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Saudi Rail Road Management

(Final Paper)

By

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Abstract

Public transportation planning and development are undergoing continuous changes often prompted by both external factors and policy-directed responses. The role of public transit, particularly rail transit, becomes increasingly importance with the changing demographic and economic pattern. The trend of returning to urban living for e.g. has significantly increased the demand for efficient public transportation in urban centers. With Saudi Arabian government emphasizing on local tourism to retain the flow of money within the Kingdom: This paper applied vector-based model to investigate how non-spatial and spatial data can be integrated within a multi criteria decision framework to formulate and evaluate the optimum rail route between central province and Asir province of the Kingdom. Multi-criteria analysis was performed on a set and specific objectives, criteria and data requirement. The set criteria proposed are in line with the objectives to improve public transportation and facilitate tourism in the region. The result showed the best optimum rail route to connect Riyadh and Abha considering all the criteria's to do so. Based on the finding, the paper made some recommendations on the use of GIS and other variables to be considered in future studies.

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Introduction

The advances in technology relating to computing have revolutionized the ways in which many companies can use the data at their disposal to better do business. “Old tech” industries are no exception, so it should come as no surprise that relatively new technologies such as Geographic Information Systems (GIS) could be useful to one of the world’s first major capitalized industries, the railroads. For as long as there have been railroads, there have been ways to track the difficulty of operation of key rail segments. Railroads must know what effects that grade, curvature, and other factors will have on their operations so that they can plan train lengths and locomotive usage accordingly.

GIS, however, provides tools which were formerly unavailable (or that would have come at too great a cost) to analyze rail lines. A sort of “overview” map can be generated for a rail line by taking into account various factors, rating them, and to combine the factors into one overview map. Perhaps the best side-effect of this approach is that it is readily available to anyone with access to the software and data resources—meaning that even small short line railroads are still capable of generating this analysis for their own lines, without having to depend on outside data resources or contractors. The process is also relatively simple enough that different maps could be generated for different circumstances, such as severe weather, problematic areas etc.

Study Area

The study area for this project is a line between Riyadh and Abha. Riyadh is the capital of Saudi Arabia. It comes under central province and is the largest homed to over 4,260,000. On the other hand Abha is the capital of Asir province in Saudi Arabia. It is situated at 2,200 meters (7,200 ft) above sea level in the fertile mountains of south-western Saudi Arabia. Its mild climate makes it a popular tourist destination for Saudis.

The Saudi government has been promoting Abha as a tourist destination and has created events, such as the Abha Festival during the summer, to draw people to the city. Events are organized to attract visitors to discover the city and its surroundings, such as sporting events, shows, exhibitions and musical performances by famous Arabic poets and singers. Being the most favorite tourist location is Saudi Arabia; Rail Routes connecting other Saudi cities to Abha will be of strategic importance.

Literature Review

Lack of scholarly work on rail road considering GIS made it difficult to acquire literature particularly pertaining to this subject. Some have certainly occurred, however; the ESRI website cites the effective use of GIS in several aspects of railroad operations and planning. The practice of buffering features around rail corridors is not new to rail analysis; it often is useful in cases involving planning for passenger stations in populated areas. A recent study involving the rail transit system MARTA in Atlanta, Georgia, buffered rail stations to make a case for accessibility in populated census tracts along a proposed new rail line.

Geographical Information Systems (GIS)

Geographical information systems are powerful tools for recording, analyzing, and displaying spatial phenomena and their relations. They are widely used for mapping and studying current situations and problems, but they can also be used by historians to map past conditions and changes. There appears to be no standard definition of a GIS in the literature. The Chorley report which has set many standards and is responsible for many co-coordinative initiatives describes a GIS as an “information system where the data have a geographical dimension”. In other words, the data can be related to some point somewhere on the earth’s surface.

A GIS is, in essence, a computer-based spatial decision-support tool that permits the input, management, analysis, output and dissemination of geo-referenced data and information. See, for example, Burrough, 1986 and Longley et al., 2005. Initially developed in the 1980s to help manage natural resources and conserve the environment, GIS is now a tool that finds application in most fields of human endeavor at local, regional and global levels, such as sitting development, agricultural soil suitability analysis, management of urban utilities, disaster management and the monitoring of desertification.

It is generally agreed that about 80 per cent of all data in current use, in virtually all fields of human endeavor, contains some spatial element or dimension. Traditional information systems for decision support, commonly referred to as management information systems (MIS), were designed to handle only non-spatial data such as salary and personnel data, stock inventories, bank account management data and so on. However, it is now recognized that even these traditional systems could have better utility if the spatial component of the data they handle could be included in the analysis.

For instance, business firms have long recognized that the knowledge of the geographic location and extent of a market is crucial in planning and evaluating marketing strategy. Examples of how such knowledge can be used include analyzing variations in sales penetration, determining sales territories, evaluating differences in promotional response, determining the location of new facilities, pinpointing promotional efforts, forecasting sales and analyzing market potential (Viswanathan,2005). Considerations such as these have led to the increased use and popularity of geographic information systems (GIS).

The utility of conventional MIS, which are now evolving into decision-support systems, can be improved by incorporating the analytical and visualization capabilities of GIS. The aim is to enhance communication texts and tables by visual presentation of data and information, and thereby to ensure that accurate results are obtained quickly, which in turn lead to better and more informed decisions. It is for this reason, among others, that the use of GIS for business is growing rapidly.

Geographical Information Systems (GIS) and databases provide essential tools and flexibility, allowing the management of land resources for different functions and uses.

Hence, GIS and associated databases are widely used in agricultural development, natural resource management, environmental science and land use planning and development (Jolly et al., 2001; Gustafson et al., 2001; Brown et al., 1998; Gar-On Yeh and Li, 1998). Surveys utilize computer systems to store, process, interpret and retrieve vast amounts of data generated from the survey that can be manipulated and displayed in the GIS. The volume of information generated in surveys is usually large, and the information generated is complex and interrelated. All points and data are

geographically related and displayed on maps to provide information on the location and area studied.

Presently, GIS application is gaining popularity and becoming a necessity in environmental studies. However, due to the high cost of commercial software, the use of GIS is limited, especially in developing countries such as Saudi Arabia.

Railways in Saudi Arabia

Rail transport in Saudi Arabia is managed by Saudi Railway Organization. It provides freight service on three main lines, 1018 km total, which connect Riyadh with Persian Gulf port of Dammam. Their passenger trains operate between Riyadh and Dammam. There are plans for extending the network to the Red Sea port of Jeddah and, eventually to the borders of Jordan, Yemen and Israel, and assumingly all the way to Egypt.

The first railway in modern Saudi-Arabia was Hejaz railway, running from the border of Jordan to Medina. This railway opened in 1908, was shut down in 1915. This line was narrow gauge.

