Modeling rural freight

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Abstract

This paper illustrates the modeling of passengers and freight in a rural multimodal network for a proposed railway with emphasis on road/rail competition for export freight. This modeling is much more complex than modeling urban traffic as the forecasting assumptions necessary to build the model are much more diverse and questionable and consequently need to be supported by external evidence. Australia's rural export economy is vitally important to our economic wellbeing and modeling freight movements to export ports is an essential ingredient in supporting these industries.

1. Introduction

This paper provides a case study of the modeling of a New South Wales rural multimodal network to assess passenger and freight movements for a proposed Canberra to Eden railway with improvements to Eden Port. The proposed project consists of upgrading the existing abandoned rail route between Queanbeyan and Bombala and the provision of a new rail alignment between Bombala and Eden. The preferred route was identified as the Towamba Valley route and the engineering and cost estimates for this proposed route was adopted[1] for the passenger and freight modeling and subsequent economic evaluation.

The passenger and freight demand forecasts have been assessed with the assistance of the upgraded CARTS model[2], which is a State-wide multi-modal transport forecasting model which incorporates estimates of road/rail competition, rail route diversion and rural industry growth induced by improved freight transport facilities. It also incorporates facilities for economic evaluation. The model utilized a network inventory of all road and rail routes in NSW.

While the proposed rail improvements will connect into the National Rail network and is therefore able to accept passengers and freight loads from any part of Australia, the most probable freight loads are likely to be from a catchment area, which stretches from Dubbo and Carathool Shire to Bega Valley Shire and Goulburn. It is therefore necessary that the model should embrace at least the whole area of the State of New South Wales.

The evaluation relies on an assumption that the port development, together with the social infrastructure within the town of Eden, will grow to support this development. Some part of the passenger and freight traffic supporting this future development will be induced by the rail development – other development will occur as natural growth.

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[1] Cooma and Monaro Progress Association. "Concept Plan for Canberra to Eden Railway". Stormcloud Engineering, 2018
[2] Scott Wilson Nairn, "Program CARTS Description and user manual".

Similarly socio-economic growth will occur at intermediate towns along the proposed rail routes and they also will contain induced elements. It is assumed that both the port and townships development will keep pace with the expected demand for socio-economic services so that rail commerce will not be constrained by social or terminal capacity limitations in future.

The natural growth of towns and the port does not form a part of the economic assets of the rail proposal although the value of a part of any new rural growth and industrial production, induced by improved rail services, was included within the benefit stream. The proposed railway is shown in Figure 1 and the existing rail network within the potential catchment area is shown in Figure 2.

Figure 1 – The proposed railway
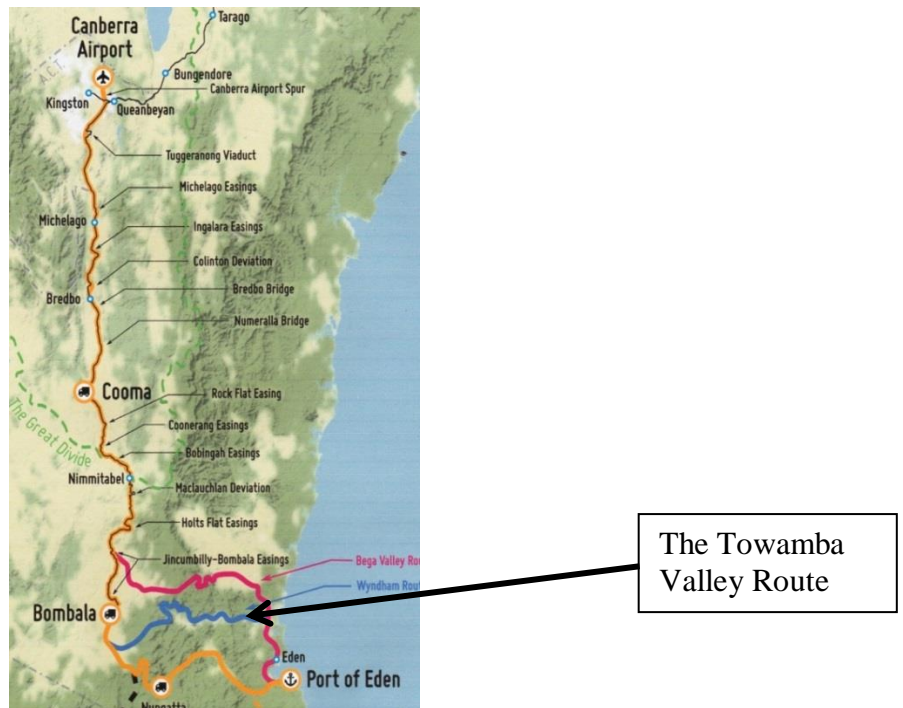
Source: "Concept Plan for Canberra to Eden Railway" prepared by Edwin Michell of Stormcloud Engineering

