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A QUANTITATIVE EVALUATION OF THE NEED FOR CONNECTING THE SOUTHWEST COAST OF TÜRKIYE TO THE NATIONAL RAILWAY NETWORK

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Abstract- South-Western coast of Türkiye, which is separated from the Central Anatolian Plateau by the Taurus Mountains, is not connected to the national railway network. The city of Antalya that stretches along the South-Western coast of Türkiye, also known as the Turkish Riviera is a major hub for tourism and agriculture. To the west of Antalya, lies the city of Muğla, which is another city with a high touristic and agricultural potential. A long shoreline, natural beauty, rich historical past, geographical qualities, mild climate and vast fertile lands support and sustain agriculture and tourism. Unlike the South-Eastern part of Türkiye, which is marked by the cities of Mersin and Adana, Antalya connects to inland cities only by roadways and airways. Large quantities of agricultural products are transported by trucks and semitrailer trucks through inland logistic centers and local markets. On the other hand, the only current alternative passenger travel along along roadways is air travel. This study evaluates the tourism and agricultural potentials of Antalya. The study evaluates the benefits of constructing inland logistic ports and connecting the city of Antalya to the national railway networks for freight and passenger travel. The cost of exporting a truck of agricultural products or a passenger bus out of Antalya are estimated and compared to the costs that would be generated if railway transportation was available. The likely benefits of railways to support and extend Antalya's tourism potential are studied. The study concludes by proposing railway routes that connect Antalya to the national railway network through the cities of Isparta and Konya and railway transportation as an alternative solution to freight transportation and its possible benefits in terms of reducing the costs of agricultural products to the consumer.

Keywords: Antalya, Agriculture, Tourism, Freight Railways, Passenger Railways.

1. INTRODUCTION

TCDD includes 9 regional directorates in relation to the distinct geographical, topographical, climatic and economic variations across Turkiye. Warmer climatic regions along the south and southwest coast of Turkiye transition into drier and colder continental climates within the central region. Cooler climates along the north western coast transition to cold and rainy climate across the northern coastline. The eastern mountainous part of Turkiye is marked with cold and snowy weather whereas the southeastern part is characterized by hot and dry weather. Figure 1 shows the operational regional districts of TCDD [1].



Figure 1. Operational regional districts of TCDD [1].

TCDD operates 13.919 km track length, 8.046 km of which is signalized and 7.274 km of which is electrified. Conventional track length is 11.668 km long whereas high speed and rapid speed track length is 2.251 km long [1]. Figure 2 presents the operational power of Turkish railways where the red colored lines that serve central and the northwestern and western most Anatolia regions are electrified whereas the eastern, northern and western inland routes are served by diesel and diesel-electric locomotives [1].

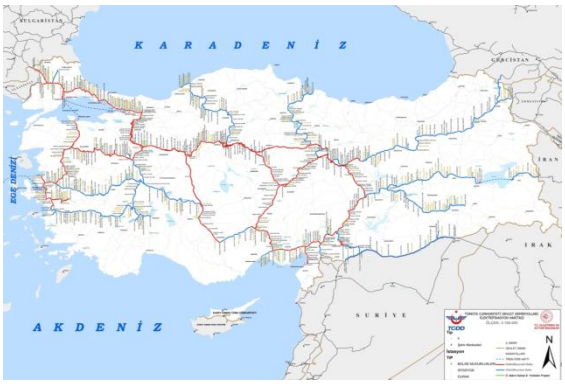

Figure 2. Operational power distribution of the Turkish railway network [1].

More than 1.000 km coastline between the city of Mersin to the south east and İzmir to the west is not serviced by regional railways and approximately 90.000 km^2 of territory lies below the southernmost railway up to the Mediterranean and Southwestern Aegean coasts of Turkiye. Cities of Muğla and Antalya that border the south west Mediterranean coast of Türkiye have populations of 983.000 and 2.511.000 respectively concentrated along the shoreline. Both cities are bordered by the Taurus Mountains to the north. The Mediterranean climate transitions into continental climate towards north as the elevations rise to 2.000 m above sea level on average; with the highest elevation at 3.767 m.

