Calculating a Distance Matrix of Locations Along River Networks

These instructions enable you to measure the length of line segments between points, which is much more useful than simple straight-line distances when you need to work in a network environment such as along water courses, as well as the more traditional applications on roads and utility features. Using ESRI's ArcInfo, ArcView 3.x and Microsoft's Access software, perform the following steps to obtain a pair-wise distance matrix between locations:

- Convert line shapefile to coverage and clean/build line topology
- Calculate distances between origin and destination sites along the river network
- Create a cross tabulation query to organize the data into a matrix

You need to install the extension **Fastest Shortest Network Paths v1.0** created by Soeren Alsleben (available for free at http://arcscripts.esri.com/) – this requires ESRI's **Network Analyst** to also be installed (available with paid license) – in ArcView 3.x.

ORIGINAL DATA

Rivers.shp	line shapefile of river branches and tributaries
Sites.shp	point shapefile of sampling/station locations with unique identification field values for each record

CREATED DATA

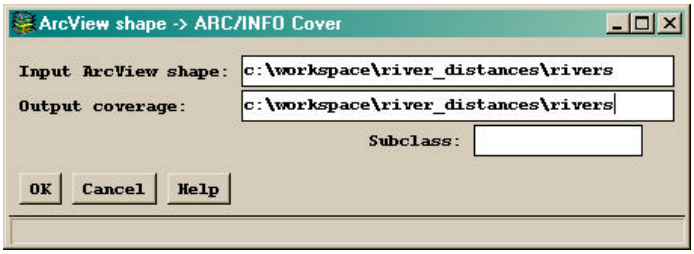
Rivers	coverage converted from the shapefile
SNP_sites.shp	shapefile consisting of pair wise distance segments between selected site locations along rivers
SNP_distances.txt	exported table of the results

Steps in ArcInfo Workstation:

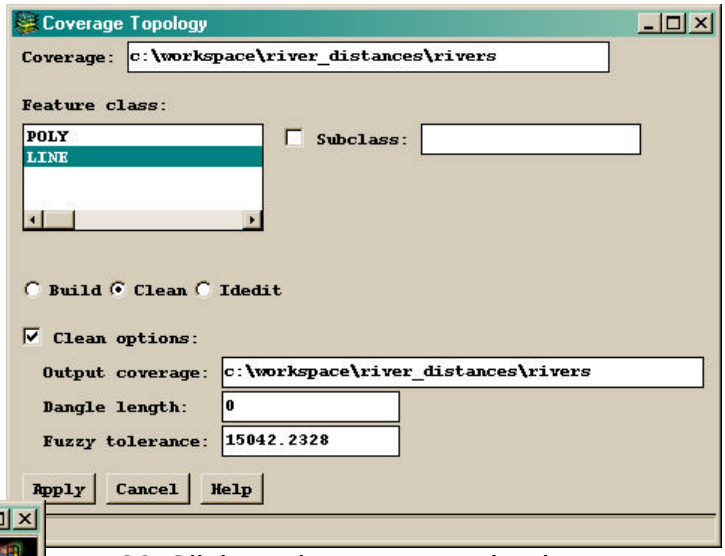
Topology explicitly defines spatial relationships. The major topological concept associated with linear features, such as rivers, is connectivity. Arc-node topology defines connectivity: arcs (linear features) are connected to each other if they share a common node (endpoints and intersections). This is the basis for many network tracing and path finding operations.

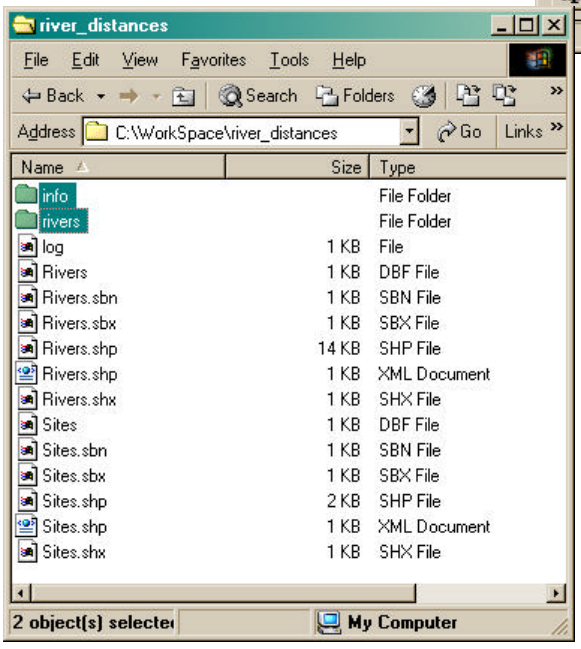
1. Start Arc/Info
2. At the command prompt, type **arctools**
3. Select COMMAND TOOLS and click OK
4. Choose FILE >>> MANAGE WORKSPACES
5. Navigate to your working subdirectory (e.g. **`c:\workspace\river_distances`**) and click OK
6. Click on the CONVERSION pull-down menu
7. Choose TO ARC >>> SHAPE TO ARC