Modern Railroads were introduced in Saudi Arabia after World War II, to facilitate transport of goods of Saudi ARAMCO from Persian Gulf ports to warehouses in Dhahran. Construction started in October 1947 and the first line was inaugurated on October 20, 1951. Initially, it was run by ARAMCO, but subsequently transferred to the state. Since 1968, it operates as a public corporation. Several development projects have been completed thereafter – such as extension of the line to Riyadh, construction of several passenger terminals and opening of a dry port in Riyadh.

Currently Saudi rail network consist of the following main lines:

- **Line 1:** Dammam – Abqaiq – Hofuf – Riyadh (449.11 km), used by passenger trains.
- **Line 2:** Dammam – Abqaiq – Hofuf – Haradh – Al Kharj – Riyadh (555.951 km), used by freight trains
- **Line 3:** Dammam Port Line (12.854 km)

Saudi Railway Organization is planning to enhance its network in the following directions:

- **The Saudi Landbridge** – construction of a 950 km line from Riyadh to Jeddah and 115 km from Dammam and Jubail, which will connect Persian Gulf with Red Sea
- **The North South Railway**-which is going from Riyadh via Buraidah, Hail and Al Jawf to Al Haditha, with a branch to Ras Azzwar at the Gulf coast and some minor branches to bauxite and phosphate mines. It is mainly considered for mineral transport but also for general freight and passenger transport.
- **Line to Makkah and Madinah**- will be connected with the network at Jeddah, to provide a safe and comfortable transport for Hajj pilgrims arriving via Jeddah.

Objective

Furnishing most efficient as well as effective rail route between Riyadh and Abha

Methodology of Study

The required information and data was obtained through several channels Based on the issues outlined above, rigorous search was done to come down to data clearinghouses with relevant information. After data was collected, it was imported into ArcGIS as required.

Data Analysis: Firstly, the collected data was aligned as required in right form. Then, Data analysis and path recognition was performed on ArcGIS.

Selection Criteria

The proposed Rail Route is to be constructed with keeping the following points in mind:

1. The Rail Route should be at least 10 Km away from Protected Areas.
2. The Rail Route should be at least 1 Km away from all water bodies.
3. The Rail Route should be at least 1 Km away from Highways and should not cross them

While developing the route using ArcGIS the above conditions were to be followed and smallest route complying with the above conditions was to be constructed.

Data and Source of Data

Data required for the study including current rail routes in Saudi Arabia, road network across the Kingdom, water bodies all over Saudi Arabia, Saudi Map dividing different provinces as well as world Map. Current rail route showed all the existing functional rail lines in the Kingdom of Saudi Arabia. Road network consisted of both secondary as well as primary routes connecting cities in the Kingdom. Water bodies consisted of all the permanent as well as temporary water bodies. It was not simple to collect the data as it is impossible to get data from agencies in Saudi Arabia like any other developing countries.

To gather the required data, online search was done and with some luck the required data was found on two different websites. All the protected areas including Bird sanctuaries, Nation Nature Reserves, protected Area, Wildlife Management Area etc. was found on http://www.wdpa.org; World Database on Protected Areas incorporating the UN list of protected Areas in each country. On the other hand data on existing Rail Routes, Road network and inland water bodies was found on http://biogeo.berkeley.edu/bgm/gdata.php. With these data we were able to implement our objectives to find the best route between Riyadh and Abha.

Analysis/Discussion

After collecting the data we used one of the available GIS software's to find the best rail route between Riyadh and Abha; keeping in mind the needed criteria. With very little knowledge on any GIS software, ArcGIS from ESRI was preferred due to its user friendliness and easiness to understand.

All the data downloaded for this study were transformed into ArcGIS usable format. Once the data was ready to use, all the necessary data for analysis was imported into ArcMap. One of the layers was for Kingdom of Saudi Arabia with administrative areas as shown in Figure-1

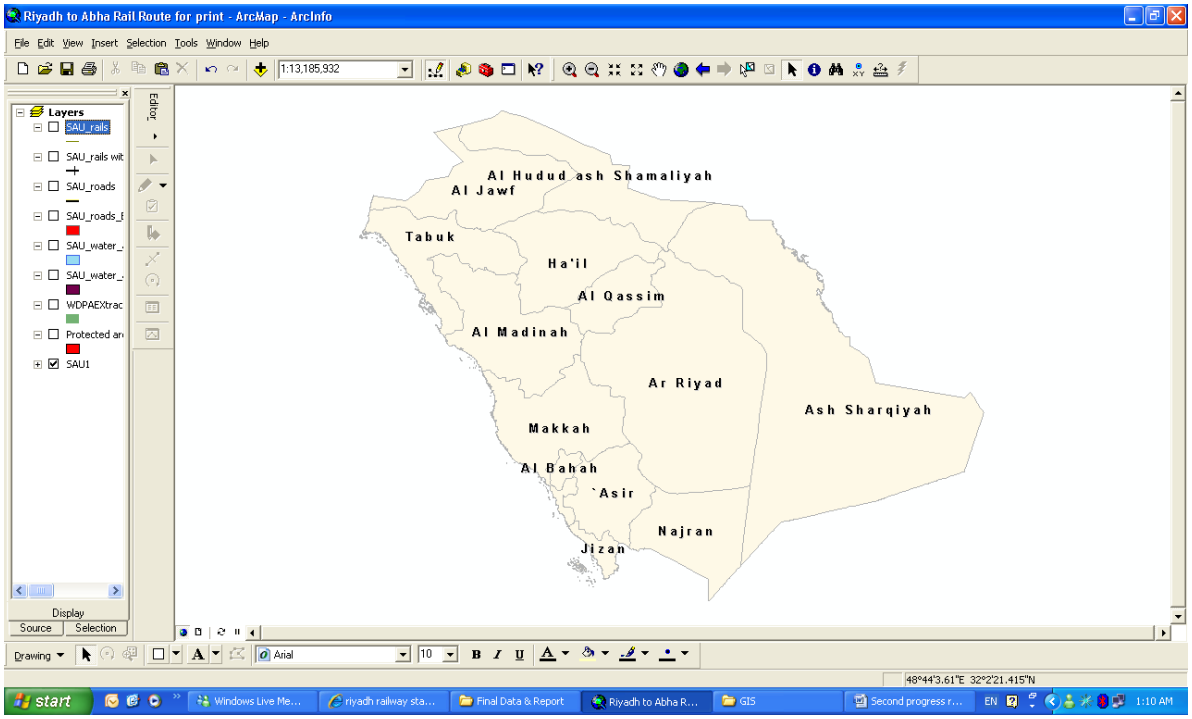

Figure-1 Map Showing Saudi Arabia and its regions

After activating the administrative layers of Saudi Arabia, road network layer was activated as shown in Figure-2.

