GIS BASED PIPELINE ROUTE SELECTION BY ARCGIS IN TURKEY

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INTRODUCTION (a)

Linear Structures (Pipeline – Road – Channel - Railway)

Huge Budget – Long Lasting Time - Great Manpower

Environmental – Social – Economical - Political ISSUES

How to eliminate or decrease these issues?

OPTIMUM ROUTE
EFFECTIVE ROUTE PLANNING

Data Management – Queries - Analysis

Raster Based Geographical Information System (GIS)

Structures such as roads, natural gas-oil pipelines, irrigation-drying channels, power lines and railways are called linear structures. These structures require huge budget, great time and manpower. So, these are costly projects. In addition to this, these projects have environmentally, social, economically and politically issues. These issues can be eliminated or decreased via effective route planning. For effective route planning, raster based geographical information system should be used.
INTRODUCTION (b)

Determining the best route through an area is one of the oldest spatial problems.

Till recently, route determination was created on the topographic maps manually.

But nowadays, GIS technologies are used effectively in route determination process.

Route selection is a critical first step in the process of pipeline design and construction and has a potential significantly impacting the construction and operation of the pipelines.

Effective route selection process is very important for minimizing economical lost.

Worldwide, pipelines transport natural gas, crude oil, and finished petroleum products over long distances within countries and across borders to meet energy needs.

Choosing the shortest, most direct route is always a goal for capital expenditure reasons, but many important goals exist simultaneously in the route selection project and at times these goals may conflict.

Geophysical, environmental, political, social, economic, and regulatory factors interact to define the route possibilities.

This is particularly true as more exploration takes place in more remote areas of the world.
PIPELINE ROUTE SELECTION WORKS–IN THE WORLD

Developed Countries
- GIS
- Remote Sensing
- Digital Databases
- Queries
- Analysis

Optimum Route

Developing Countries
- Manually,
- Classic Methods,
- Paper Maps,

The Shortest Route
Turkey has an important geographical position in the world. And it is most important way from Middle East to Europe to transport rich petroleum and natural gas sources. **Current pipelines and projects in progress are indicators for this.**

In this content, in route determination process, the criterions such as environmental, sociological, economical and safety have must been evaluated altogether. But, so far, efficient systems have not been used for route determination in Turkey.
### PIPELINE ROUTE SELECTION – IN TURKEY

<table>
<thead>
<tr>
<th>Government Agency</th>
<th>Method</th>
<th>Base Maps</th>
<th>Need for GIS</th>
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PIPELINE ROUTE SELECTION – IN TURKEY

- NABUCCO (Turkey-Bulgaria-Romania-Hungary-Austria pipeline)
- SEGP (South European Gas Pipeline)
- BLUE STREAM I
- BLUE STREAM II
- BTC
- South Caucasus Pipeline
- Tabriz – Erzurum
- Trans – Caspian Pipeline

**Nabucco:** It will connect Turkey with Austria via Bulgaria Romania and Hungary. Total length of pipeline will be approximately 1999 km. (Turkey Passing). The total budget of the project is estimated as 4.6 billion Euro.

**Segp:** It will connect Middle East and Caspian Countries to Greece and other European Countries, via Turkey. Total length of pipeline will be approximately 211 km. (Turkey Passing). The total budget of the project is estimated as 135 million Euro.

**Btc:** The Baku-Tblisi-Ceyhan Crude Oil Pipeline Project (BTC P/L Project), which became an unequivocal reality with the ratification of relevant agreements in year 2000, is the apogee of these efforts. Based on its feasibility studies, the total investment cost of the Project as US$ 2.4 billion.