8. Right click in the "*Input ArcView shape*:" text box



9. Select the **Rivers.shp** file as the input
10. Double click to highlight the input text box and simultaneously hit the **Ctrl-C** keys on the keyboard to copy the information
11. Click in the "*Output coverage*:" text box and simultaneously hit the **Ctrl-V** keys on the keyboard to paste the information
12. Click OK
13. Click on the EDIT pull-down menu
14. Choose TOPOLOGY >>> BUILD FEATURES
15. Right click in the "Coverage:" text box and select the **Rivers** coverage as the input
16. Click on the CLEAN option button
17. Click a check in the "Clean options:" check box to optionally change the defaults
18. Highlight the LINE feature class
19. Click APPLY





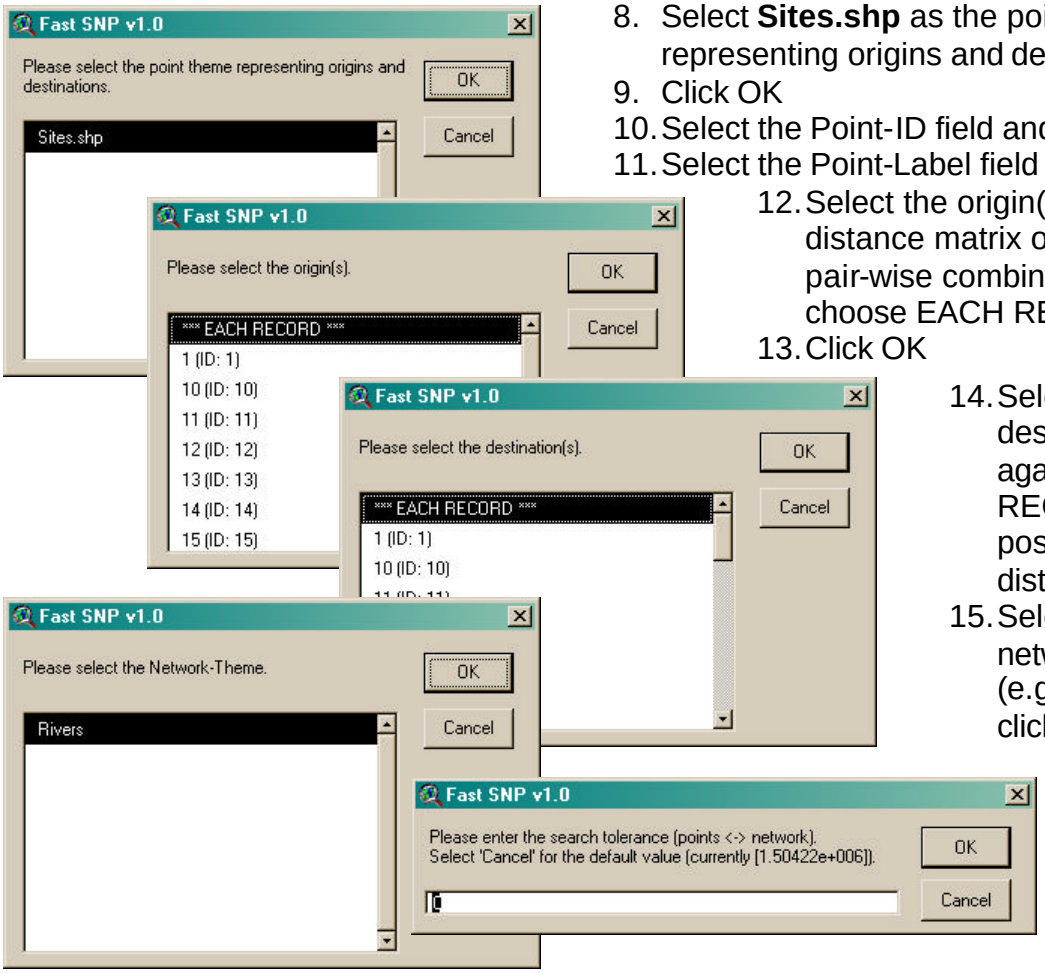
20. Click on the BUILD option button
21. Highlight the LINE feature class
22. Click APPLY
23. Click CANCEL when finished
24. Choose ARCTOOLS >>> QUIT
25. QUIT from the ArcTools interface and then type '**q**' to quit ArcInfo altogether

