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GIS DATA BASE DEVELOPMENT FOR ESCWA INTERNATIONAL TRANSPORT SYSTEM

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* The views expressed in this paper are those of the author and do not necessarily reflect those of the Economic and Social Commission for Western Asia.

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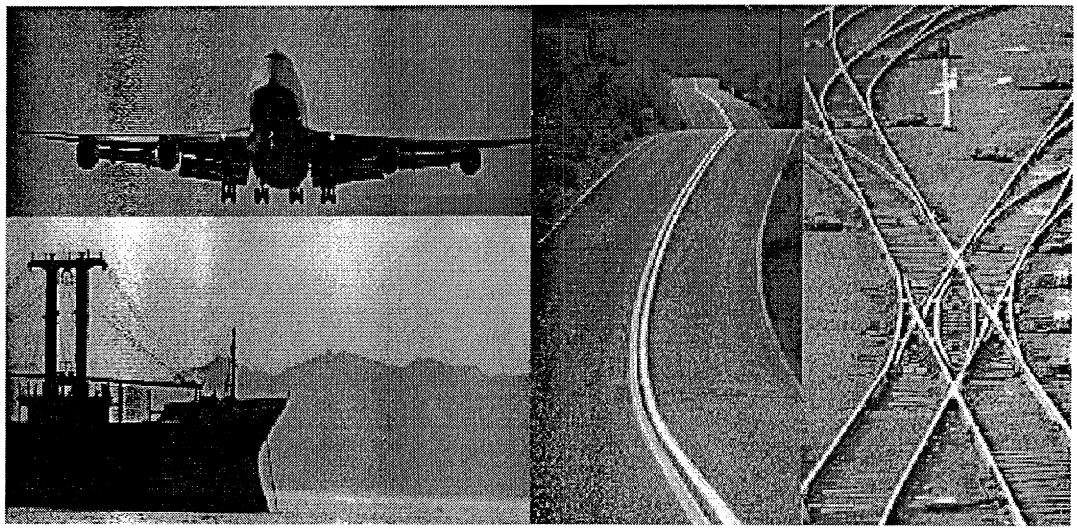
GIS Data Base Development for ESCWA International Transport System



Developed for
SIPD/Transport Section on GIS

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DATA BASE DEVELOPMENT FOR ESCWA TRANSPORT SYSTEM

Introduction

The ESCWA international transport system represents the inter-modal connections between the member countries that include Egypt, Jordan, Syria, Lebanon, West Bank, Gaza Strip, Iraq, Saudi Arabia, Kuwait, Bahrain, Qatar, United Arab Emirate, Oman and Yemen. The GIS map for the international transport system consists of six major layers that are: the surface roads, the rail roads, the waterways and seaports, the pipelines and utility lines, airways and airports, and the socioeconomic layers. These components of the transport system constitute the multimodal transport system for the ESCWA region. The major objective of the project is to develop a database for the transport system that reflects the operational, physical and spatial characteristics of the point and linear features for each GIS map layer.

Development of the GIS database for the transport system involved setting up a data dictionary, populating the data dictionary fields, refinement of the GIS maps and developing data manipulation tools. These four steps of the development are described as follows:

1) Setting up the data dictionary was done by designing a structure of database fields that incorporate the different data types required for describing the physical and functional characteristics of the transport network components.
2) Populating the data dictionary fields involved entering data into the database associated with each layer using the information derived from the paper maps and documents provided by the ESCWA officials.
3) Refinement of the GIS maps was done by removing the map features that do not serve the purpose of an international and regional transport network such removing the gravel and unpaved roads from the road network.
4) The data manipulation tools are utilities to assist the users in conducting network specific changes in addition to the default editing utilities provide in the Arcview software.

The database for each layer consists of two sub-layers. The first sub-layer contains the linear features, such as the road segments and the railroad lines. The second sub-layer contains the point features, which could be a road intersection, center of activities such as a seaport, and a rail station or border point. The following sections provide a description of the database structure and the two sub-layers constructed for each map.

