaces, and widening roads to enable access for higher productivity vehicles.

TraNSIT was able to provide the most comprehensive mapping and optimisation of the cattle supply chain ever undertaken across Australia, accounting for 20 million annual cattle transport movements between more than 100,000 enterprises.

The tool was then used to evaluate the transport savings to the beef industry for each of the 60 upgrade proposals, helping to direct investment to the projects where it would have the most impact.

In October 2016, the Australian Government announced that 18 projects would be funded under the Beef Roads Program. TraNSIT estimated that implementation of these 18 road projects would lead to an annual transport cost saving of $957,616.

The first project to be initiated under Beef Roads Program was the sealing of 16.9 kilometres of the Clermont to Alpha Road in Central Queensland in 2018. The $8 million works aimed to improve road safety and access for oversize vehicles while reducing freight and maintenance costs.

Co-benefits arising from some of the upgrades, which were not costed by the tool, included increased road safety for other road users, reduced impact on cattle due to shorter trip times and better road conditions, less wear and tear on vehicles, and potential savings on fuel costs.

TraNSIT's application in the Beef Roads Program provided a strong evidence base for decision makers to improve the reliability, productivity, cost-efficiency and resilience of cattle supply chains in northern Australia.

Inland Rail

Saving $213 million in transport costs through inland rail

Inland Rail is a key Australian Government infrastructure project designed to connect farmers and producers in regional communities to domestic and international markets.

The project involves the construction of a 1,700 km freight rail line directly connecting Melbourne and Brisbane via regional Victoria, New South Wales and Queensland. Construction of the line is divided into 13 projects, with 733 km of new track and 994 km of upgrades to existing track.

On completion, the project aims to deliver an efficient, reliable and cost-effective means of delivering goods and meeting consumer demand – but realising its full potential requires a thorough understanding of existing local supply chains and the role that Inland Rail might play.

To develop a better understanding of the potential freight savings for industry with a shift from road to rail, the Australian Government partnered with CSIRO.

Over two years (2018-2020) researchers used the TraNSIT tool to undertake extensive research and engage in stakeholder consultation with industry and local governments in the vicinity of Inland Rail. The aim was to learn which supply chains might use the proposed Inland Rail route.

TraNSIT analysed more than 175,000 annual transport movements of 140 commodities associated with nearly 5,000 industrial enterprises and 11,000 supply chains.

Of the 140 commodities in TraNSIT at the time of the analysis, 94 had the potential to use Inland Rail. Across these commodities, which ranged from horticulture and wood products to processed food, CSIRO found that there was a potential total annual transport cost reduction of $213 million, for 22 million tonnes of freight.

This included a $34.5m per year cost reduction for existing rail users shifting to Inland Rail, as well as a $178.5 million per year cost reduction for 2.28 million tonnes of road freight shifting to Inland Rail.

The results of the project indicated that the benefits from Inland Rail would be widespread and not limited to those communities directly alongside the route. There is a potential benefit for industrial enterprises as far as Townsville, Perth and Launceston.

The final Inland Rail report was delivered in March 2022.

The research now enters Phase 3 (May 2022 to December 2023) to explore the benefits of the complementary investments from the Interface Improvement Program, and the extension of Inland Rail between Toowoomba and Gladstone. Phase 3 will also consider a large range of counterfactuals, such as new processing opportunities at the key hubs along the Inland Rail route.

TraNSIT's application to the Inland Rail project enabled the mapping of existing freight supply chains and revealed the cost benefits of proposed investments over the long term.

Improving the national response to extreme weather events

More than 1.5 billion tonnes of freight are moved around Australia each year, but the country's supply chains are vulnerable to disruption from events like bushfire, cyclones and flooding.

Road closures and rail cancellations sometimes make it hard to get essential items like food and fuel to a community, just at the moment when they need it most.

The TraNSIT team have been working with the Australian Climate Service (ACS), a partnership established in 2021 to support improved decision making in the face of natural hazards. CSIRO has been using TraNSIT to support the National Emergency Management Australia (NEMA) in its national response role, building capability around supply chains and reducing the impacts of extreme events on communities.

During the 2021/2022 High Risk Weather Season, which saw authorities responding to severe flooding events in New South Wales and Queensland and the impacts of Tropical Cyclone Tiffany in South Australia, NEMA accessed TraNSIT capability to support predictive analysis, impact and consequence assessments. This aided the emergency response and mitigated the impacts of supplies not reaching crews and communities.