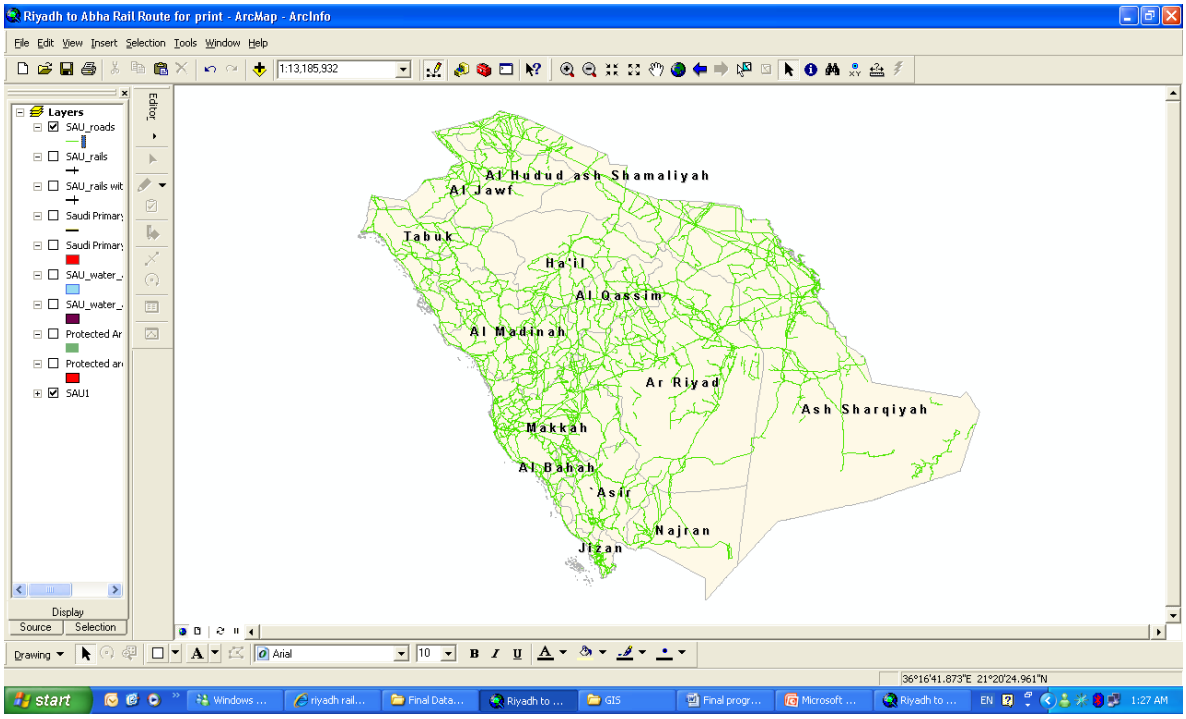

Figure-2 Map Showing Road network in Saudi Arabia

As the required roads were only primary roads i.e. Highways all over Saudi, secondary roads were eliminated and the layer was renamed Highways Figure-3.

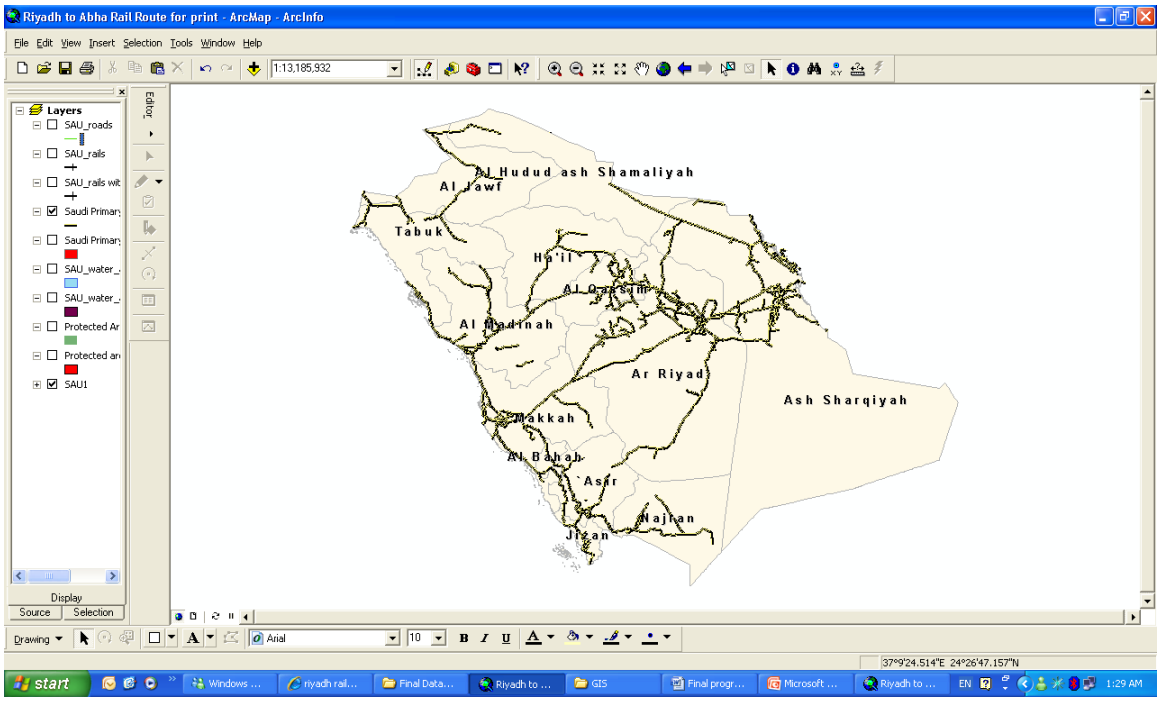

Figure-3 Map showing highways in Saudi Arabia

Later to see the protected areas highway layer was deselected and protected area layer was activated Figure-4. We can see all the protected area in Saudi Arabia, be it Bird sanctuaries, Nation Nature Reserves, Wildlife Management Area etc.