Figure 2   The existing New South Wales rail network in the probable catchment area
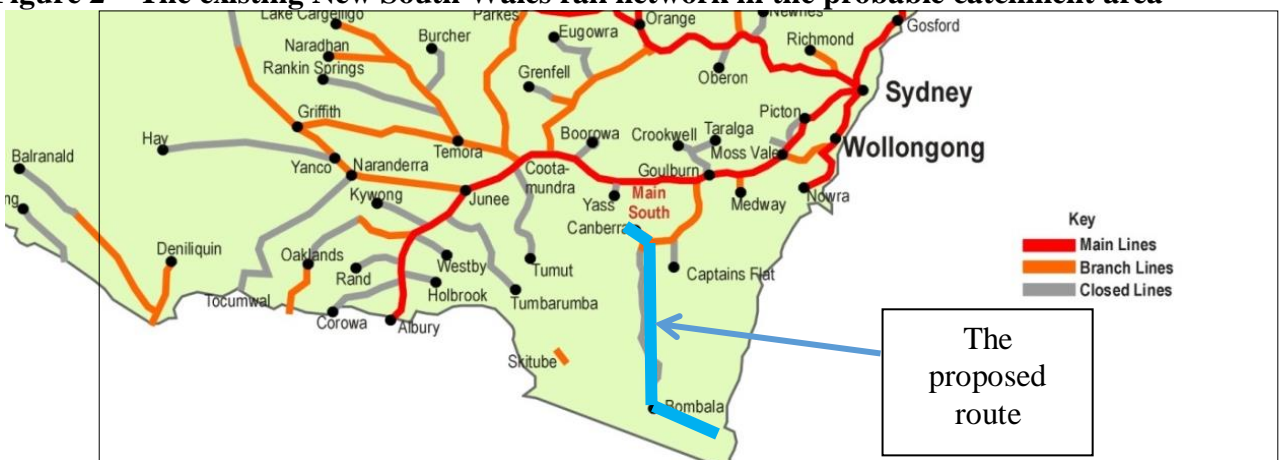
Cootamundra is the focal point for rail transit in the Riverina. It is about 60 Km closer to Port Botany than Port Eden and Port Kembla with Port Melbourne being not much further.

2. Methodology Overview

The CARTS model utilizes socioeconomic data from each of the Local Government Areas in the State to simulate the passenger and freight loadings on the network and is calibrated so that these loadings reflect the actual loadings on the real network in the "base" year, in this case 2021.   The calibration acknowledges any network congestion and serious bottlenecks causing delays.   However few details of rail traffic were available.

The first simulation test was just for the necessary improvements to the port at Eden, which was to include both bulk and new container handling facilities, but without the rail improvements.   This established the degree to which the port improvements will continue to attract freight by road.   While the ensuing economic benefits from this test are not attributable to the rail project, it provides a basis for examining the degree to which the rail project, when tested, will induce freight transfers from road transport. This showed that about half of cost of the port improvements could be attributed to road improvements.

The future traffic forecasts depend on forecasts for the socioeconomic parameters of each Local Government District.   They include population, employment, vehicle ownership, rural industry and agricultural production, mining, manufacturing and tourism.   These forecasts are assembled for several future years.   Applying these within the CARTS simulation model, together with the upgraded networks, in each future year, provides the demand forecasts. The forecasts also depend on future changes to the transport network. Although some rail changes may be expected in the Riverina, the only significant new rail line is the Inland Rail shown in Figure 3.

Figure 3 - Future changes to the rail network

Source: "Concept Plan for Canberra to Eden Railway" prepared by Edwin Michell of Stormcloud Engineering

The modeling provides predictions of induced growth in rural production and tourism as a result of the improved transport access. There may also be some shifts in residential population.   Preparation of the data involved resolving the following questions:-
- What are the Local Government growth rates – ex-urban migration patterns etc?
- What is the potential growth in tourism in the catchment area?
- What is the potential growth for rural export produce and what factors affect it?
- What is the potential export market and it's growth for NSW rural produce?
- What are the competing ports and their conditions – container and bulk handling facilities?
- What is the cross-elasticity between road and rail and rail routes haulage? and
- Are there capacity limits in the network?