To document the source of data, a database was developed to store the document names from which the information was obtained for each layer. The database contains an entry for each field in the database of the GIS layer and a brief description of the field as shown in Appendix-7. These database files carries the name of the layer they belong to with the word "SOURCE" attached (e.g. ROADSOURCE.dbf).

International Roads Network

Development of the database for the road transport network involved creating two data dictionaries for the road links and nodes sub-layers. The road links sub-layer represents the road segments between logical end points (nodes). The road nodes sub-layer represents the two end points of each road link. A node could represent a road intersection, a railroad crossover, a city, a town, a checkpoint, an industrial area, a geographic boundary such as a river, or a political boundary such as a border crossing point. Appendices 1A and 1B show the data dictionary for the links and nodes of the ESCWA international road transport network. Appendix 8 shows selected fields from the database of the road links sub-layer.

In the road network, each link is identified by its two end nodes, where each node is assigned a unique number stored into the UFID field. The first end is named ANODE and the second end is named BNODE. Combined together, the Anode and Bnode establish a unique road link identifier that is essential for conducting travel demand analysis or traffic forecasting. The node numbers are grouped by country, where, each country is assigned a range of numbers to use in identifying the nodes within its boundaries. The numbering ranges are as follows:

1) Egypt: 1000 - 1999
2) Jordan: 2000 - 2999
3) Syria: 3000 – 3999
4) Lebanon: 4000 – 4999
5) Iraq: 5000 - 5999
6) Saudi Arabia: 6000 – 6999
7) Yemen: 7000 - 7999
8) Oman: 8000 - 8999
9) United Arab Emirates: 9000 - 9999
10) Qatar & Bahrain: 10000 - 10999
11) Kuwait: 11000 – 11999
12) West Bank: 12000 – 12999

Important to note that the number assigned to the ANODE is always lower than the BNODE for two ways links. For the one way links the node numbering sequence reflects the traffic direction of the road regardless the value of the node UFID.

A vehicle classification lookup database file was created based on the vehicle classification scheme obtained from the Ministry of Communications in Saudi Arabia to be an example for other countries when similar data become available. This table can be linked to the road links database using the count station identification number as a common link between the two database files. Table-1 shows an example of the Average Annual Traffic station counts broken into the fifteen classes. Figure-1 shows a copy of the vehicle classification scheme used by the Saudi Arabia Ministry of Communications. The database files for the road network are named as follows:

1) ROADLINK.aat for the road links sub-layer.
2) ROADNODE.nat for the road nodes sub-layer.
3) ROADSOURCE.dbf for the source of data.
4) VEHCLASS.dbf for the vehicle classification database.