*You now have a line **coverage** that is clean (corrected for geometric coordinate errors by splitting lines at intersections, etc.) and built (created/updated the feature attribute table based on the changes made by the clean operation) with arc-node topology for the rivers data – very important for the network analysis below.*

Steps in ArcView 3.2:

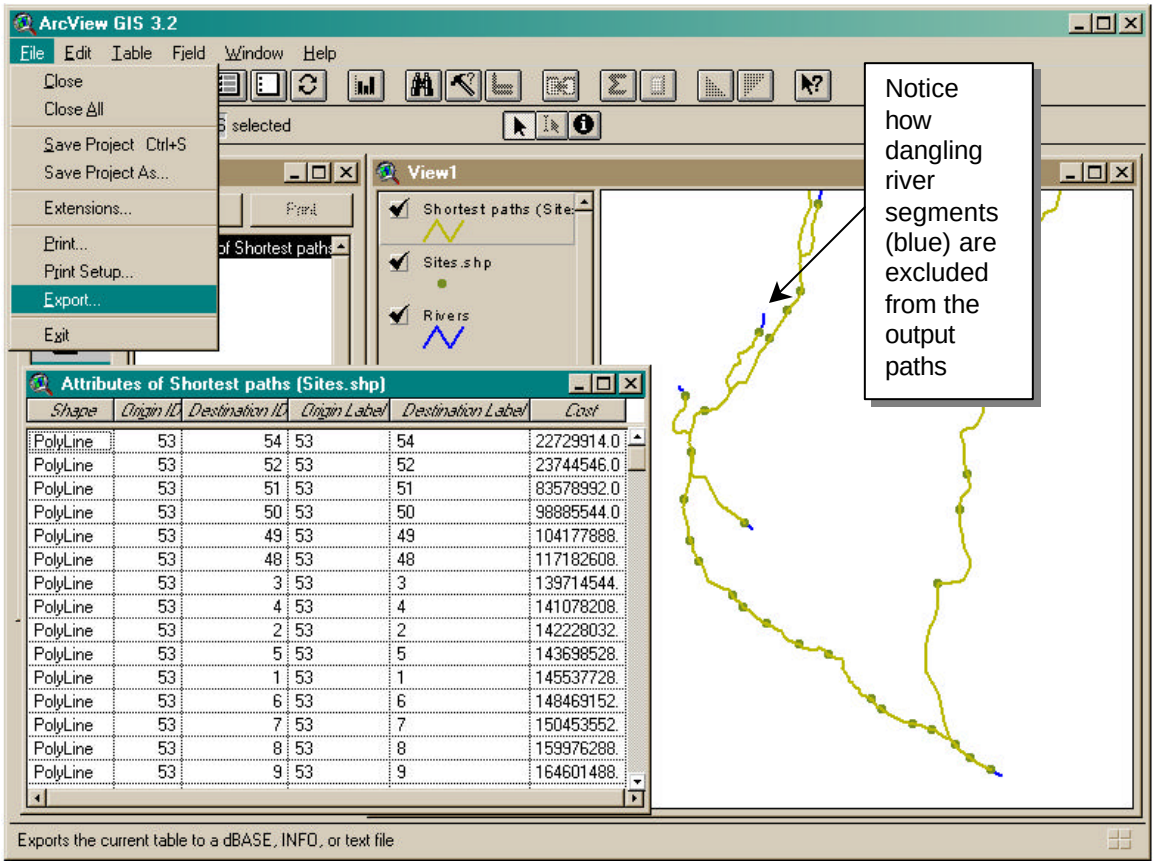
FAST SNP V1.0 for ArcView 3.x (Network Analyst required) is a third-party extension that calculates shortest paths between origins and destinations using the path length or travel time.