Cities of Denizli, Isparta, Konya and Karaman, with elevations of 324 m, 1035 m, 1016 m and 1039 m are already a part of the national railway network of Türkiye. City of Muğla has a varying elevation from sea level to 655 m at the city center. Figure 3, shows the cities along the southwest coast of Türkiye [2]. Figure 4 shows the population densities across Türkiye [2].



Figure 3. Cities of Muğla and Antalya along the southwest coast of Türkiye [2].

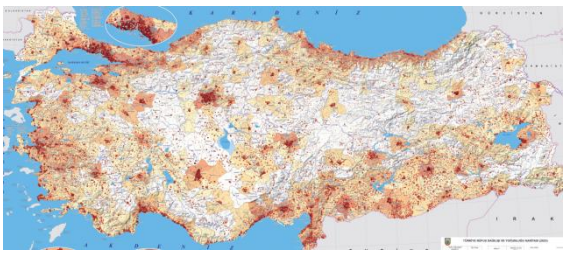
Figure 4. Population densities across Türkiye [2].

Approximately 3.8% of the Turkish population lives in Antalya and 1.1% in Muğla. The city of Antalya and Muğla contribute to approximately 5% of the nominal Turkish gross domestic product, which is near 70 Billion USD [3]. Currently, roadways provide land transport to reach inland with limited speeds equal to or below 90 km/h with varying spot speeds that further reduces along the hairpin curves that facilitate passage over the Taurus Mountains. Figure 5 shows the black colored state roads that connect southwest coast of Türkiye, inland [4].

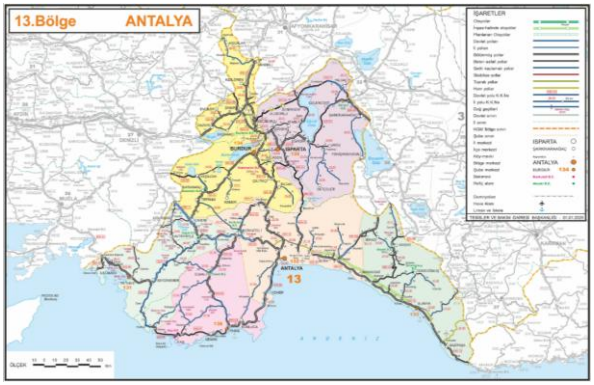

Figure 5. State roads that connect Antalya to inland Türkiye [4].

2. AN INSIGHT INTO FREIGHT POTENTIAL OF ANTALYA

Antalya is a significant economic hub for tourism and agriculture but remains unconnected to the national rail network. As a result, agricultural production zones are entirely dependent on road transport, leading to higher logistics costs, increased congestion, and elevated greenhouse gas emissions [5]. Despite its role as a touristic destination, lack of proper connectedness to inland touristic destinations Despite the ongoing investments in railways, freight corridors, are yet to receive the same attention as the passenger corridors, with limited investment in capacity expansion and intermodal infrastructure.

Freight operations are concentrated in the Marmara, Central Anatolia, and Southeastern Anatolia regions, connecting industrial zones, ports, and border crossings. However, operational limitations persist due to single-track segments and insufficient intermodal terminals [6, 7] Antalya is among Türkiye's most significant provinces in both tourism and agriculture. The city is a global tourist destination, welcoming over 13 million international visitors annually, with Russia, Germany, and the United Kingdom as its main source markets [8]. Tourism contributes significantly to the provincial GDP, supported by a robust hospitality sector and extensive resort infrastructure.