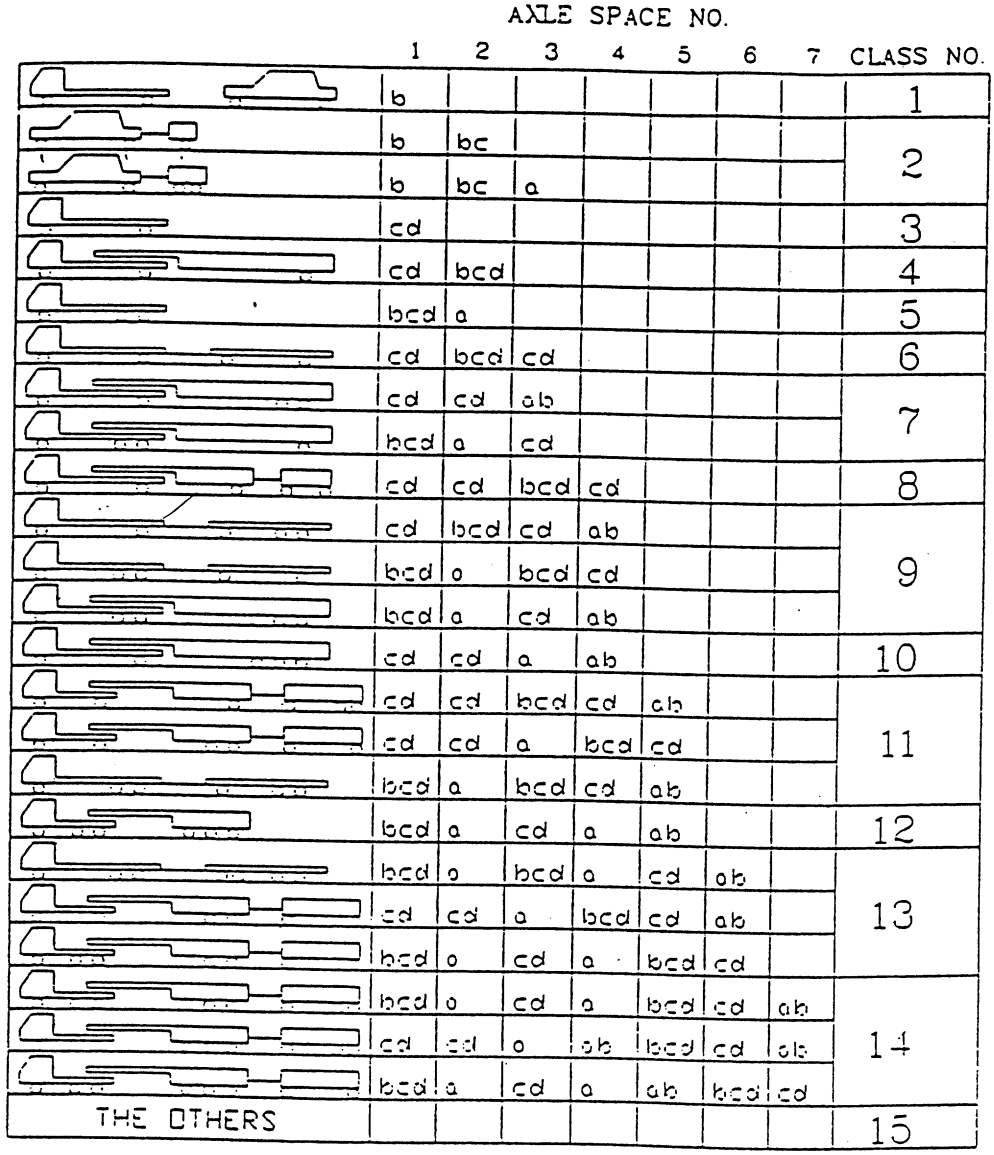
Table-1

Vehicle Distribution Counts for Station No.10 on Road No. 517, Alkharj – Riyadh

Vehicle Class	Daily Traffic Volume	% of Daily Volume
1	7334	84.9%
2	33	0.4%
3	574	6.6%
4	105	1.2%
5	87	1.0%
6	5	0.1%
7	140	1.6%
8	1	0.0%
9	38	0.4%
10	5	0.1%
11	2	0.0%
12	2	0.0%
13	1	0.0%
14	0	0.0%
15	309	3.6%

Source:

Figure-1
Vehicle Classification Scheme for Saudi Arabia



AXLE SPACE

$0.50 < a < 1.80$ met.
$1.80 \leq b < 3.30$ –
$3.30 \leq c < 5.50$ –
$5.50 \leq d < 10.00$ –

Source: Kingdom of Saudi Arabia, Ministry of Communications
Annual Traffic Report 1413 (1992)