1. Start a new project in ArcView 3.2
2. Open a new View and add the **Rivers** coverage and the **Sites.shp** theme
3. Choose FILE >>> EXTENSIONS
4. Click a check beside the **Network Analyst** and **Fastest Shortest Paths v1.0** extensions
5. Turn the themes on
6. Highlight the river theme
7. Click on the Fast SNP v1.0 button 



8. Select **Sites.shp** as the point theme representing origins and destinations
9. Click OK
10. Select the Point-ID field and click OK
11. Select the Point-Label field and click OK
12. Select the origin(s); for a distance matrix of all possible pair-wise combinations, choose EACH RECORD
13. Click OK
14. Select the destination(s); again, use EACH RECORD for all possible pair distances
15. Select the network theme (e.g., **rivers**) and click OK
16. Enter a search tolerance or click CANCEL for the default
17. Click OK to the warning that the distance will be used as the cost for calculating shortest paths
18. Enter the directory and filename (e.g. **`c:\workspace\river_distances\SNP_sites.shp`**) for the resulting shapefile and click OK
19. Click YES or NO to exclude 'A-A' paths (identical origin/destination locations)

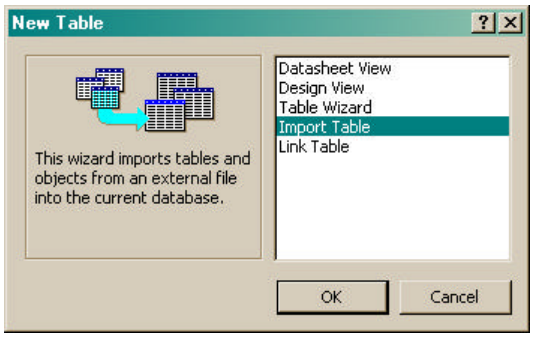
20. Click YES to add the new theme to the View
21. Highlight **SNP_sites.shp** and open its attribute table 



The Origin and Destination fields indicate the site pairs and the Cost field shows the distance in map units along the river and between the sites.

22. Choose FILE >>> EXPORT
23. Select DELIMITED TEXT as the export format and click OK
24. Save as **`c:\workspace\river_distances\SNP_distances.txt`**

Steps in MS Access:

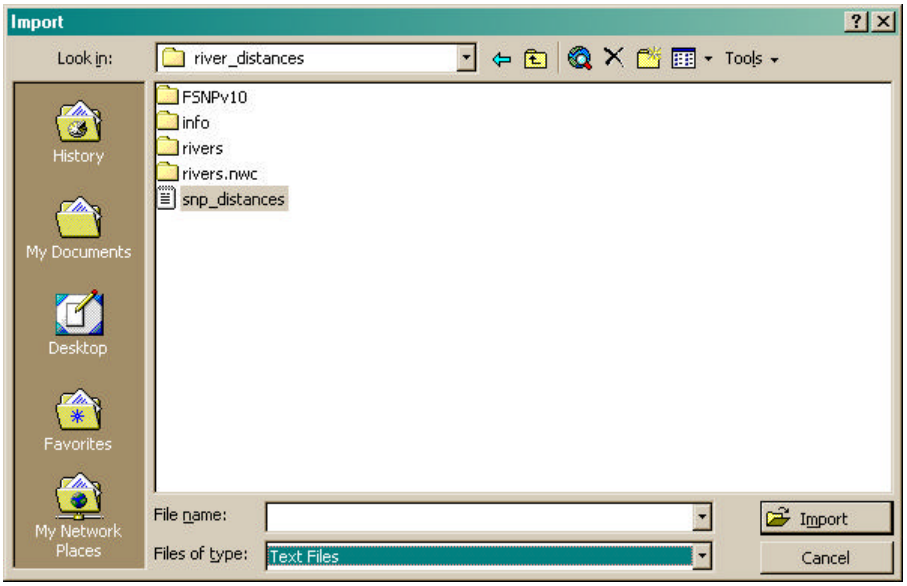


The shapefile that results from the network analysis simply lists the pair-wise distances along the river network. The following assumes prior familiarity with starting an Access database and instructs on how to get the data into a matrix form using this common database software program:

