# Strategic Oil Export Networks

## *Bypassing the Strait of Hormuz*

## Overview

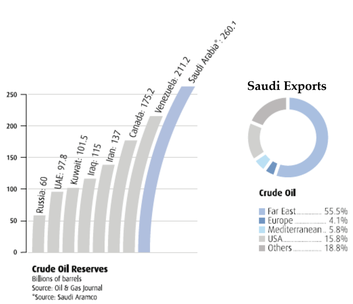
The Strait of Hormuz is the most important node in the global oil transit network. Nearly 35 percent of sea-borne oil passes through the Strait and a disruption would have a devastating impact on world energy markets.

Saudi Arabia occupies a unique place in the industry because it is not only the world's largest oil producer and holder of reserves, but it is the only country that can throttle production up or down depending on demand. If Saudi Arabia's oil export capabilities were curtailed, the price of oil would quickly skyrocket—leading to crippling increases in energy prices across the world. Saudi Arabia itself would also be in a precarious situation as the government depends primarily on petroleum revenue to run its country.

This project explores Saudi Arabia's options for oil exports in the event of a closure of the Strait of Hormuz. It uses Geographic Information System (GIS) software to determine the least-cost path for two hypothetical petroleum pipelines in Saudi Arabia.

## Where does the oil go?

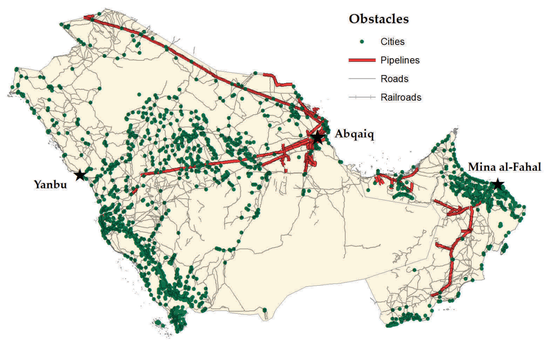
Saudi Arabia produces roughly 10 million barrels of oil per day, yet it only consumes about a quarter of that amount. The rest of it is exported to the world markets, mostly to the Far East. Saudi Arabia's oil and gas resources are





located in the eastern part of the country along the Persian Gulf. The vast majority of its crude oil is processed in a facility in Abqaiq before being piped to the ports of Ras Tanura and Ras al-Ju'aymah on the Persian Gulf.

After making it to the ports, the crude oil is loaded onto large tankers which then move through a two mile shipping lane in the Strait of Hormuz. The tankers then sail through the Gulf of Oman until reaching the Arabian Sea, when their paths diverge depending on their final destination. While other countries export a sizeable amount of oil via pipelines, Saudi Arabia is highly dependent on maritime exports — primarily through the Strait of Hormuz.




## Pipeline Planning

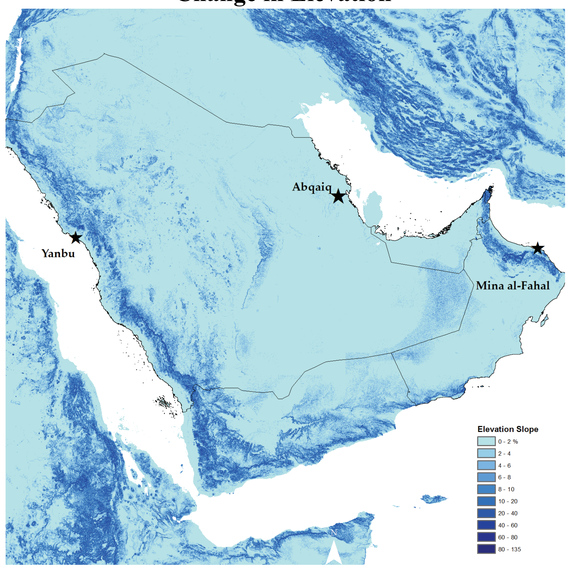
Pipeline construction is complex and costly. The planning and design phase seeks to minimize costs and prevent potential disruptions during construction. Factors that influence the eventual route include terrain, slope, elevation, land cover, access and right of way, weather, and overall length.

The ideal line would be the shortest path between the origin and destination points that successfully avoids any off-limits areas (for example, a populated area or a historic ruin) and that avoids challenging terrain. While adding to the length of a pipeline may be costly in terms of extra materials and added labor, it may be preferable if the shorter route goes through rough terrain and high slope areas. These areas would be more difficult to build on and would require additional operating costs through the life of the pipeline (i.e. pumping stations).