International Rail Roads Transport Network

The database of the international railroads network was developed following the same approach implemented for the road network. A database dictionary was created and attached to the existing database of the GIS map provided by ESCWA. The railroad links sub-layer represents the line segments between rail stations, road intersections, or at geographical or political boundaries. The sub-layer of railroad nodes represents the rail stations and has a database dictionary for the operational and spatial characteristics. Appendices 2A and 2B show the data dictionary structure of the railroad links and nodes. In addition, a database file was created for the 1996 Statistics data provided by the Arab Union for Railways and could be linked to the rail lines using the company identification code. In this file, each member country has an entry that represents the different characteristics of the railway system. Appendix 8 shows the data dictionary for this file. The database files for the rail road system are named as follows:

1) RAILLINK.aat for the rail links sub-layer.
2) RAILNODE.nat for the rail nodes sub-layer.
3) RAILSOURCE.dbf for the source of data.
4) RAILUNION.dbf for the statistics data of the Arab Union for Railways

Maritime Transport Network

The database development of the maritime transport network involved creating data dictionaries for the seaports layer and the maritime routes network. In the GIS layer of seaports, each port is represented as a point that has a connection to the maritime routes. The seaport database contains data for the physical, operational and spatial characteristics of each port such as the port length, water depth, flow of containers in and out of the port. The sub-layer of maritime routes represents the waterways in the region and contains information such as the route name and water basin name. Should more information become available, the routes data dictionary could be expanded to accommodate more fields. Appendices 3A and 3B show the data dictionary structure of the seaports and maritime network links. The database files for the seaports and maritime routes network are named as follows:

1) SEAPORTS.pat for the seaports sub-layer.
2) SEAROUTES.aat for the maritime network.
3) SEASOURCE.dbf for the source of data.

Air Transport System

The air transportation system database represents the network of airports in the ESCWA region. The air transport map contains point features that represents the airport locations throughout the region. The data dictionary for the airports sub-layer contains data fields that represent the type of operation, the passenger and goods movement through the airport for the transit and non-transit flights etc. The database for the airways sub-layer contains imaginary lines that link the different countries in the ESCWA region. Appendices 4A and 4B show the data dictionary structure of the airports and airways network. The database files for the air transport layers are named as follows:

1) AIRPORT.pat for the airports sub-layer.
2) AIRROUTE.aat for the airways sub-layer.
3) AIRSOURCE.dbf for the source of data.

International Pipelines and Utilities Network

The international pipeline and utility layer represents the different utility lines in the region including pipelines, electric lines and water lines. The data dictionary of the utility layer contains fields that represent the functional and geometrical characteristics of a line such as the type of service it provides, the segment length etc. The utility nodes sub-layer represent the end points of the utility lines which could be a pump station, a valve or lift station etc. Should more information becomes available for the utilities network, the data dictionary can be expanded to accommodate more fields and data. Appendices 5A and 5B show the data dictionary structure for the utility layer. The database files for the utilities network are named as follows:

1) UTILLINK.dbf for the utility lines sub-layer.
2) UTILNODE.dbf for the nodes sub-layer.
3) UTILSOURCE.dbf for the source of data.

Socioeconomic Layer (TAZ)

The Transportation Analysis Zones database represents the socioeconomic data affecting the transportation demand in the region. The TAZ layer contains polygon features that are extracted from the administrative map of the ESCWA countries. Each analysis zone has a unique identification number and entries for the socioeconomic data. The

socioeconomic data associated with each TAZ are aggregation of the demographics of the cities and towns located inside the zone boundaries. The data can be used for land use analysis, demographic analysis and travel demand forecasting. Each TAZ polygon is assigned a number that is based on ranges of numbers assigned to each country. The TAZ numbering scheme is as follows:

1) Egypt: 1 - 49
2) Jordan: 50 - 99
3) Syria: 100 – 149
4) Lebanon: 150 – 199
5) Saudi Arabia: 200 – 249
6) Qatar: 200 - 249
7) Kuwait: 250 - 299
8) Bahrain: 250 - 299
9) Iraq: 300 - 349
10) Yemen: 350 - 399
11) Oman: 350 - 399
12) United Arab Emirates: 400 - 449

The database file for the TAZ Layer is named as ESCWATAZ.dbf.