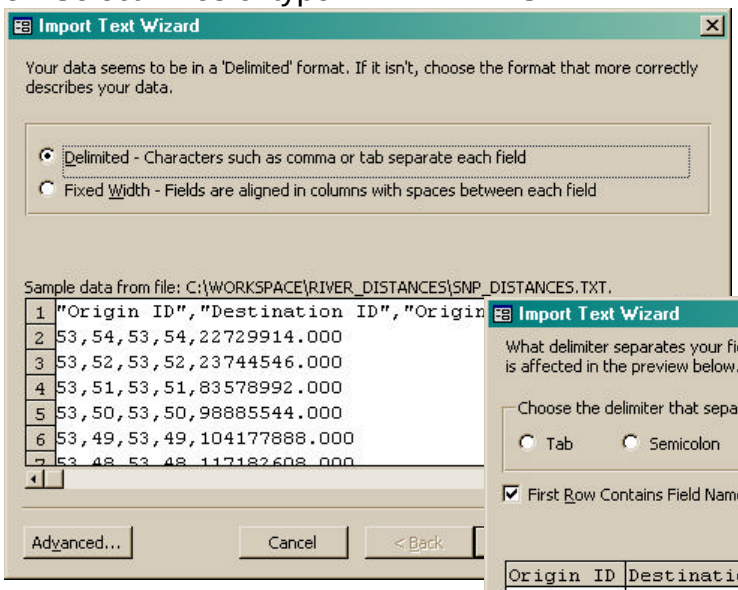
1. Start MS Access by creating a new Blank Access database; e.g. **`c:\workspace\river_distances\SNP_distances.mdb`**

Create a new table by importing the SNP_distances.txt file.

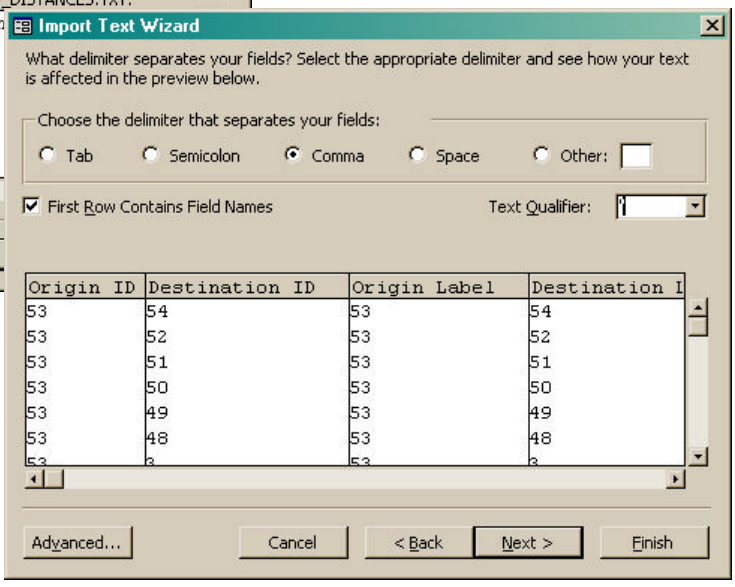
2. Choose INSERT >>> TABLE
3. Select IMPORT TABLE and click OK



4. Navigate to your working directory
5. Select "Files of type:" TEXT FILES

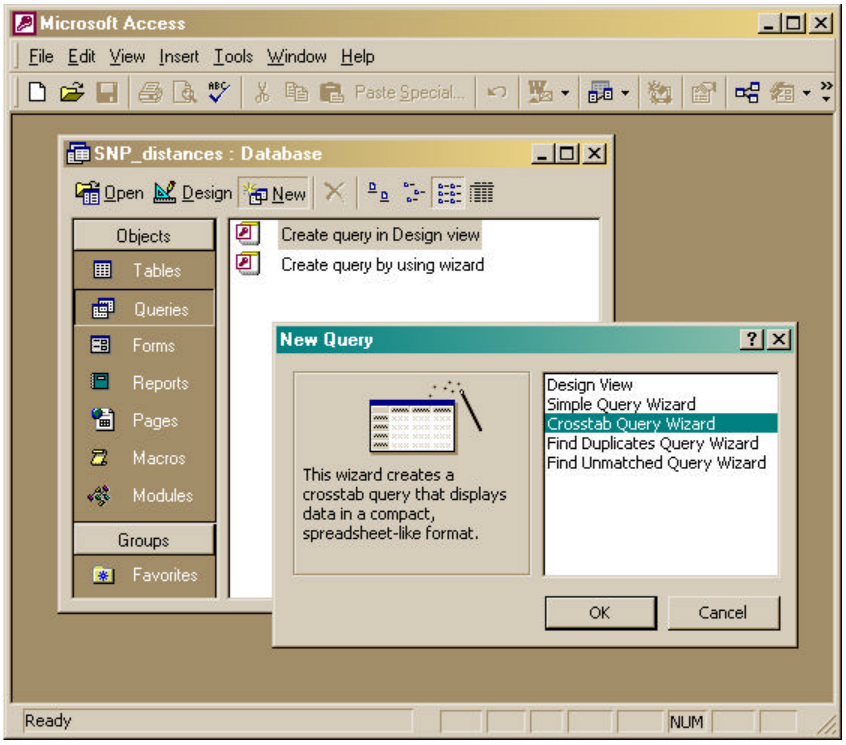


6. Select **SNP_distances.txt**
7. Click IMPORT
8. In the Import Text Wizard, accept DELIMITED and click NEXT



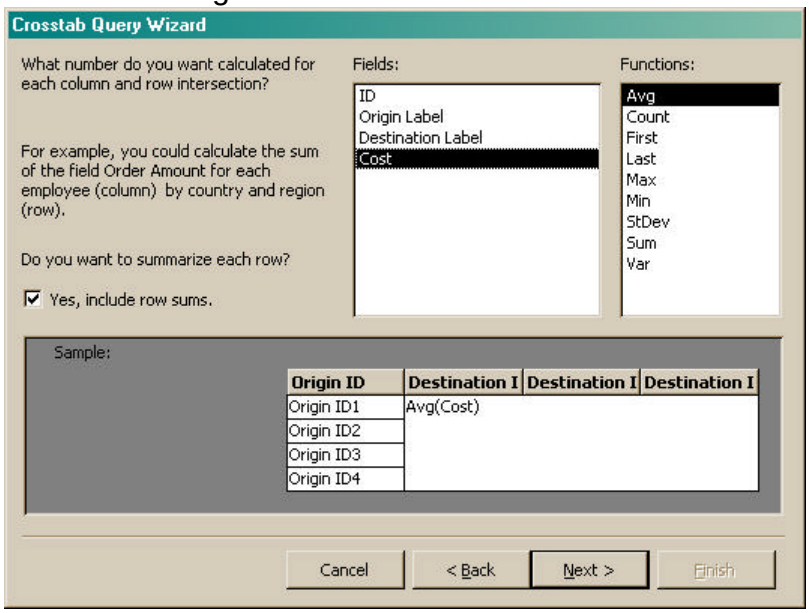
9. Choose COMMA as the delimiter, click a check by "*First Row Contains Field Names*," and select the double quote (") as the "*Text Qualifier*", and then click NEXT
10. Click NEXT subsequently to accept the defaults (or optionally modify) and then click FINISH when done

11. Open the new table to view it



It is virtually identical to the attribute table from the SNP_sites.shp file. Apply a query to create a cross tabulated matrix. A crosstab query displays values (and optionally sums, counts, and averages) from one field in a table and groups them by one set of record IDs listed down the left side of the datasheet and another set of record IDs listed across the top of the datasheet.

12. In the Database window, click QUERIES under Objects.
13. Click NEW on the Database window toolbar
14. In the New Query dialog box, click CROSSTAB QUERY WIZARD
15. Click OK
16. Follow the directions in the wizard dialog boxes and click NEXT after each selection:
    - Table = **SNP_Distances**
    - Row headings = **Origin ID**
    - Column headings = **Destination ID**
    - Specify the field for each column-row intersection = **Cost**



The default Avg function is okay since the table contains the same Cost for A-B and B-A pairs.

17. Click FINISH
18. View the query

This final display of the data in matrix format indicates Site IDs in the column and row headings, with the distance between them along the river network in the corresponding table cell.