Antalya produces approximately 50% of Türkiye's greenhouse vegetables. According to the Antalya Agricultural Production Report (HAL, 2023), annual

production includes, Tomatoes: 2.8 million tons, Peppers: 1.2 million tons, Cucumbers: 0.8 million tons and Citrus fruits: 1.5 million tons with substantial volumes of pomegranates and peaches**.** Due to the absence of a railway connection, Antalya relies exclusively on road transport for outbound freight. During peak seasons, March to June for spring harvests, and September to November for autumn harvests, 3,000–5,000 trucks depart daily, covering average distances of 500–700 km to reach domestic markets or rail-connected ports [9]. This truck dependency results in higher logistics costs, road congestion, and substantial CO_2 emissions. The current railway logistical costs depend on a single reference, which is a guideline published by the Turkish Ministry of Transportation [10]. The data is taken from page 53, section "4.1.7 General Average Costs." The value obtained is 0.2 ₺/ton km, which was applicable for 2021. To estimate the current cost, this value is multiplied by the change in oil prices between 2021 and 2025. Table 1 shows the petroleum barrel prices in both U.S. dollars and Turkish lira.

Table 1. Barrel prices for different dates

Date	[1] Barrel Price	[2] Exchange Rate ($-TL)	Barrel Price (TL)
2021, June	75,18 $	8,6803	652TL
2025, August	73,53 $	40,519	2979TL

The increase rate between these two dates is 4.56, and the estimated cost for transporting goods by railway is 0.91 TL per ton per km. Finally, the total transportation cost of one ton of vegetables from Antalya to Istanbul is 704.53 TL, which is 1,630.28 TL less than the cost of using highways. It is estimated that annual agricultural shipments between Antalya and Istanbul amount to 400,000 tons, including vegetables (greenhouse and open field), fruits (citrus, banana, etc.), and floriculture products. In conclusion, an additional 1,630.28 ₺ × 400,000 = ₺652,112,896.00 is spent annually on highway transport for vegetables from Antalya to Istanbul compared to railway transport.

2.1 Additional Speed Data for Highway Transport

While the specific running speed, spot speed, and average speed along highway routes in Türkiye vary based on traffic conditions and road segments, typical values have been established through national traffic studies. For freight trucks, the maximum permissible speed on Turkish highways is generally between 80 and 90 km/h. However, actual spot speeds can fall as low as 30 km/h in congested areas and rise to near maximum limits in free flow segments. Over long distances, especially on routes to and from Antalya such as the D400 coastal highway and D650 inland corridor, average freight truck speeds range between 50 and 70 km/h. These figures reflect delays caused by traffic congestion, road conditions, and rest requirements [4]. Including this data strengthens the case for a rail alternative. A dedicated railway line offering a consistent and higher average speed could significantly outperform current road transport efficiency in both time and cost, making it a more sustainable logistics option for the region.

Studies estimate that a direct railway connection could reduce logistics costs by 25%, cut CO_2 emissions by 30%, and increase export volumes by 15% [11, 12].

3. LOGISTIC COSTS: TRUCK AND TRAIN

This section presents a discussion about current logistical costs of transporting vegetables between Antalya and Istanbul by roadways and railways. It also presents potential cost outcomes of the upcoming railway connecting Istanbul and Antalya. In reference-12. several cost items (such as storage costs, ordering costs, or material handling costs) are omitted, and key costs are analyzed based on market research. The comparison of the costs does not include the costs associated with traffic accidents, delays and perished items due to accidents. Environmental costs associated with higher usage of fuel along roadways are not included as well. Table 1 lists these cost items along with their assigned costs. The current fuel oil cost per liter is 52 TL/liter. The distance between Istanbul and Antalya is approximately 784 km. It is estimated that a truck can carry around 15 tons of vegetables. This truck is assumed to make 20 trips between Istanbul and Antalya per month, consuming 34 liters of fuel oil for every 100 km. In total, the truck travels approximately 15,680 km per month. Consequently, the fuel cost for one vehicle amounts to 277,222 TL. Table 2 shows the logistics monthly expenses, including percentages. Figure 6 shows the relative portion of each expense. The fuel costs of the truck account for nearly 80 percent under Türkiye's conditions. The total monthly cost of this truck is 350,222 TL, and it carries a total of 150 tons of vegetables from Antalya to Istanbul. Transportation cost of one ton of vegetables equals 2,334 TL.