Multimodal Transport Network

The multimodal transportation network is a combination of the roads, railroads, maritime and air transport networks. The links sub-layer contains the linear features from each network such as the road links, railroad lines and maritime routes. The data dictionary of the links sub-layer contains information common to all networks such as the segment length, the segment name, the tons of commodities delivered on each link etc. The nodes sub-layer represents the end nodes of each line segment in the links sub-layer whether that node is a road intersection, a railroad station or seaport node. Respectively, the nodes data dictionary contains information on different node characteristics such as the type, time delay at the node etc. Appendices 6A and 6B show the data dictionary structures for the multimodal sub-layers. The database files for the network are named as follows:

1) MODLLINK.aat for the links sub-layer.
2) MODLNODE.nat for the nodes sub-layer.
3) MODALSOURCE.dbf for the source of data.

City Layer

The database development for the city layer focused on adding more cities and towns to the GIS map and attaching population data to each city. The cities and towns are represented as point features in the GIS layer of cities. The GIS map provided by the ESCWA officials contained 138 cities and towns. Using the paper maps provided by the ESCWA an extra 226 city were added to the map. This addition brought the total number to 364 cities. Two more fields were added to the cities database that are the population count and the year of demographic count. The demographic data were acquired from the database of the GIS maps provided by the CEDARE organization in Egypt for the African and Asian cities and which contained a total of 158 cities. Therefore, more population and demographic numbers need to be gathered to reach the exact figures of population for each country. The database file for the cities layer is named CITY.dbf.

Data Editing and Manipulation

The database development of the ESCWA multimodal transport system involved development of tools for data editing and manipulation for the Arcview software. The editing tools are developed using the Arcview/Avenue objected oriented programming language. These tools provide the following functionality:

1) Data listing tool, to list information from the database for the selected GIS layer and the selected line, point or polygon features. This tool provides a description of the selected feature by compiling data from the different fields in the database.
2) Data editing tool, to update the database for the selected feature in the active map.
3) Tool to list source of data, for the selected feature and database field. This tool compiles a message for the source of data from the database file of data source.
4) Annotation tool, to annotate the map features using information from the specified database field on the screen such as the road number, the international road number, the speed, the number of lanes etc.

The above four tools are accessed from the Map View button and tool bars by clicking on the button designated for each tool. Figure-2 shows the Arcview menu with arrows pointing at the customized buttons such as the button "I" for Information on the selected feature, "S" for the Source of data, "E" for data Editing and "A" for feature Annotation. When the user clicks on one of the custom buttons a series of menus pops up on the screen. The popup menus provide an interactive process that requires a user selection or input. The following sections describe the functions associated with each tool.

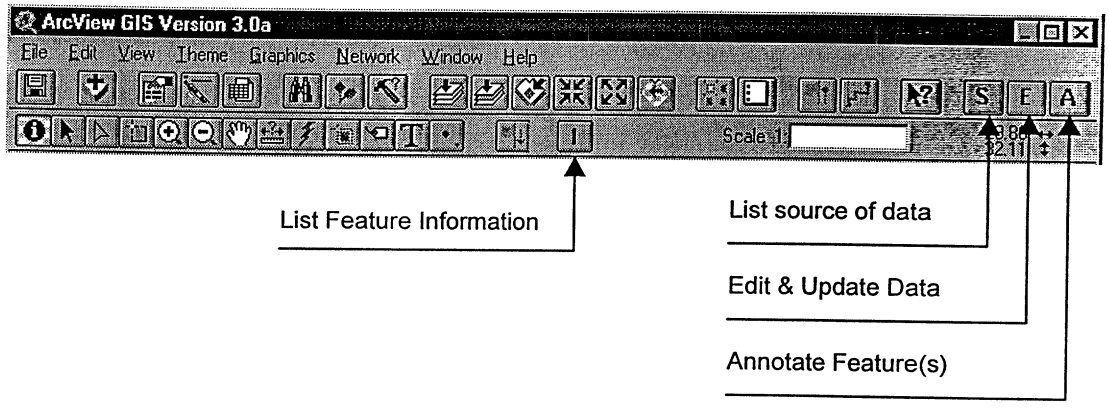
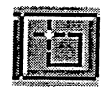