In the immediate aftermath of an extreme weather event or natural disaster, TraNSIT is used to identify supply chain corridors that have been impacted and can help identify alternative routes that make it easier to target resources where they are most needed.

Later on, during the recovery period, the role of the TraNSIT team shifts slightly and the tool can be used to help get supplies moving again. Knowing that there are a finite number of both vehicles and potential routes in the affected region, TraNSIT modelling can help provide a robust evidence base that assists decision makers in prioritising efforts.

There is also a role for TraNSIT to play in longer term planning, and prioritising actions and investment that will improve the resilience of Australia's supply chains in future.

By undertaking a historic analysis of past events, researchers will be in a position to identify ongoing or repeated issues within the country's supply chain network. Decision makers can then target investment at the areas where it will have most impact.

Taking regional differences into account is an important part of any analysis. Australia's East Coast is generally considered more resilient in the face of extreme events because the higher density of roads usually makes it easier to find alternative routes in and out of communities.

But as the impacts of climate change continue to be felt across the country, even regions with well-developed infrastructure will face challenges. Actions that could improve the resilience of the system might include steps like improving road quality, raising bridges, or exploring alternative routes. What TraNSIT can do is help provide the evidence base for making those decisions.

Working through the Australian Climate Service, CSIRO has been able to enhance the Australian Government's response during times of extreme weather. TraNSIT has a valuable role to play in the immediate aftermath of an extreme event, in the recovery period that follows, and in longer-term planning and resilience building.

ROAD
CLOSED

Bringing more resilient transport infrastructure to Vietnam and Indonesia

Researchers have now adapted TraNSIT for use overseas, helping to understand costs and improve the flow of agricultural transport in Indonesia and Vietnam.

In less developed countries, unreliable transport infrastructure can hinder the ability of producers to get products to market. This is a major barrier to agricultural development.

Increasing demand for higher-value food products throughout Asia represents a real growth opportunity for local producers in Indonesia and Vietnam – but only if they are able to get their products to domestic and overseas markets in a timely and cost-efficient manner.

TraNSIT was used to map current logistics, transport routes and costs – for commodities including rice in Indonesia, and cassava, sugar, coffee and maize in Vietnam.

Researchers then worked with stakeholders across the supply chains - from farmers to collectors, processors, transport and logistics operators – to develop and model a range of potential real-life scenarios and examine the resulting changes in costs and routes.

The CSIRO team liaised closely with ministries, government agencies and industry to demonstrate the value of the model's outputs in helping to inform infrastructure investment and policy changes that can improve transport efficiency, reduce costs and increase resilience.

In Indonesia, where rice is a staple crop, one of the key project goals was to demonstrate national-scale transport and logistics solutions for this commodity. The country's unique geography presented a major challenge – with more than 17,000 islands and lots of mountainous terrain.

TraNSIT was used to model 64.4 million tonnes of national annual rice production across 4,130 representative production locations (totalling 12.7 million hectares and approximately 15 million smallholder farms). The results highlighted the heavy freight demand along the major road and sea toll routes, particularly from Java to Kalimantan, Sulawesi and Sumatra.

The modelling also revealed a heavy impact on road infrastructure in the regions where rice is harvested and transported for milling and on to storage. These areas have twice the transport and logistics relative to enterprises at the downstream end of the supply chain and can often be a bottleneck in the system, greatly impacting the overall efficiency of the supply chain flows.

In Vietnam, researchers focused not on national-scale supply chains but on commodities and transport issues at smaller administrative scales of province, district and commune.

For the main crops of cassava, sugar, coffee and maize, TraNSIT modelling revealed that 62 per cent of transport costs were associated with trucking crop products between farms and traders, and 26 per cent between traders and processing factories. Only 12 per cent of transport costs were incurred post-processing.

These high upstream transport costs are typical of "first-mile" challenges of procuring agricultural products from scattered, smallholder farming systems in remote and upland areas.

Enhancing connectivity is critical for countries and communities to access domestic and global markets. TraNSIT has been successfully adapted for application in Vietnam and Indonesia to examine supply chains for key agricultural commodities.

Using maths and modelling to keep Australia moving

Australia's continuing prosperity and community wellbeing depend on strong and resilient supply chains.