[1] https://tr.investing.com/commodities/brent-oil

[2] https://herkesicin.tcmb.gov.tr/wps/wcm/connect/ekonomi/hie/icerik/enflasyon+hesaplayici

Table 2. Monthly logistic cost items for a truck

Cost Item	Assigned Value (TL)	Percentage of total cost
Fuel Cost	277.222	79 %
Driver Salary	35.000	10 %
Care & Repair	10.000	3 %
Insurance	6.000	2 %
Bridge & Highway Crossings	3.000	1 %
Depreciation	15.000	4 %
Administrative and Other Expenses	4.000	1 %

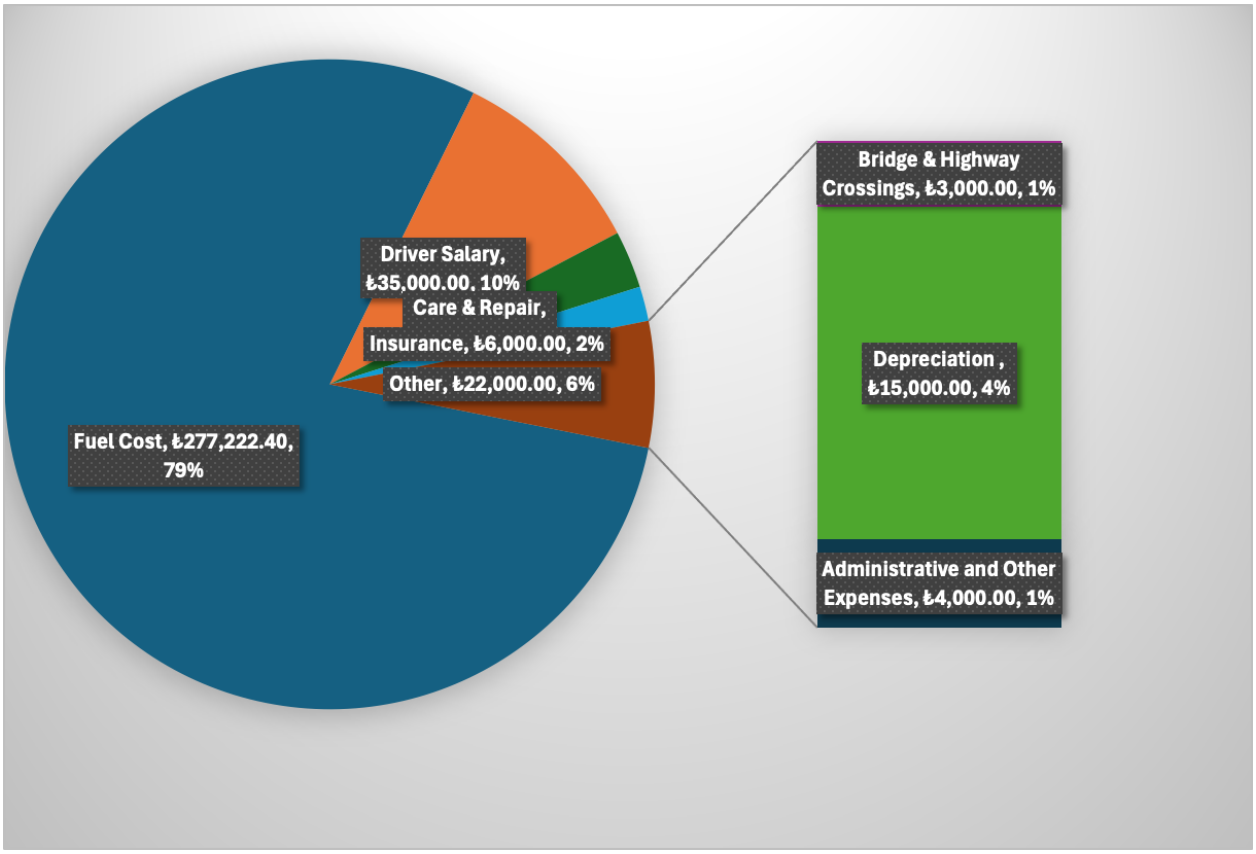

Figure 6. Monthly logistic cost items for a truck

4. A PROPOSAL FOR RAILWAY ROUTES

Design and construction of railways require a substantial effort that optimizes travel speeds, route selection, capacity usage and inter-modality. The mountainous terrain of the southwestern coast of Türkiye poses significant challenges to connect the Mediterranean coast to inland Anatolia.

However, there are many mountainous regions in the world such as the Japanese archipelago, Italian and Swiss alpines and Scandinavian geographies where freight and passenger railways have successfully been implemented and operated. Therefore, difficulties cannot be accepted as excuses for not overcoming them. Compared to roadways, railways have much lower footprint on earth and support a travel choice that is far less dependent on fossil based fuels compared to roadways. The individual roadway transportation as opposed to the collective railway transportation is a major contributor to the lower costs per passenger or per ton of material carried over a kilometer of distance.

The investment costs of railways over such mountainous terrains are costly and can easily reach and exceed 30 million USD per km for a double track electrified railway [14]. The need for tunnels and viaducts along mountain ranges increase the investments costs for railways [15].

Nevertheless, the pressing needs and the associated benefits for better transportation can, in the long run, meet and exceed the costs of investment. To the North of Antalya, lies Isparta, which is already a part of the national railway network and to the northwest of Isparta lies the city of Afyon, which is a major intersection within the national railway network. To the northeast of Antalya lies the city of Konya, which is also a part of the national railway network. The railways leading to and from Isparta and Afyon are not electrified and operate on diesel and diesel-electric powered locomotives. Konya is already a part of the electrified national railway network.

First proposed main route is a diesel operated double track railway connecting Antalya to Isparta and then to Afyon for freight and passenger travel. Second proposal for a main route is to connect Antalya to Konya by a double track high speed railway. Figure 7 shows the suggested routes.

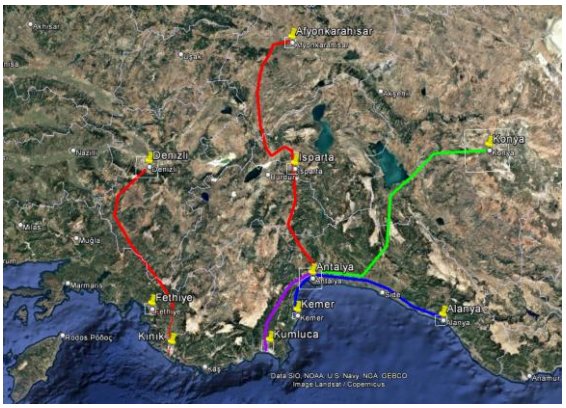

Figure 7. Suggested railway routes.

The electrified railway line can support both rapid speed passenger railways and freight trains for agricultural products. Konya has a population of more than 2 million and a gross domestic product that accounts for approximately 2% of the Turkish economy. A rapid speed connection between the cities of Antalya and Konya can have substantial benefits in terms of trade, tourism, services, agriculture and perhaps low weight and high value industrial products in the future.

The proposed routes, not only aim to connect Antalya inland, but also connect certain districts of Antalya to its city center. A freight line from the district of Kumluca to Antalya, can support the demand for freight transport further as Kumluca is a district with a dense conglomerate of agricultural greenhouses. In order to support passenger travel, connection of the touristic districts of Kemer and Alanya to Antalya can further promote passenger mobility and provide a low cost and a speedy alternative to air travel for travelers that seek to travel inland.

Currently, one can reach from Antalya to Isparta via D350-D650-D685 highways along a 127 km long route or via the D400-D685 highways along a 150 km long route. One can reach from Isparta to Afyon via D650 highway along 161 km route. The average speeds on both roads for passenger cars are 75 km/h. One car reach Konya via 266 km long D400-D687-D330 highway along which the average speed is about 77 km/h for passenger cars. Along the shoreline, the distance between Antalya and Alanya is 133 km and between Kemer and Antalya is 44 km along the D400 state highway with average speeds of 63 km/h and 50 km/h respectively. Distance between Kumluca and Antalya is 94 km with an average speed of 61 km/h. Average speeds are estimated from GPS maps at 06.00 on September 4, 2025 and the average speeds for trucks along these routes are considerably lower.

Approximate length of the shoreline between the districts of Kemer and Alanya is 180 km. More than 17 million tourists arrive at Antalya annually. Together with the native population of the city, a commuter train service that responds to the travel needs of the commuters across this shoreline and provide them with an alternative to current roadways with low average speeds is an important matter to consider. A commuter train service along two tracks with an average train speed of 100-120 km/h along the shoreline between Kemer and Alanya and a regional train from Antalya to Konya with an average speed of 140-160 km/h can be considered. The suggested freight track to Isparta and then to Afyon and the track to Kumluca can support passenger travel as well, with an average train speed of 100-120 km/h for both freight and passenger. Table 3 presents estimate intervals between the mentioned cities and districts. The routes to Konya, Isparta, Afyon and Kumluca will necessitate the extensive use of tunnels, bridges and viaducts, which will increase the costs of construction. The total length of the presented routes in Table 3 for double track railways can reach and exceed 750 – 1000 km resulting in a track length of 1500 km – 2000 km. Approximately, half of this track length will be non-electrified and half will be electrified. With an average cost per route km of 20 Million USD (averaged for both types of route), the cost for such an endeavor can reach 40 Billion USD.

Table 3. Approximate estimates for railway route lengths.

	Distances (km)				
	Konya	**Isparta**	**Kemer**	**Alanya**	**Kumluca**
Antalya	220 - 270	120 - 150	40 - 50	120 - 140	100 - 130
Afyon	-	160 - 190	-	-	-

Choice of speed for the suggested routes will a matter of demand, distribution of stations, track curvature, track slope and the associated costs for earthworks, viaducts and tunnels. Selection and development of route characteristics will be the subjects of detailed studies aimed to provide the optimized solution in terms of investment and operational costs. However, the current condition for land travel for the southwest coast of Turkiye is dependent on roadways without an alternative. Despite being a part of Türkiye, Antalya and the city of Muğla needs to better connected to national transportation networks. The average speeds along the current roadways are low with today's standards. Both the current demand and the unrealized economic potential of these regions demand a viable alternative to roadways that can provide cost effective and higher speeds. Despite the high investment costs to connect the southwest part of Türkiye to the national railway network, the authors think that the benefits gained and the savings that will occur with a shift of the intercity land transportation to railways will much higher.

5. RAILWAYS AS A CHOICE TO REACH THE MEDITERRANEAN

The demand for land transportation at higher speeds can be satisfied with railways and/or roadways. Both modes of transportation are needed based on the specific accessibility and mobility needs of the particular region. Roadways have better prospects for accessibility whereas regional railways have much better prospects for mobility. Increasing demands at high speeds require higher mobility that can be met with highways and freeways. Nevertheless, both types of roadways come at a cost of higher footprint and higher carbon emissions. A four-lane and two-way freeway shown in Figure 8, require a minimum of 26 m width including the inner and outer shoulder lanes, whereas a two-track contemporary railway shown in Figure 9 needs 10.6 m – 12.1 m width depending on the service speed of the train that provides a much higher capacity only requires half that width [16, 17, 18].

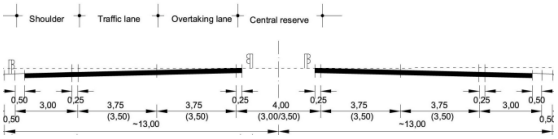

Figure 8. Cross section of a four-lane roadway along a tangent [16].

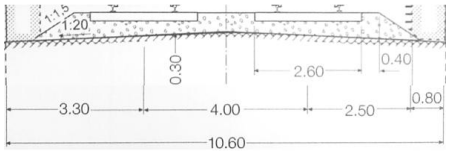

Figure 9. Cross section of a two-track contemporary railway [18].

A freeway lane can offer a capacity of approximately 2200 passenger vehicles per hour. Four such lanes can support the movement of 8800 passenger vehicles per hour. If on average, each passenger vehicle holds 1.5 passengers each, then the total number of passengers serviced via the four lane freeway would be 13,200 passengers per hour. On the other hand, a contemporary railway track managed with the state of the art methods and proper station design can support passenger trains with less than minute headways with contemporary standards. If 12 such trains per direction per hour were to carry 600 passengers each, the total number of passengers that can be carried in total would be 14,400 with a much lower environmental cost when compared to roadways.

In terms of freight, unit trains composed of agricultural products can reduce the trucks on the roadways. A freight train travelling at 100 km/h with 100 wagons can replace more than 100 trucks travelling across the Taurus mountain ranges at average speeds less than half the speed of the train.

Benefits of a railway network can be realized with open minded far reaching policies. Sole reliance on airways to connect Antalya as an alternative to roadways cannot solve the mobility issue alone and is a costly alternative. Construction of freeways as alternative to the existing divided state roads, will not only cause irreversible damage to the pristine nature of the region but also will not reduce the operational costs of transportation.

Carefully studied and evaluated railway routes that is respectful to the many national parks and historical routes present in the region is another challenge that needs to be overcome. Three of the fifty national parks in Türkiye are within the Antalya region along with countless natural heritage sites, mountain ranges, waterfalls and historical travel routes. Figure

10 shows protected areas of significant natural and historical relevance that must be carefully considered when planning the railway routes. Figure 11 presents the distribution of national parks across Türkiye.



Figure 10. National parks and protected areas in Antalya [19].

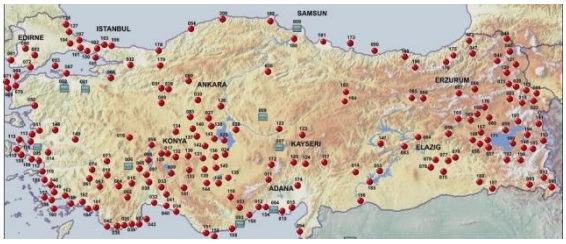

Figure 11. National parks of Türkiye [20].

6 CONCLUSION

In this study, a feasibility analysis is made on the possible railway line starting in the city of Antalya in terms of calculating logistical costs of vegetables shipment between Antalya and İstanbul. Possible economic impact is calculated based on current transportation costs using highways, and railways. Antalya, which is connected by roadways and airways needs railways as well to address the mobility needs of the region based on its tourism and agricultural potential.

Railways is a viable land transportation alternative compared to roadways. The operational costs and variable costs associated with freight and passenger transportation through railways are lower than roadways. Dependence of roadway transportation on fossil fuels is much higher than the railways. Railways, with a lower footprint compared to roadways make it a viable option in comparison to roadways.

Historically, railway routes towards Türkiye's northern coast have been developed during the period following the declaration of the Turkish Republic in 1923 under difficult conditions. The routes to the cities of Samsun and Zonguldak through the Black Sea Mountains were opened in early 1930's with the day's technology and all the economic hardships of the newly found republic. Given the state of our technological and economic abilities today, there is no reason why the same development cannot or should not take place to our Southern Coast.

With a correct and long reaching planning policy, railways can support and enhance the already present potential of the region. Further studies will concentrate on possible solutions to build land ports for the agricultural products throughout Antalya that can be used to collect and convey the local produce at centralized hubs to be transferred inland. The studies will also concentrate on determination of routes and route optimization with respect to service speed and route length.

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BRIEF RESUMES

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