Figure-2: Custom Buttons added to Arcview to manipulate the ESCWA MAP layers

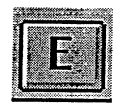
Steps for Data Editing and Update

The process of editing or updating the attribute data for either a single feature or multiple features requires the following actions from the user:

1) Select a feature or group of features by clicking on the Selection button and pointing at the feature or by drawing a box around a group of features to select many features.



2) Click on the Edit feature button "E" in Figure-2. This brings up a menu list for the available data fields for the selected feature from the active Map Layer. In this menu the user can select one or many fields to update as shown in Figure-3.



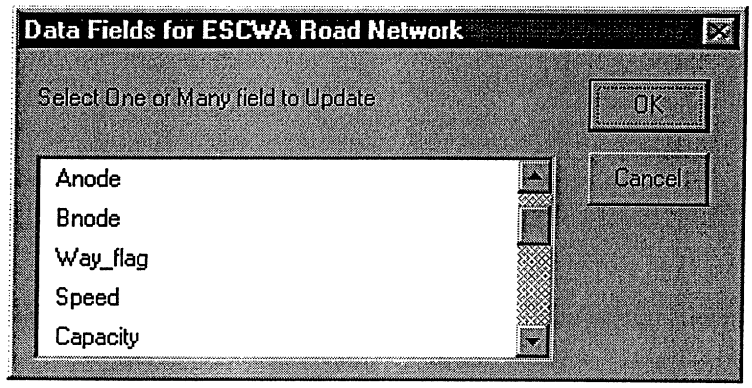


Figure-3: List Menu for Multi Field Selections

3) After selecting the fields and pressing OK a data entry menu comes up on the screen where the user can enter data for the selected feature and database fields for the active Map Layer as shown in Figure-4.

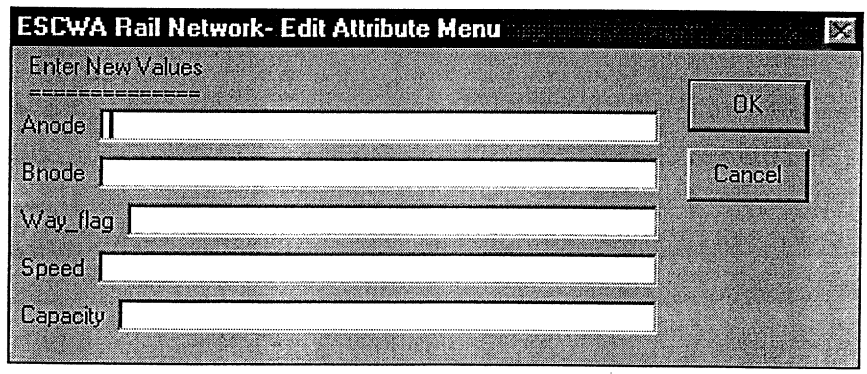


Figure-4: Data Entry Menu

Steps to List Feature Information

The list of information tool allows for displaying information for one selected feature in a time. The process of listing feature information involves manipulation of the individual data fields to compile English sentences that could be read and understood by an ordinary system user. This is done by converting the numeric values and flags stored into the database to words that represent the meaning of each value as represented in the data dictionary for each layer. To get information on features from a map layer the user needs to do the following steps:

1) Click on the list feature information button "I" in Figure-2. Following that a cursor will appear in the map area, which the user can use to point to the feature from the map drawing.