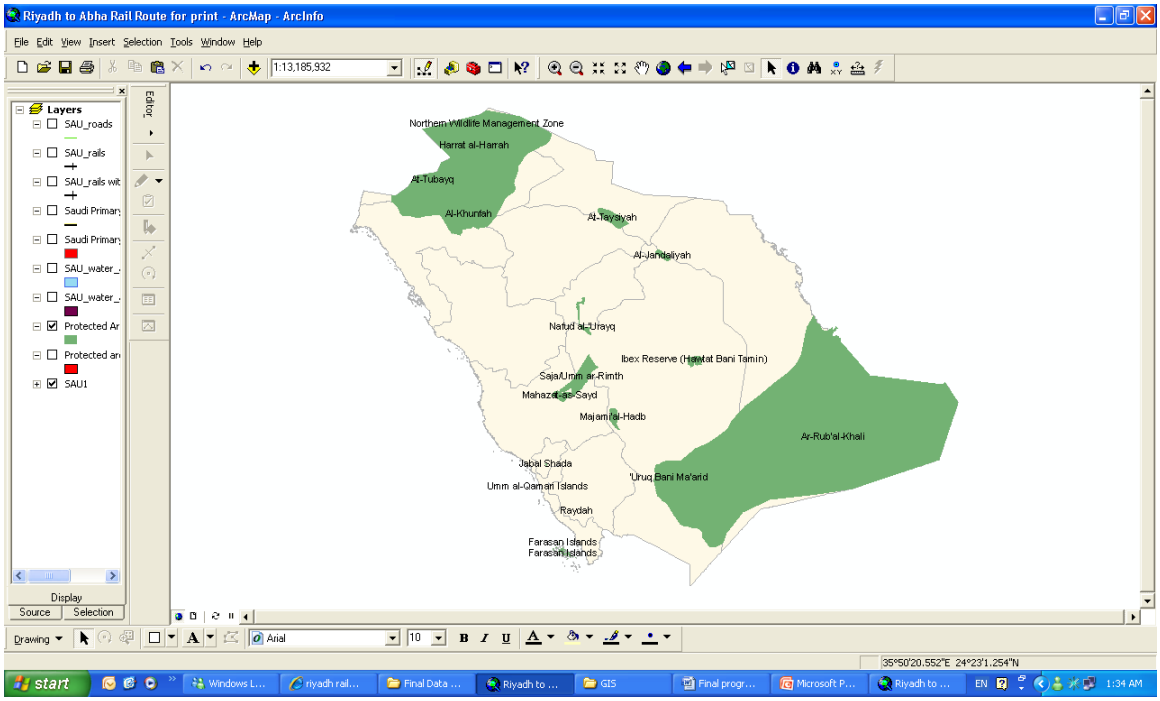

Figure-4 Map showing protected areas in Saudi Arabia

To see the water bodies in the Kingdoms deserts. Protected area layer was deselected and water bodies layer was activated Figure-5.

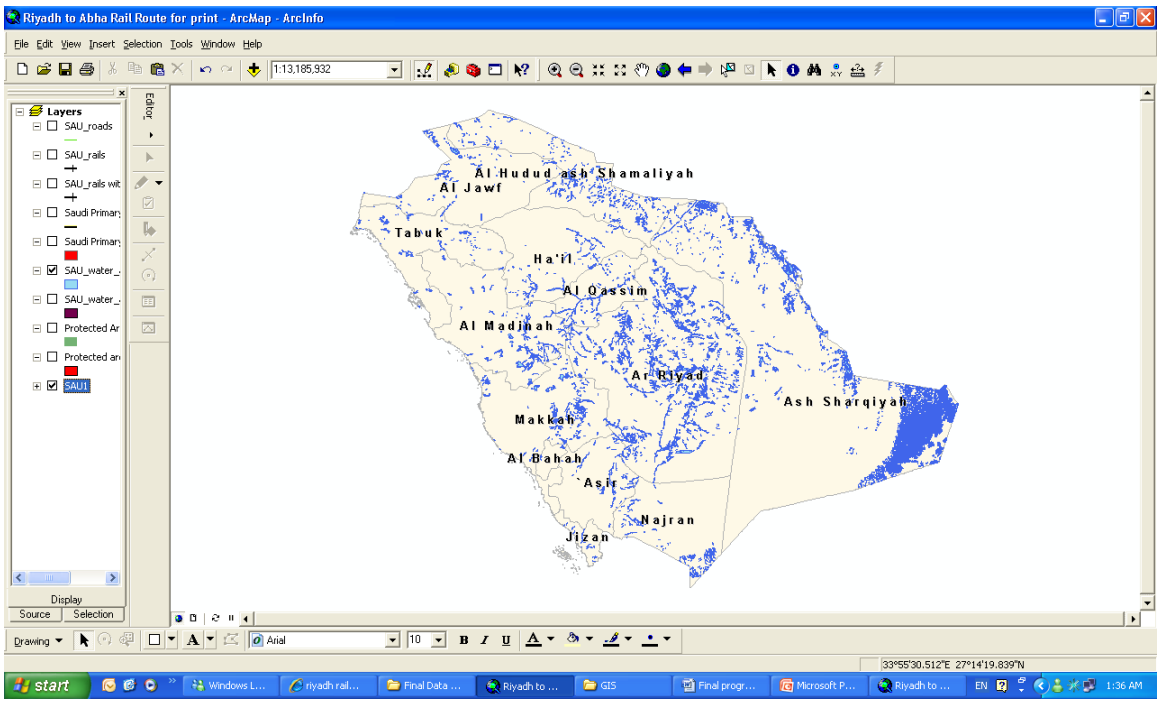

Figure-5 Map showing different water bodies in Saudi Arabia

Water bodies' layer was deselected to select the most important layer i.e. the existing rail road network in Kingdom Figure-6. This route is to be extended to Abha.

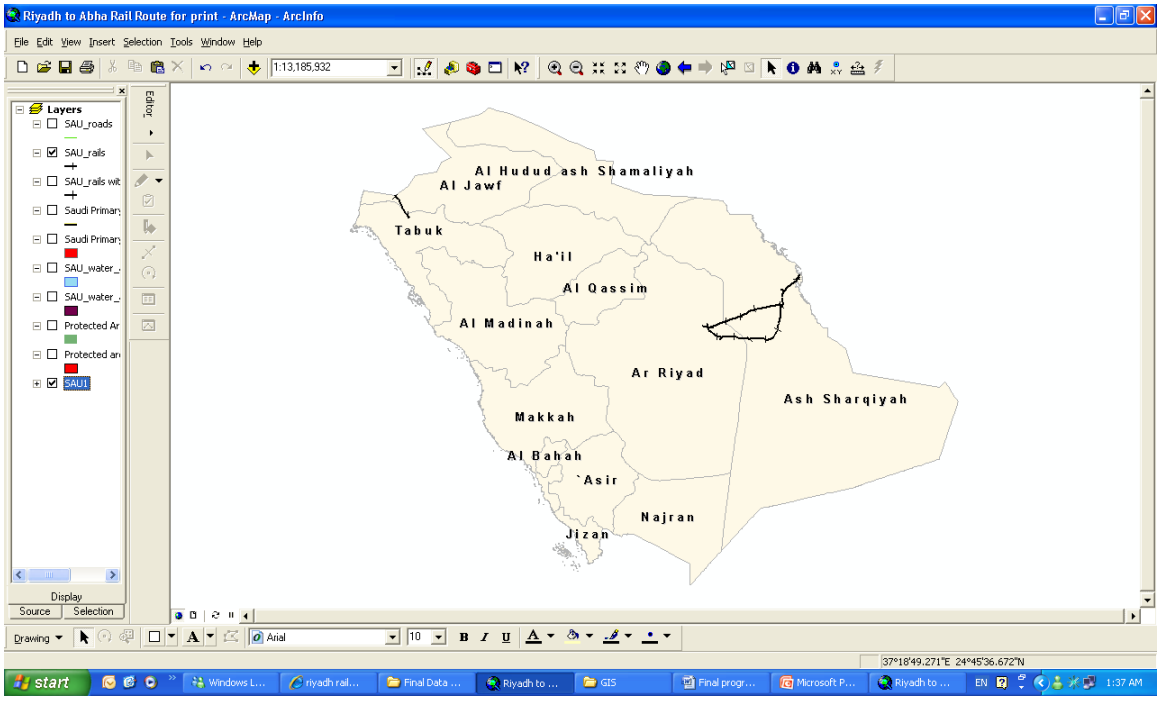

Figure-6 Map Showing Existing Rail Route in Saudi Arabia

Three points were designated and labeled as Riyadh Railway station, Abha crossing (this crossing is proposed crossing not an existing one) and Abha Railway Station (Again this is also proposed station in Abha). All the locations were designated based on the actual Latitude and longitude available online. Abha crossing was chosen as it is the only place from where the rail line can cross without disrupting Highways.