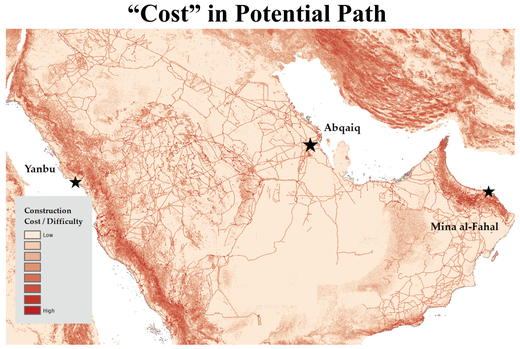
In my analysis, I chose two potential pipeline paths that Saudi Arabia could construct in order to ensure their oil export capabilities and reduce dependence on export via the Strait of Hormuz. Both originate in Abqaiq, where the vast majority of oil is processed to make it suitable and stable for export via tanker. One destination is the port of Mina al-Fahal, in the north of Oman near the capital of Muscat. Oman was chosen for its relatively stable government, its close proximity to Saudi Arabia, and its port access to the Arabian Sea without the need to pass through the Strait of Hormuz.

The second destination is Yanbu, an existing port facility on Saudi Arabia's Western border along the Red Sea. This pipeline would mirror the existing East-West pipeline, enabling export to the world without crossing any national boundaries.

**Change in Elevation**




**"Cost" in Potential Path**



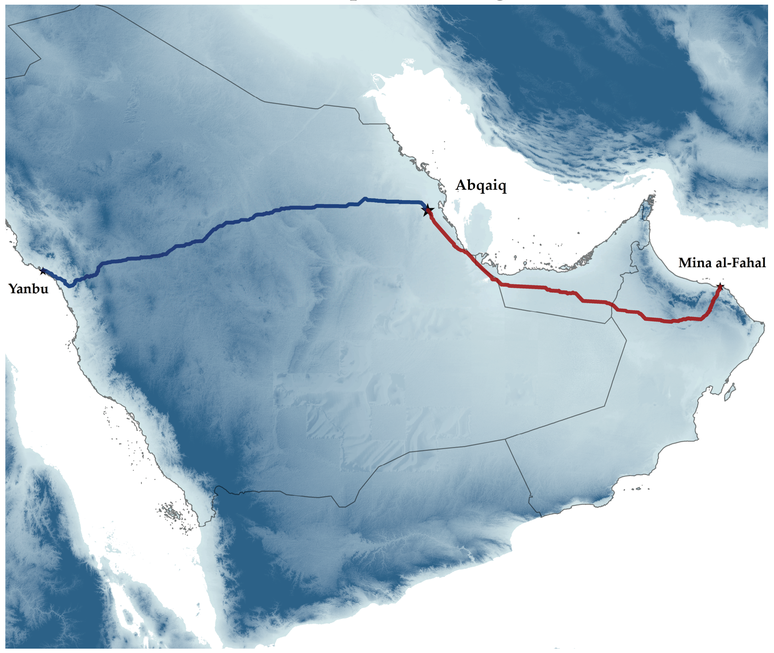

## Outcomes

The final map shows the hypothetical least-cost path for the two pipelines, based on the weighted criteria. GIS software tabulates the "cost" for each point on the map and then traces backwards from the destination to find the least-cost path. The Abqaiq to Yanbu pipeline is relatively direct, somewhat closely following the existing pipeline. The Abqaiq to Mina al-Fahal pipeline skirts through the southern part of the UAE before crossing through Northern Yemen. Both pipeline paths varied significantly as I weighted the variables differently—for example, I downgraded the "cost" of crossing existing roads and railroads to achieve a more accurate and less lengthy least-cost path.

## Limitations

The biggest issue is the availability of high quality, precise data for the terrain and location of environmental and human barriers. Another significant limitation is the nature of weighting the variables—each project would weight them differently and there is no industry standard weighting to base the analysis off of. Finally, a real world project would take into account a higher number of variables and would apply other rules to help the construction phase, such as minimizing angles and sharp turns, maximizing straight lengths, and designing all road and utility crossings at 90 degree angles.

**Final Pipeline Routing**

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**Class:** GIS for International Applications

**Instructors:** Barbara Parmenter and Patrick Florance

**Data Sources:** Digital Chart of the World (DCW) 1992, Database of Global Administrative Areas (GADM) version2—2010, Global Land Cover 2000, Central Intelligence Agency World Factbook—2012, Energy Information Administration—Saudi Arabia Analysis and World Oil Transit Chokepoints—2012

**Projections:** WGS 1984 UTM Zone 38N