3. The relevant potential market for passengers and freight

In view of the importance of freight haulage to the rail proposal, the potential market for exports and imports from the catchment area is a primary focus. The primary export products from the catchment area are agricultural products. The top three agricultural commodities produced nationally ranked by export value in 2018-19 were cattle and calves ($9.485 billion), wool ($4.159 billion) and wheat ($3.676 billion). Out of the $62.2 billion worth of food and fibre Australian farmers produced in 2018-19, 79% ($49.2 billion) was exported. The pre-COVID value of export sales of commodities produced in the catchment area to countries easily served from the eastern seaboard in the year 2019 in shown in Table 1. Table 2 illustrates the value of the major imports from some of the above countries.

Table 1 - Value of commodity exports to eastern seaboard countries $Millions - 2019

Commodity	China	Vietnam	Japan	Korea	Malaysia	NZ	USA	HK	S'pore	Total
Foodgrains	693	373	552	38	225	56	0	0	33	2,470
Meat/Cattle*	3,974	629	2,836	1,759	319	148	3,353	300	270	13,588
Dairy Products	643	61	514	74	149	87	38	101	173	1,840
Cotton	1,116	114	23	1	44	2	0	0	-	1,300
Alcoholic Bev	1,239	41	56	31	71	171	448	143	177	2,377
Timber	1,497	7	524	7	41	9	3	1	-	2,089
Wool	2,433	0	17	83	13	1	7	0	-	2,554
Total	11,595	1,225	4,522	2,393	862	574	3,849	545	653	26,218

*includes live animals   Source:- Department of Foreign Affairs and Trade Pivot Tables

Table 2 - Value of imports from some eastern seaboard countries – 2017/2018 - $Millions

Category/Country	China	USA	Japan	Thailand	Korea	World
Minerals & Fuels	$ 3,138	$ 2,218	$ 220	$ 1,256	$ 250	$22,922
Agriculture, Forestry, Fisheries	$ 1,562	$ 1,284	$ 4,020	$ 211	$ 5,395	$41,322
Manufactures	$72,499	$28,779	$16,597	$12,725	$ 6,237	$231,704
Other Goods	$ 1,046	$ 1,697	$ 1,414	$ 394	$ 566	$10,720
Total	$78,246	$33,978	$22,251	$14,587	$12,448	$306,668
Growth %pa 2006/7-2017/8	6.4%	2.0%	2.8%	4.5%	7.0%	4.7%

Source:- Department of Foreign Affairs and Trade Pivot Tables

These five countries are Australia's largest import partners accounting for 53% of imports. Four other Eastern seaboard counties (Malaysia, Singapore, New Zealand and Vietnam) account for another 13%. The value of agriculture related imports is shown in Table 3.

Table 3 - Value of agricultural-related imports – 2017/2018 - $Millions

Import	Value $millions	Growth Rate*
Petroleum products	$ 249.63	4.7%
Motor Vehicles and parts	$ 5,395.28	14.1%
Tractors and Farm machinery	$ 6,237.22	1.4%
Fertilizers and Insecticides	$ 565.99	1.6%

* Average 2006/2007 to 2017/2018   Source:- Department of Foreign Affairs and Trade Pivot Tables

3.1. The Competing Ports

The seven Australian ports, which handle the greatest value of export trade, are listed in Table 4

Table 4 - Australia's even busiest ports – Value of export goods handled - $Billions

Year	Dampier	Port Hedland	Melbourne	Hay Point	Newcastle	Brisbane	Sydney Ports	All
2006-07	$15.5	$6.8	$21.1	$10.4	$6.6	$10.4	$11.4	144.4
2015-16	$33.2	$26.3	$22.4	$12.1	$13.5	$13	$11.7	218.4
Growth	8.8%	16.2%	0.7%	1.7%	8.3%	2.5%	0.3%	4.7%

Source: BITRE – Australian Sea Freight – 2015-16

Possibly the greatest causes of uncertainty for freight exporters or importers in New South Wales are the questions of reliability of Port Botany, which is the possible cause of its slower growth.

The Port of Eden is the southernmost deep water harbour in NSW and is situated equidistant between Sydney and Melbourne. The Port provides a Harbour Master, 24 hour pilotage services, management of a Navy wharf and port security functions. There is also a deep inner anchorage.

The port also owns and manages an eight hectare cargo storage facility. The major users of the port are the Royal Australian Navy, wood chippers, and cargo ships for logs and cruise ships. The Port Charges include Navigation, Pilotage, Site Occupation and Wharfage and are competitively priced with respect to other Ports in New South Wales. There are frequent visits from some of the world's largest cruise ships.