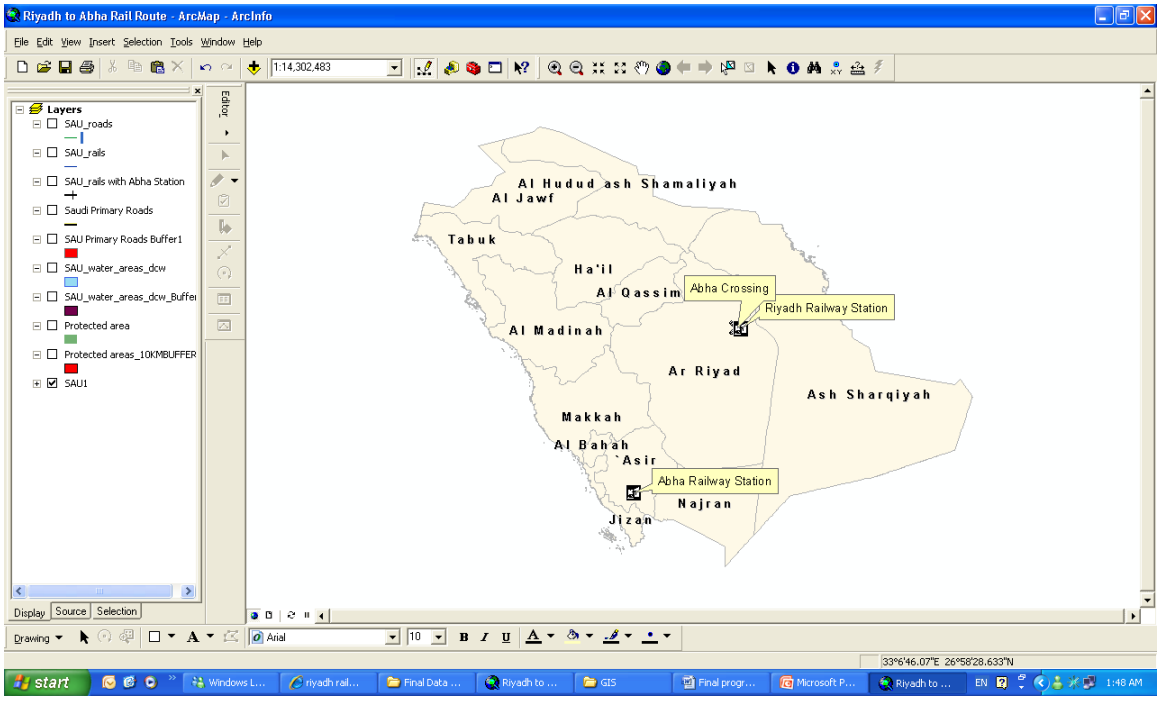

Figure-7 Map Showing location for Riyadh, Abha railway station along with Abha Crossing

Following Figure-8, 9, & 10 show buffered highway, protected areas & Water bodies as per the criteria.