**Turkey is the most important way from Middle East to Europe to transport rich petroleum and natural gas sources**
认定路线选择

油和气产业正日益利用GIS技术来规划新管道，作为一种工具来降低建设和运营成本。这一过程中的主题和变量主要用于输入直接的建设成本和管道效率，一旦管道完成。

一些变量包括；
- 最短距离从来源到市场
- 最少次要（树木等的移除）
- 双线涉及的费用
- 坡度
- 水流、道路和铁路交叉口的数量
- 底质（岩石、土壤等，与埋藏有关）
- 现成的法律和规定（湿地等）
- 人口中心的接近
- 利用现有公用事业通道与其他工程因素

基于GIS的路线选择

GIS Technology的使用作为工具来降低建设和运营成本。这一过程中的主题和变量主要用于输入直接的建设成本和管道效率，一旦管道完成。

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A long distance gas pipeline is a complex system. It relates closely to geographic location, environment, geological condition and many other factors as a geographic object with continuous distributive character. There will be many different data, diagrams, figures, files and other information, which are difficult to use and update them together and effective on each step of pipeline planning, construction, operation and management by manual method.
The study area is selected in Trabzon which is situated in the Black Sea Region of Turkey. Source point is Macka County, Cayırlar Village (in the southern part) and target point is Bulak Village (in the northern part). Route length is approximately 38 km.
Collecting Data

Satellite Image; Landsat 7 ETM+ September 19th, 2000

Land cover types were obtained by classifying Landsat ETM+ images in ErMapper software. Supervised classification technique was used for this process. Area proportion for each class was calculated.

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>FACTOR WEIGHT</th>
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<tr>
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<tr>
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<tr>
<td>Fault</td>
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<tr>
<td>Fauna</td>
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<td>Flora</td>
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<tr>
<td>Culture - Tourism</td>
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<tr>
<td>Protected Area</td>
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<td>Adminis. Unit</td>
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<tr>
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<td>Stream</td>
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<tr>
<td>Road</td>
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<tr>
<td>Soil</td>
<td>0.05</td>
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</table>
## GIS BASED ROUTE SELECTION

### Collecting Data

<table>
<thead>
<tr>
<th>Data Layers</th>
<th>Entity Type</th>
<th>Attributes</th>
<th>Data Sources</th>
<th>Scales</th>
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<tbody>
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<tr>
<td>Soil</td>
<td>Poly</td>
<td>Btg, Ed, Saks, At, Akks, As</td>
<td>General Directory of Rural Affairs</td>
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<tr>
<td>Stream</td>
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<td>Name, Flow</td>
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<td>MTA, Cadastre Offices, Field Survey</td>
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</tr>
</tbody>
</table>
ArcGIS Spatial Analysis

ArcGIS™ Spatial Analyst provides a broad range of powerful spatial modeling and analysis features.

Using ArcGIS Spatial Analyst, GIS users can create, query, map and analyze cell-based raster data; perform integrated raster/vector analysis; derive new information from existing data; query information across multiple data layers; and fully integrate cell-based raster data with traditional vector data sources.

ArcGIS Spatial Analyst integrates real-world variables such as elevation into the geospatial environment to help solve complex problems.
GIS BASED ROUTE SELECTION

Raster Network Analysis and Queries

In this implementation, the best route is determined for a new gas pipeline. The steps to determine such a path are outlined below.

Path is performed using ArcGIS 9.2 Spatial Analysis Module.

- Create Source, Destination and Cost Datasets
- Generate a Thematic Cost Map (Classify and Weighting)
- Building up Cost Weighted Distance
- Create Direction Datasets and drawing Shortest Path
GIS BASED ROUTE SELECTION

Results

Pipeline Length : 37.7 km.
Construction Site : 1.508 km²
Road Crossing : 10 times
Stream Crossing : 8 times
Landslide Crossing : None
Protected Area Crossing : None
Fauna Crossing : None
Pasture Crossing : 15.4 km.
Brush Crossing : 18.2 km.
Hazelnut Crossing : 4.1 km.
CONCLUSIONS

Pipelines and similar large scale energy projects undertaken in majority countries are rarely vetted through a process of environmental or social impact assessment.

But this study, by incorporating both the environmental and traditional sets of criteria an optimal route could be achieved using GIS.

Safer and cheaper pipeline transportation of energy resources is a major concern for the public and the pipeline industry. So, these models should be implemented in developing countries.
Today, the pipeline owners and operators are under increasing pressure to produce accurate maps of pipeline routes to assure safety in design, construction, operation, maintenance, and emergency response of pipeline facilities. So, raster based GIS and effective route are needed.

ArcGIS 9.2 Spatial Analyst module can be used effectively in the optimum route selection of pipeline to minimize environmental impacts and construction costs. But also, it should be customize for user needs and new functionalities.
thanks for your attention...

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Thanks to;

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