Events over recent years, including the impacts of COVID-19 and the effects of severe weather events, have shown how important our road and rail supply chains are but also how vulnerable they are to disruption.

It's essential that we develop a deeper understanding of national supply chains, the potential risks they face, and any steps that can be taken by government and industry to mitigate those risks.

Using the TraNSIT tool, CSIRO researchers can identify and monitor the resilience of the supply chains that are most critical to Australian communities and businesses, providing a strong, robust evidence base for government to make infrastructure investment and regulatory decisions.

In October 2021, CSIRO and the Federal Government launched the Supply Chain Benchmarking Dashboard: an interactive web tool which provides detailed and interactive modelling of Australian transport and logistics supply chains.

The benchmarking has been informed by 10 years of industry engagement and co-operation. The Dashboard itself provides industry and governments with a shared picture of supply chain performance for evaluation, helps identify supply chain vulnerabilities, and assists with the identification of potential areas for action or collaboration.

In partnership with the Department of Infrastructure, Transport, Regional Development, Communications and the Arts, which is currently undertaking a Road and Rail Supply Chain Resilience Review, CSIRO is now undertaking work to expand on the Supply Chain Benchmarking project and include resiliency measures for all commodities included in the tool.

The Benchmarking outputs will allow ongoing and systematic evaluation of Australia's supply chain resilience over time, and the ability to assess the potential economic and operational impacts of changes and disruptions to Australia's critical supply chains and freight routes.

This capability will provide insights into key areas for action and targeting of interventions to ensure Australia's sustainable socio-economic wellbeing. This wellbeing is often reliant on critical goods across a wide range of sectors and moving across different supply chain paths throughout Australia.

This resilience initiative considers a much broader range of disruptions that are not focused on just climate or specific regions, and also considers the range of policy interventions that impact incrementally on resilience of some supply chains.

TraNSIT maps millions of vehicle trips across thousands of supply chains between production and domestic and export markets. Modelling based on aggregated outputs from TraNSIT provides a picture of supply chain performance and can help assess current and future supply chain resilience, ensuring that Australia's freight networks remain fit for purpose.

What's next for TraNSIT?

The year 2022 marked the ten-year anniversary of TraNSIT. The tool has come a long way since its initial development for the agriculture industry in Australia.

Researchers continue to develop new applications for TraNSIT – often at the request of industry – and new commodities are added to the modelling almost every year.

While the focus of the tool remains on reducing costs and improving efficiency, a number of important co-benefits have been realised through the different applications. These include reduced carbon emissions from more efficient journeys; less food damage and wastage, especially with degradable products; and improved, safer driving conditions for all road users.

Part of TraNSIT's success in revolutionising the way Australia's transport-related infrastructure investments are prioritised stems from the grassroots support that has been evident since the earliest days. The research team has worked closely with stakeholders including farmers, freight operators, industry leaders, and government at every level – and that engagement has been an important catalyst for growth.

In 2020, this critical work by the TraNSIT team was recognised when it was awarded the CSIRO Sir Ian McLennan Impact from Science and Engineering Award. Selection for the award is based on demonstrated achievement, through effective interaction with industry, that shows potential to benefit the Australian economy or community.

The tool continues to be used by government and industry for informed decision making around major infrastructure investment, and a user-friendly, web-based version of the tool has been developed to allow organisations to undertake projects and test infrastructure and regulatory scenarios themselves.

Through the Australian Climate Service and a continuing partnership with the Australian Government's Department of Infrastructure, Transport, Regional Development, Communications and the Arts, TraNSIT will be a crucial tool as Australia seeks to build more resilient supply chains that will continue to operate efficiently even in the face of climate change, extreme weather events, and other disruptors.

Ongoing work in Indonesia and Vietnam will seek to integrate TraNSIT and other spatial analytics in decision-making institutions and industry. This supports both public and private sector institutions and planners to better evaluate options and allocate resources in ways that reduce transport and logistics costs. This will improve connectivity for agricultural value chains, smallholder farmers and rural communities for many years to come.

A new initiative with the Australian Government called Supply Chain Scenario Resiliency Modelling will expend TraNSIT to a range of resilience measures for critical commodities. It will produce a scenario analysis capability within interactive tools for stakeholders, and provide an ongoing, systematic evaluation of Australia's supply chain resilience over time.

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