2) Once the feature is identified by the cursor, the feature color will become yellow and a message box appears on the screen with boxes that contain information for the selected feature. Figure-5 shows the multi box information message.

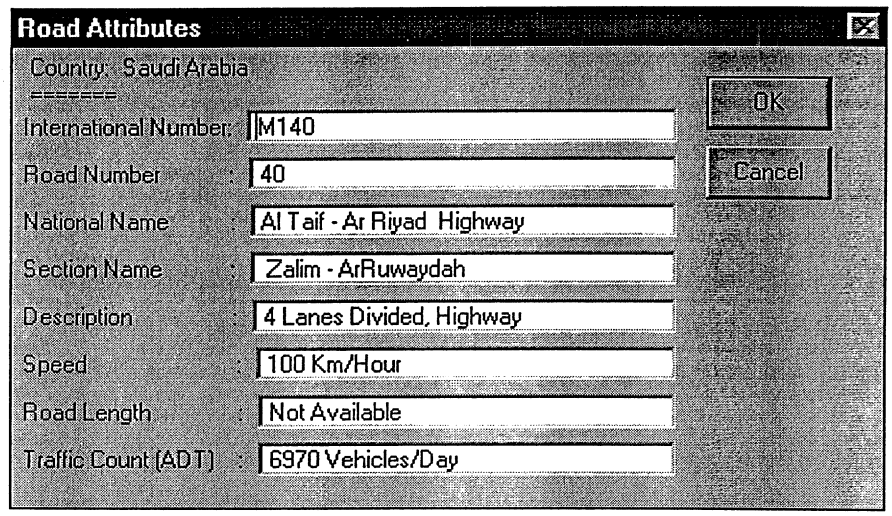


Figure-5: Message Box for Feature Information

Steps to List Data Source

The process to list data source allows for getting information for one individual data field and one selected feature in a time. To get information on source of data, the feature has to be already selected by either the selection button or has been identified by the list feature attribute tool and still active (i.e. has a yellow color). The steps to list data source are as follows:

1) Click on the list source of data button "S". Following that a menu list for the available data fields will popup on the screen. In this menu the user can select one field only to list information for. Figure-6 shows the field selection list box.

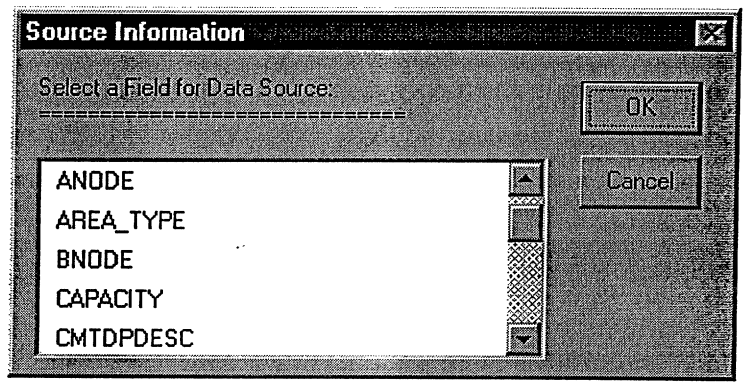


Figure-6: Field Selection Box for Data Source.

2) After selecting the field name and clicking OK, an Info Message box appears on the screen stating the source of data for the selected field and feature. When finished the user clicks OK to dismiss the message. Figure-7 shows the Message Box for data source.

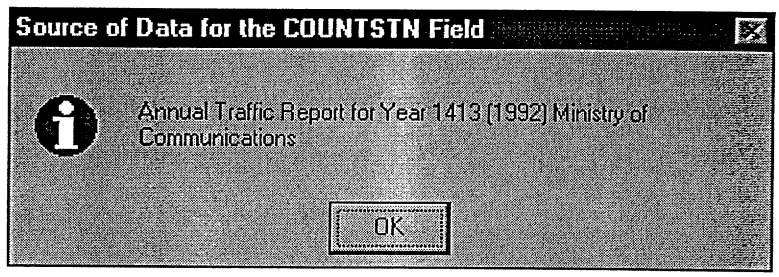


Figure-7: Info Message Box for data source.