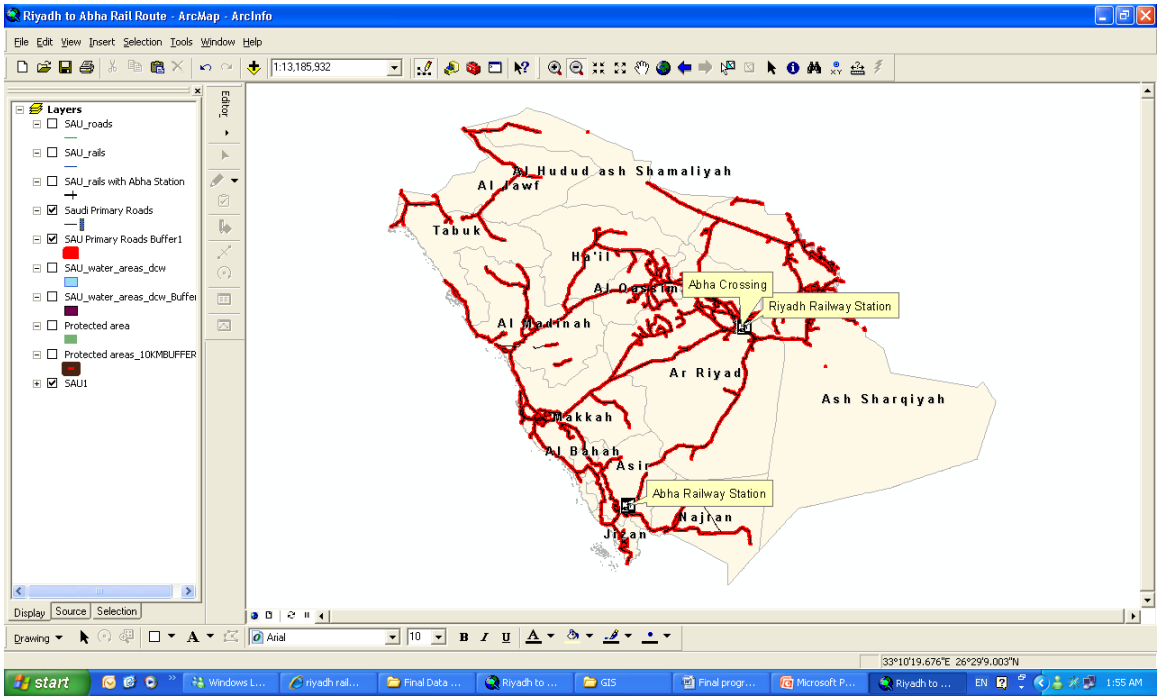

Figure-8 The result of 1 km buffer of the highways in Saudi Arabia

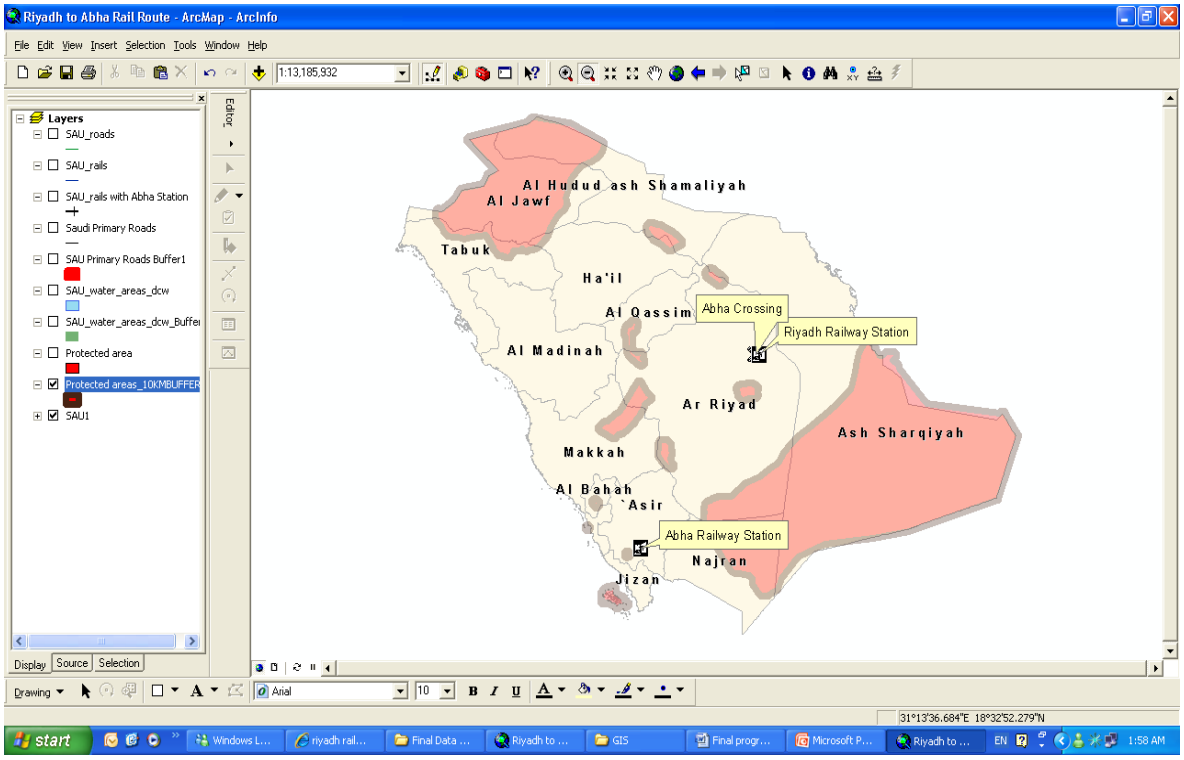

Figure-9 The result of 10 km buffer of the protected Areas in Saudi Arabia

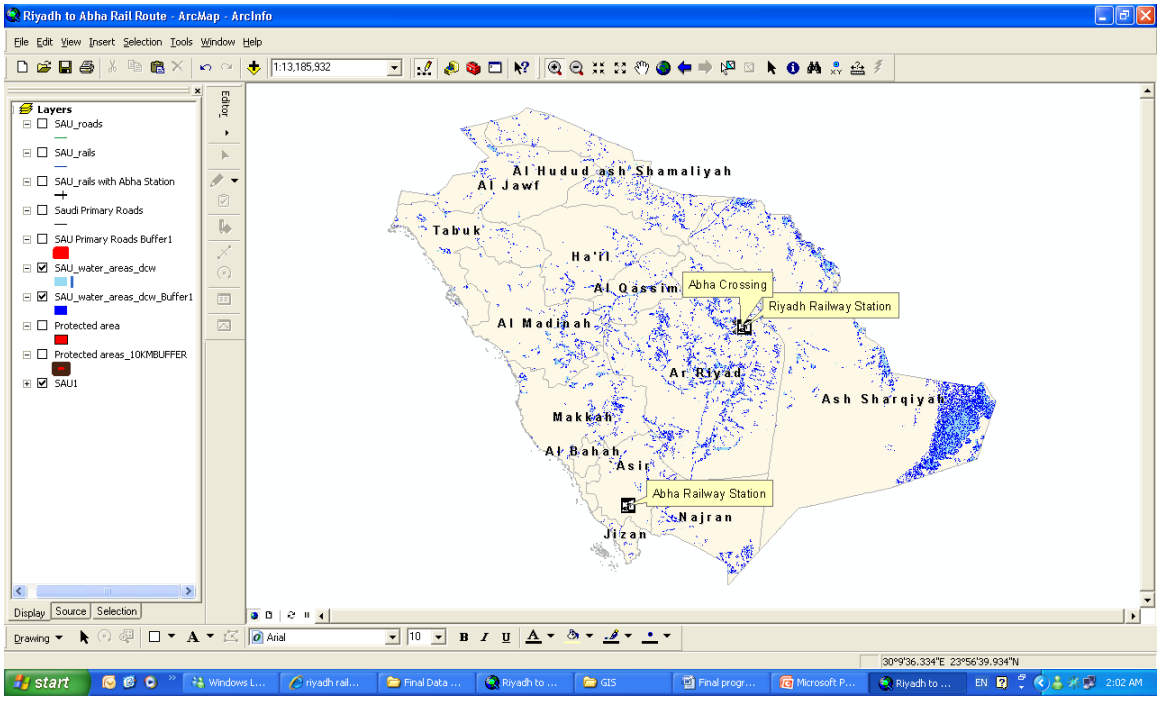

Figure-9 The result of 1 km buffer of all the water bodies in Saudi Arabia

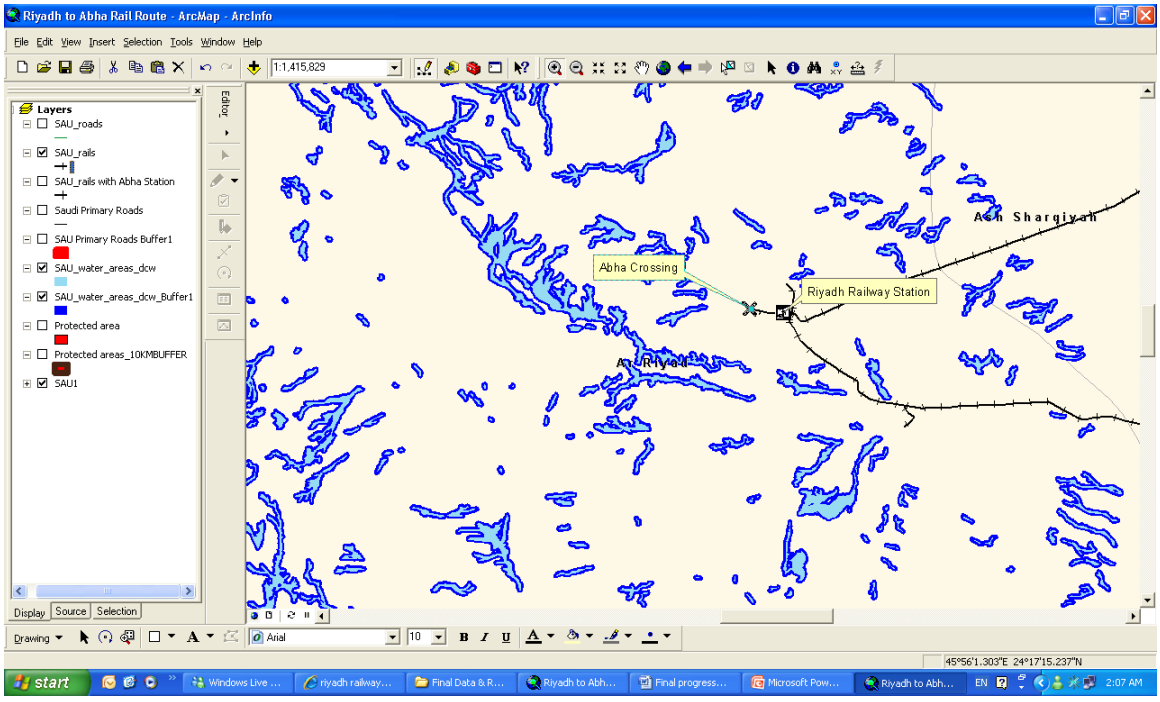

Figure-9a Zoomed result of 1 km buffer of all the water bodies in Saudi Arabia

To give a better image of how all the activated layers look we can see it in Figure-10

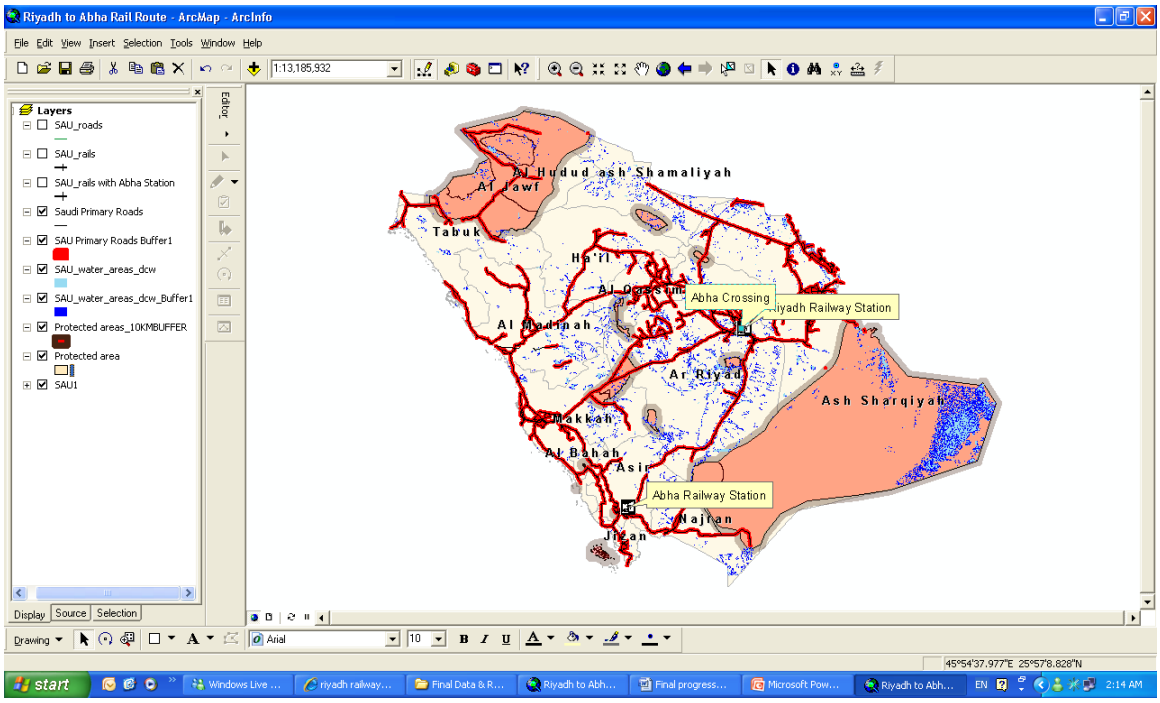

Figure-10 Map showing all buffered layers activated

After activating the entire buffered layers, the optimum rail route from Riyadh to Abha was found with the tools available in ArcGIS. We found the route as shown in Fgure-11.

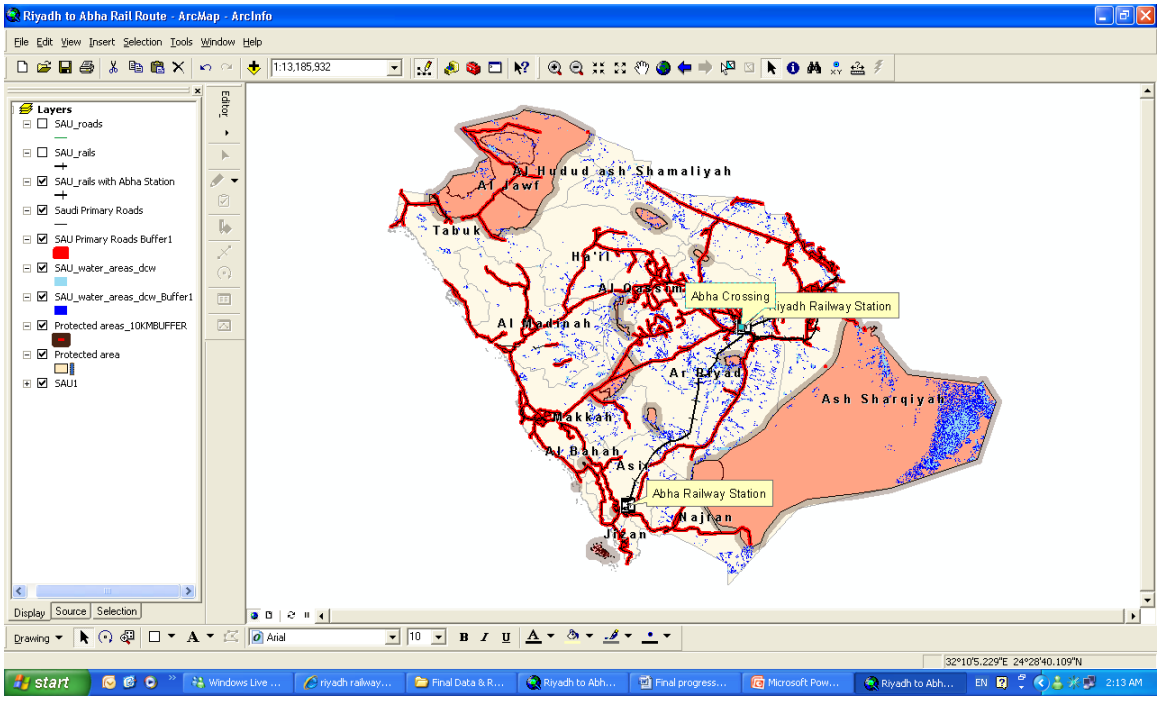

Figure-11 Result showing the optimum route between Riyadh railway station and Abha Railway Station.

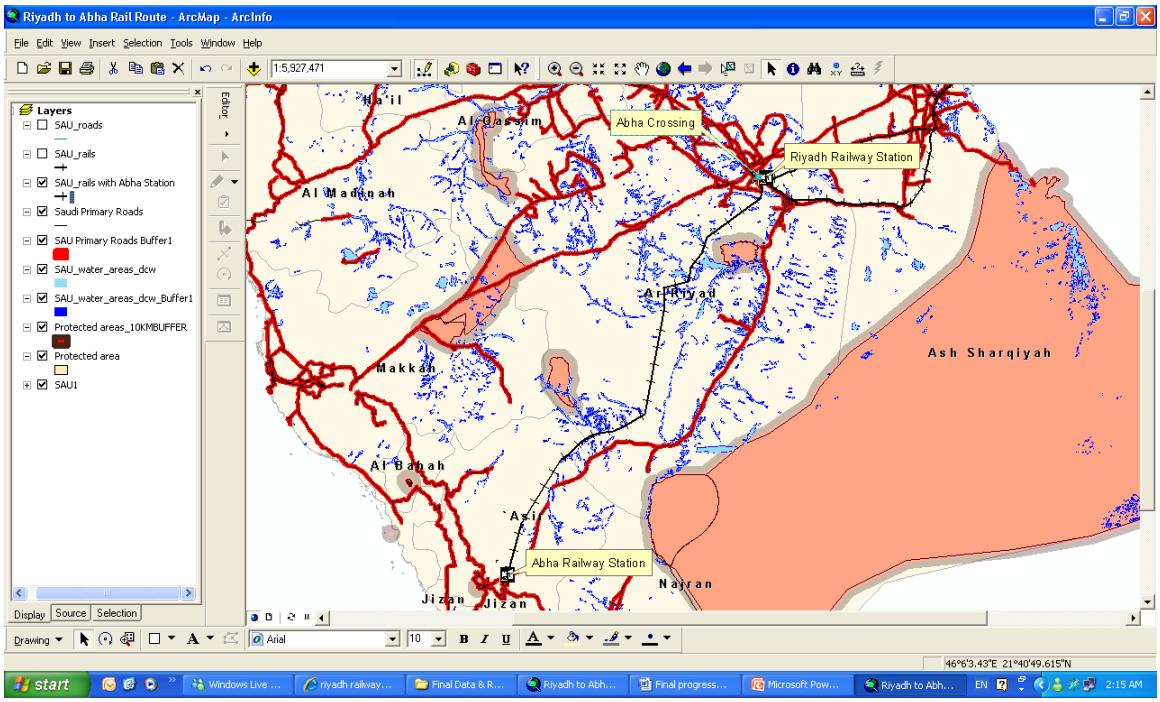

Figure-11a Zoomed layer showing the optimum route between Riyadh railway station and Abha Railway Station.

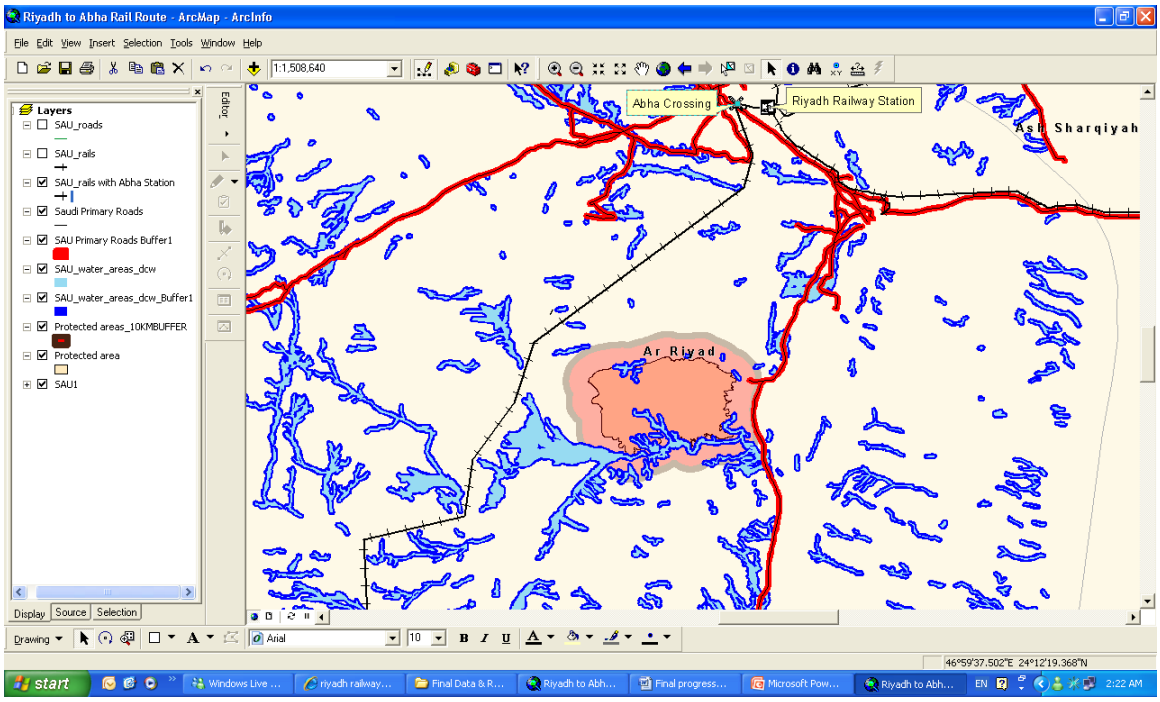

Figure-11b Much better view of optimum route between Riyadh railway station and Abha Railway Station.

Optimum Rail Route

- Distance between Riyadh Station and proposed Abha rail Crossing is only around 12 KM.
- Distance between Abha Crossing and Abha Railway station is around 876 Km.
- The optimum Distance between Riyadh Railway station and Abha Railway station is around 888 Km.

Study Limitations

There were 2 major constraints in this study:

Data collection: As most of the data in developing countries are considered as "sensitive information" outside the concerned organization. It was impossible to get relevant information from the respective organization.

Using ArcGIS: With limited knowledge of ArcGIS, it took considerable time to study and understand the software and use ArcGIS in best possible way to achieve the objective. However, ArcGIS is an excellent user friendly system.

Conclusion

The study has shown that a GIS is a good tool to help aid in finding of suitable rail rout between cities sites for tourist activities. The optimum rail route is selected by applying different criteria's. GIS made the process of selecting the route simple and efficient as it was very easy to locate the right path and then recommending it. The biggest strength of using a GIS program for optimum route identification is that it is very quick and outputs good results that can be viewed and understood. Many criteria can be factored into the creation of a map which allows for detailed study if necessary data are available. It is recognized that availability of data really dictates the level of detail of a GIS analysis. Further analysis can be carried out if necessary data are available and in the right format and standard. Another advantageous capability of GIS is that more criteria can be added easily as more information becomes available.

Finding and Recommendation

- Presently, GIS application is gaining popularity and becoming a necessity.
- However, due to the high cost of commercial software, the use of GIS is limited, especially in developing countries such as Saudi Arabia.
- There are clearly wealth of other variables that may be at play. E.g. dense population, natural elevation.
- Further analysis can be carried out if necessary data are available in the right format and standard.
- More criteria can be added easily as more information becomes available

Acknowledgments

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