Port Botany, the largest port in New South Wales, is the seventh largest in Australia but is growing more slowly than any other major port despite the fact that Australia's eastern coast ports handle about two-thirds of all freight and are growing faster than the average as shown in Table 5.

Table 5 - Eastern seaboard ports freight value $Billions

Year	Eastern Seaboard	Port Botany	All Ports	% Eastern Ports
2006-07	$ 90.0	$ 11.4	$ 144.4	62.3%
2015-16	$ 143.1	$ 11.7	$ 218.9	65.4%
Growth rate	5.3%	0.3%	4.7%	

Source: BITRE – Australian Sea Freight – 2015-16

Port Botany is geared to handle containers and imported fuel products, such as petroleum, bitumen, LPG and bulk chemicals. Rail is the major means of delivering containerized agricultural freight including grain, pulses, cotton and meat to Botany's three portside container terminals. It suffers from congestion and delays which impose financial and other penalties on exporters. Container volumes have historically been relatively volatile, leading to substantial uncertainty in their forecasts. However TfNSW forecast that annual growth in containers should be 2.5%[3].

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[3] Source: TfNSW Freight Commodity Forecasts – 2016-2056

Port Kembla, situated in Wollongong and 90 Km south of Port Botany, also handles bulk liquids and has New South Wales' largest grain export terminal.   It handles motor vehicle imports and mining product exports, such as coal.   Port Kembla has been approved by the NSW Government as the site of NSW's next container terminal once Port Botany nears capacity.

The port at Newcastle is primarily a coal loading port but it has facilities for other types of cargoes.   Recent initiatives to establish larger container handling facilities have been thwarted by a Federal Court decision so that this Port is limited to 30,000 TEU per annum (about 350,000 Tonnes).   The relative importance of the various NSW ports is shown in Table 6.

Table 6 - Tonnage handled at NSW ports 2018-19 – '000 Tonnes

Port	Import	Export	Total
Botany	15,500	9,579	25,079
Newcastle	5,420	161,718*	167,138*
Kembla	8,412	7,820	16,232
Eden	-	263	263
Total	29,332	179,380	208,712

Source: Ports Australia Trade Statistics   * Mainly coal

Export trade obviously depends on the frequency with which shipping vessels are available. Table 7 displays the current forecasts for vessel calls to Australian Ports.

Table 7 - Forecast numbers of vessels calling to Australian ports

Vessel Type	Year			% Growth	
	2007-08	2012-13	2029-30	08-13	08-30
Container Ships	7,161	6,910	11,200	-0.7%	2.1%
Bulk Carriers	14,439	15,500	23,100	1.4%	2.2%
General Cargo	3,633	3,710	4,080	0.4%	0.5%
Other	2,201	2,242	2,475	0.4%	0.5%
Total	27,434	28,362	40,855	0.7%	1.8%

Source: Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2010

The potential for Port Eden to attract shipping will depend on congestion at Port Botany, future plans for container facilities at Port Kembla, on the expected growth of shipping and the probability of Port Eden being developed to cope with an extra types and tonnages of freight handling.   Coastal movement of non-containerized freight is expected to continue to grow steadily throughout the forecast period and improvements to Port Eden could attract some of this traffic.

3.2. The Potential for Passenger Travel

The potential for a regular passenger service to attract patronage encompasses commuting to Canberra and elsewhere for work, day-trips for business, commuting to Canberra for educational purposes, particularly TAFE and University, and general travel to Canberra and elsewhere for shopping, medical purposes or entertainment.   The towns of Canberra, Queanbeyan, Michelago, Bredbo, Cooma, Nimmitabel, Bombala and Eden are located on the proposed rail route and would form the most probable primary rail passenger catchment,

although passengers from Bega, Merimbula, Pambula and other towns in the area may also seek the opportunity for rail travel to Canberra, Sydney and other parts of the catchment area, particularly the snow fields and coastal resort villages.

This patronage is modeled in the CARTS model.   In addition, there has been an accelerating trend for residents to move out from Canberra into surrounding small towns in New South Wales.   This is predicted to continue and, in addition, it is likely that any rail passenger service would induce further ex-urban relocation.

Tourism presents another major source for rail patronage, particularly snowfields patrons from Sydney and Canberra.   About 17.7 million tourists visited the catchment area in 2020 as

shown in Table 8.   They spent about $4.27 Billion.

Table 8 - Tourism in the catchment area - 2020

Region	Number '000	Expenditure $Mill	% Car	NSW Residents
South Coast	9,888	$ 1,326	93%	80%
Snowy Mountains	$1,158	$ 603	98%	76%
Riverina	$2,215	$ 427	92%	84%
Capital Country	$3,918	$ 819	93%	69%

Source: Destination New South Wales   Note: LGA data has been compressed to Regions.

Tourism in the coastal areas is highly seasonal but the snow country peaks at different times than the coastal beaches.   Given the high proportion of visitors who are residents of NSW and their dependence on car travel, the potential for attracting rail passengers is substantial.

Table 9 shows the primary socio-economic features of in regions in the catchment area.   This data was collated by Local Government Areas but aggregated for brevity.   The Riverina stretches from Carathool to Tumut, Murray from Albury to Wentworth and the South Coast region from Yass to Snowy Monaro.

Table 9 - Regional population and productivity of the catchment area

Region	Area SquKm	Popl 2018	Growth Rate	Regional Product $Mill
Riverina	70,546	171,156	0.87%	$ 7,347
Murray	78,972	116,117	-0.36%	$ 5,913
South Coast	51,673	227,876	7.09%	$ 9,819
ACT	2,358	414,400	4.05%	$ 39,440

Source:- NSW Govt. Health Statistics & ACT Government

This data, together with Local Government employment data is coded into the CARTS model to provide a basis for estimating passenger and tourism travel by road and rail.

3.3. The potential for freight movement

Similarly, major mineral, crop and other rural industry production in each Local Government Area is coded into the CARTS model to provide a basis for forecasts of freight movements to cities and ports by road, rail or intermodal travel.

The location of ports, abattoirs and major grain-handling sites are also coded into the model as are major fuel distribution depots to aid in tracing movements from cities and ports to the rural towns.

In 2018–19, the gross value of agricultural production in the Riverina region alone was $2.5 billion, which was 21% of the total gross value of agricultural production in New South Wales ($11.7 billion). The value of each agricultural crop grown in the Riverina is shown in Figure 4.

At present all export wheat is carried to port by rail, some to Port Geelong and some to Port Kembla. Most rice, cotton and nut crops in the Riverina are currently forwarded to Melbourne.

NSW yearly produces 52 kilotons of rice, 755 kilotons of cotton lint and seed, and 4,750 kilotons of wheat. Regional NSW supplies agricultural commodities, food and beverages to the world's largest and growing consumer markets in Asia, the Pacific Rim and Europe. Table 10 shows the value and growth rates of rural production in New South Wales.

Figure 4 – Value of agricultural production – Riverina – 2018/2019
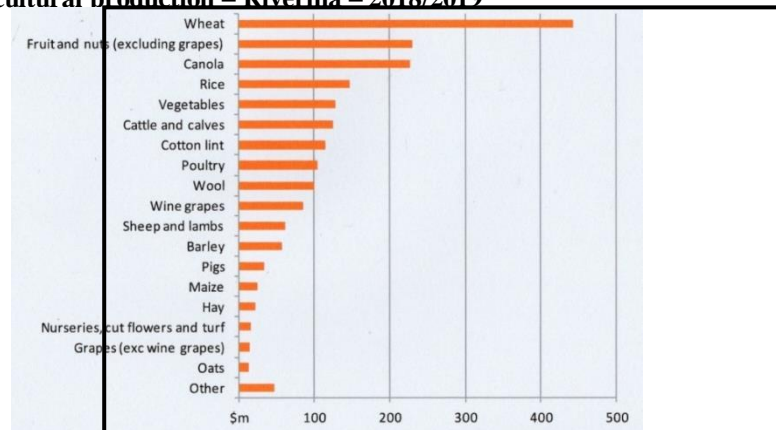
Source: Australian Bureau of Statistics, cat. no. 7503.0, Value of agricultural commodities produced, Australia 2020

Table 10 - Value of NSW rural produce

Agricultural Industry	$Millions pa	Growth rate
Cropping	$ 2,498	Variable
Meat	$ 4,671	4.0%
Livestock products Incl. Wool	$ 2,062	4.0%
Fishing	$ 181	2.1%
Food products	$ 30	5.0%
Wine	$ 2	Variable

Source: 'NSW Primary Industries – Performance, Data and Insights 2019'

There are about 70 cattle farms and/or Feedlots in NSW. Cattle in the Riverina are currently processed through Wagga Wagga but the Abattoir at Cootamundra is due to reopen. China buys about 80% of wool grown in New South Wales and is the fastest growing market for beef from New South Wales – 35% but growing at about 33% per annum. China buys 51% of all Australian dairy product exports and there is further potential for the export of Dairy produce from the Bega and the Murray-Goulburn areas where producers are already exporting