Steps to Annotate Map Features

The process of annotating map features involves posting information from a selected field in the database for a selected feature, a selected group of features or the entire map. The steps to annotate map features are as follows:

1) Click on the Annotate Feature button "**A**" from the buttons bar shown in Figure-2. Following that, the Annotation Dialog box will popup on the screen

2) At the top of the box the user can select the database field to use to post data on the screen from the choice menu. The dialog box provides different options for the annotation characteristics from which the user can pick and choose or leave the default settings. Figure-7 shows the field selection list box

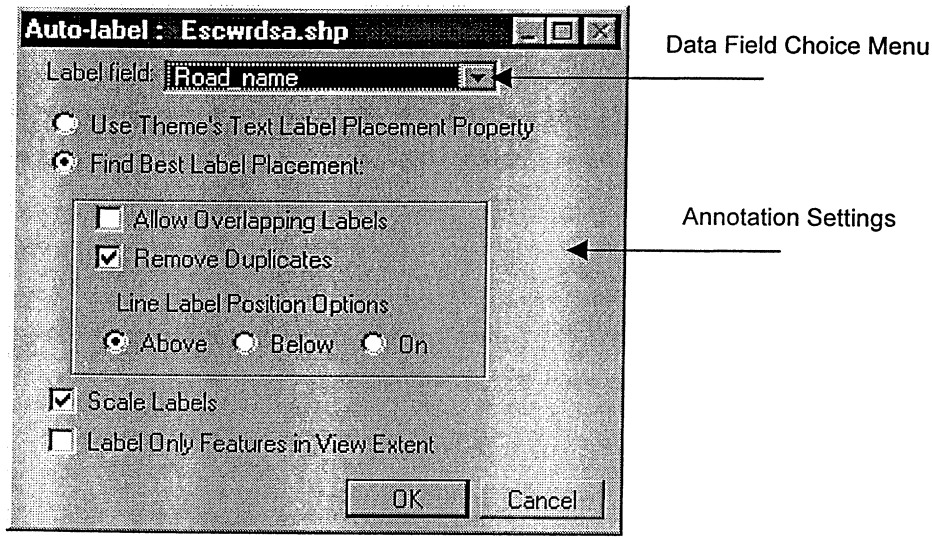


Figure-7: Feature Annotation Dialog Box

3) After specifying the field to get the annotation from and click on the OK button, the annotation values will show on the screen at the text size specified by the from the Window Pulldown Menu.

Appendices
For
Networks Data Dictionaries

Appendix - 1A
Data Dictionary for International Road Network

Roadway Links

The data base structure of the ESCWA international road links consists of the data fields described in the following. The data dictionary description includes the field name, type and data values that are valid to enter into each field. The data description is as follows:

Field Name	Field Width	Decimals	Type	Data Description
UFID	6	0	I	Unique Feature Identification number Valid Values: 1-999999
Anode	6	0	I	First end of the road segment Valid Values: 1-999999
Bnode	6	0	I	Second end of the road segment Valid Values: 1-999999
LinkLength	7	2	N	Length of a road link in kilometers Valid Values: 0.00001- 9999.00 Km.
Way_Flag	2	0	I	Flag to identify the direction of traffic on the road. Valid values: One-Way = 1 Two-Way = 2
Speed_Dsgn	3	0	I	Design speed on a road segments. Valid Values: 1-999 Km/Hours.
Speed_Oprt	3	0	I	Operating speed on a road segment. Valid Values: 1-999 Km/Hours.
Capacity	6	0	I	Hourly carrying capacity per lane. Represent the number of vehicles that utilize a lane for level of congestion "E". Valid Values by Road type: