## 1.4 WATERSHEDS MODULE

This module offers a wide variety of tools specifically designed to analyse and visualize watersheds. These tools take advantage of the hydrologic relationships between watersheds and use these relationships to identify which watersheds are upstream, which are downstream, and which make up the overall flow regime and/or megabasin. In addition to watersheds, users can also use this module to visualize and possibly analyse data based on any polygonal data type, including administrative boundaries, simple watershed delineations, or surface water bodies. The Watersheds Module is opened or started by clicking on the WS button on the AWRD Interface, or by clicking the "*Open Watershed Viewer…*" menu option in the AWRD Modules menu (Figure 1.28 and Table 1.19).

FIGURE 1.28
**Starting the Watersheds Module**

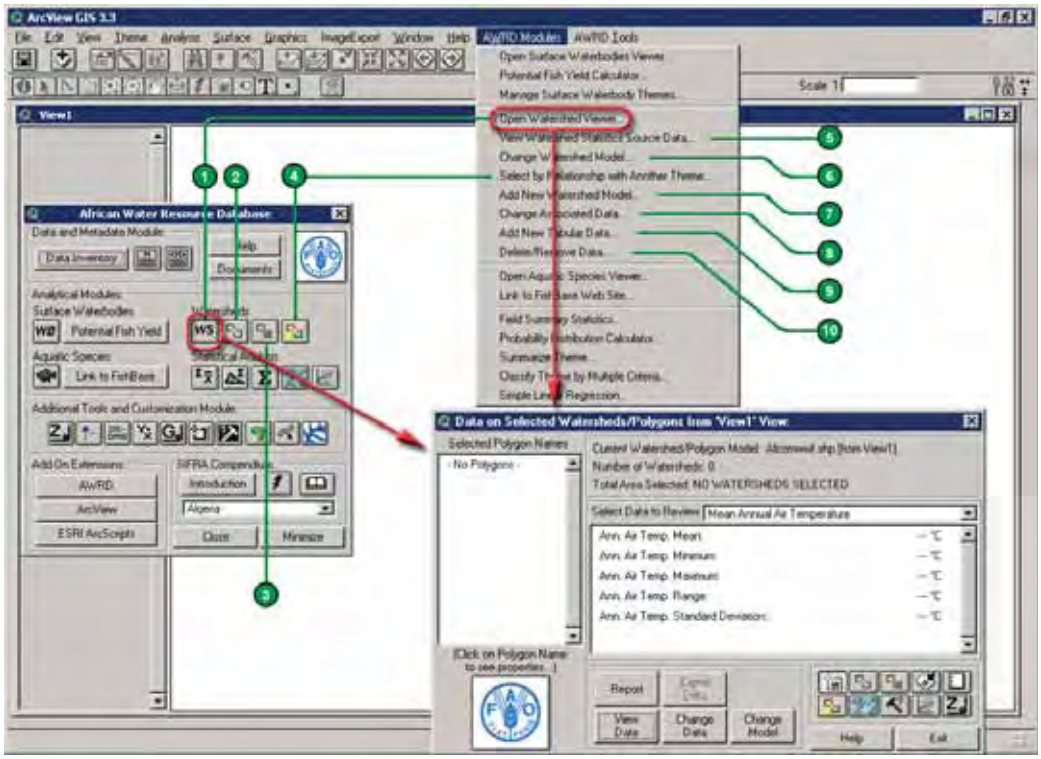
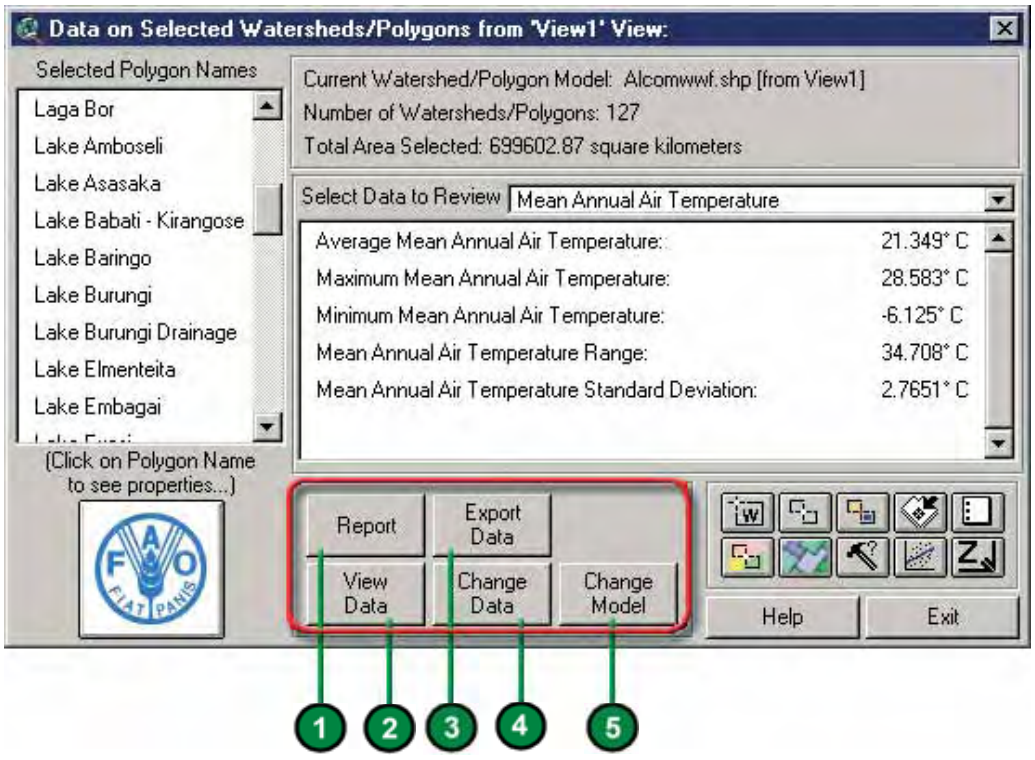



TABLE 1.19
**Watersheds Module buttons and menu items**

| Label (Fig. 1.28) | AWRD button | AWRD Modules menu option | Action executed |
|---|---|---|---|
| 1 | WS | "*Open Watershed Viewer...*" | *Open Watershed Viewer*: Opens the Watershed Statistics Viewer dialog, allowing you to conduct a wide variety of analyses on watershed themes |
| 2 | | N/A | *Select Upstream and Downstream Watersheds*: clicking this tool opens the Watershed Selection Criteria tool dialog, allowing users to select watersheds based on their hydrological relationship to a particular watershed selected by the user. |

| | | | |
|---|---|---|---|
| 3 |  | N/A | ***Identify Upstream and Downstream Watersheds***: this tool opens the "Watershed Visualization Tools" dialog to produce a clear visual map of all the watersheds that are hydrologically related to any particular watershed, i.e. watersheds that are upstream, downstream, or within the same megabasin, plus toools to zoom to the extents of any of these components, to flash the borders of any region, to move upstream or downstream from the base watershed, and to save the flow regime. |
| 4 |  | "Select Watersheds by Relationship with Another Theme…" | ***Select by Relationship with Another Theme***: clicking this tool opens the "Select Watersheds by Other Themes" dialog, allowing users to select watersheds based on their hydrological and/or spatial relationship to selected features in another theme. |
| 5 | View Data | "View Watershed Statistics Source Data…" | ***View Source Data:*** this function shows you the background data used to generate the watershed statistics for a particular watershed theme. If Spatial Analyst is installed, the background data will be added as grids. Otherwise the data will be added as greyscale images. |
| 6 | Change Model | "Change Watershed Model…" | ***Change Model***: this function is used to change or switch analyses between watershed models. This extension comes with several options (see discussion of Watershed Models) and provides users the ability to customize the AWRD by adding their own data. |
| 7 | N/A | "Add New Watershed Model…" | ***Add New Watershed Model:*** this function allows users to register new custom watershed models or other polygonal themes so they can be used with the tool-sets of the AWRD Watersheds Module. This tool comes with a Simple and an Advanced version. |
| 8 | Change Data | "Change Associated Data…" | ***Change Data***: this function allows the user to customize which data themes (e.g. elevation, precipitation, population densities, etc.) the AWRD should calculate statistics for. |
| 9 | N/A | "Add New Tabular Data…" | ***Add New Tabular Data:*** this function allows a user to generate new data from grid themes. |
| 10 | N/A | "Delete/Remove Data…" | ***Delete/Remove Data:*** this function allows users to delete and/or unregister watershed models, grid themes and specific data tables. |

FIGURE 1.29
**The watershed maintenance tools**



## Watersheds maintenance tools

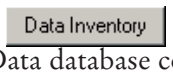
The watershed maintenance tools dialog contains five buttons for exporting and viewing data, and for changing watershed model preferences (Figure 1.29 and Table 1.20).

Table 1.20 provides a summary of the buttons available in the watershed maintenance tools.

TABLE 1.20
**Watersheds maintenance tools buttons**

| Label (Fig.1.29) | AWRD button | AWRD Modules menu option | Action executed |
|---|---|---|---|
| 1 | Report | N/A | Report: The Report button produces a text report summarizing all the data currently presented on the watershed statistics module. The report is saved as a text file on the hard drive and also appears in a text report on the screen. |
| 2 | Export Data | N/A | Export Data: The Export Data button allows users to save the current set of selected watersheds, plus the summary statistics, to a new dBASE table where it can be used with many other software packages. |
| 3 | View Data | *"View Watershed Statistics Source Data..."* | *View Source Data:* This function shows you the background data used to generate the watershed statistics for a particular watershed theme. If Spatial Analyst is installed, the background data will be added as grids. Otherwise the data will be added as greyscale images. |
| 4 | Change Data | *"Change Associated Data..."* | *Change Data*: This function allows the user to customize which data themes (e.g. elevation, precipitation, population densities, etc.) the AWRD should calculate statistics for. |
| 5 | Change Model | *"Change Watershed Model..."* | *Change Model*: This function is used to change or switch analyses between watershed models. This extension comes with several options (see 4.2 Watershed Models) and provides users the ability to customize the AWRD by adding their own data. |

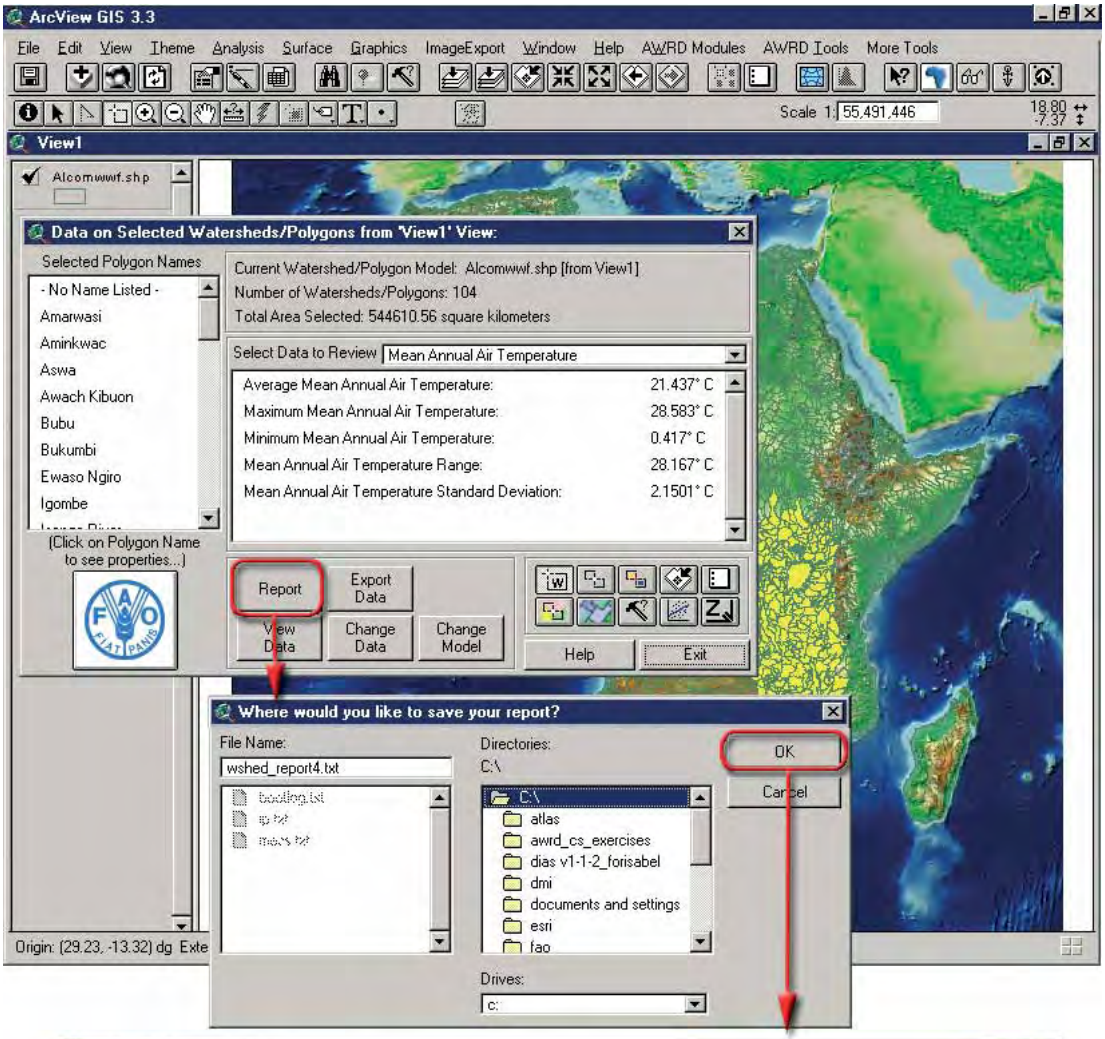
In the following illustrations, the ALCOM watershed model (i.e. Alcomwwwf.shp) was selected to demonstrate the use of AWRD watersheds maintenance tools.

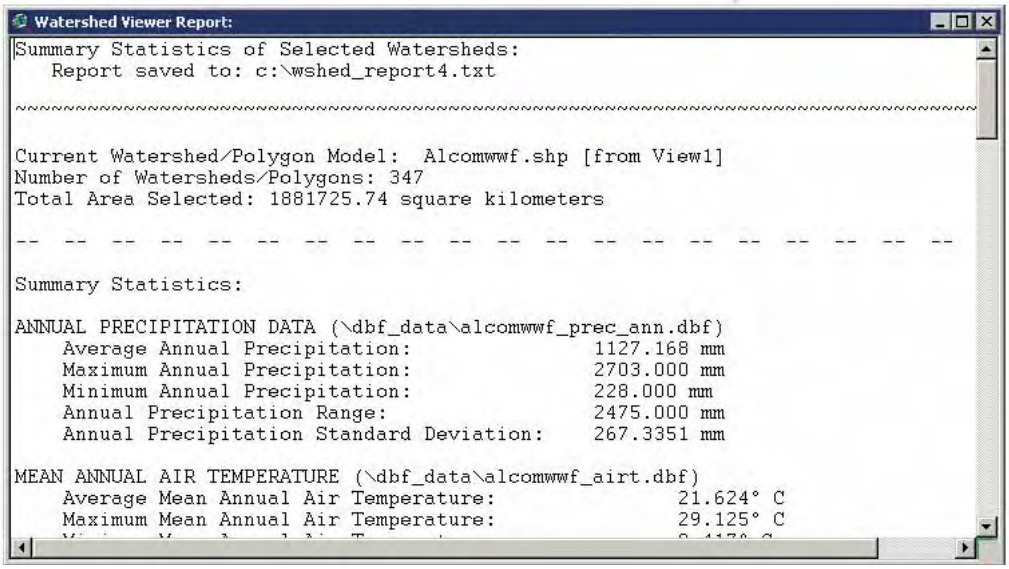
1. Click on the "Add Basemap Image to View" tool  to load one of the image backgrounds (e.g. "Africa_background_2.tif") from the image database component folder. This background image is not necessary for proper functioning of the SWB Viewer, but it makes it easier to locate your area of interest in the view.
2. Click on the "Data Inventory" button  to add the ALCOMWWF watershed model from the Watersheds Data database component.
3. Open the Watersheds Viewer by clicking on the  button on the AWRD interface or by choosing "Open Watersheds Viewer" from AWRD Modules menu.
4. You may be notified that your preferred watershed theme is not present in your view. If you see this message, you will need to set "ALCOMWWF.shp" as your default watershed model. Click the "Specify a new preferred watershed theme" option, and then pick "ALCOMWWF.shp" in the next dialog.
5. Click on the Upstream and Downstream Watersheds button  and the click on any desired location on the watersheds map (i.e. you can select a single watersheds or a group of watersheds). The watersheds selected will be displayed in the "Selected Polygons Names" list and are highlighted in yellow on the watersheds map.

Clicking the "Report Button" 

generates a text report summarizing the statistics for the selected watersheds, saving it as a text file on the hard drive and displaying it in a text report on the screen. In this example a group of watersheds surrounding Lake Tanganyika were selected and are highlighted in yellow (Figure 1.30).

FIGURE 1.30
**Saving the information regarding the selected watershed as a text file on the hard drive and viewing the report produced by the Report button on the screen**

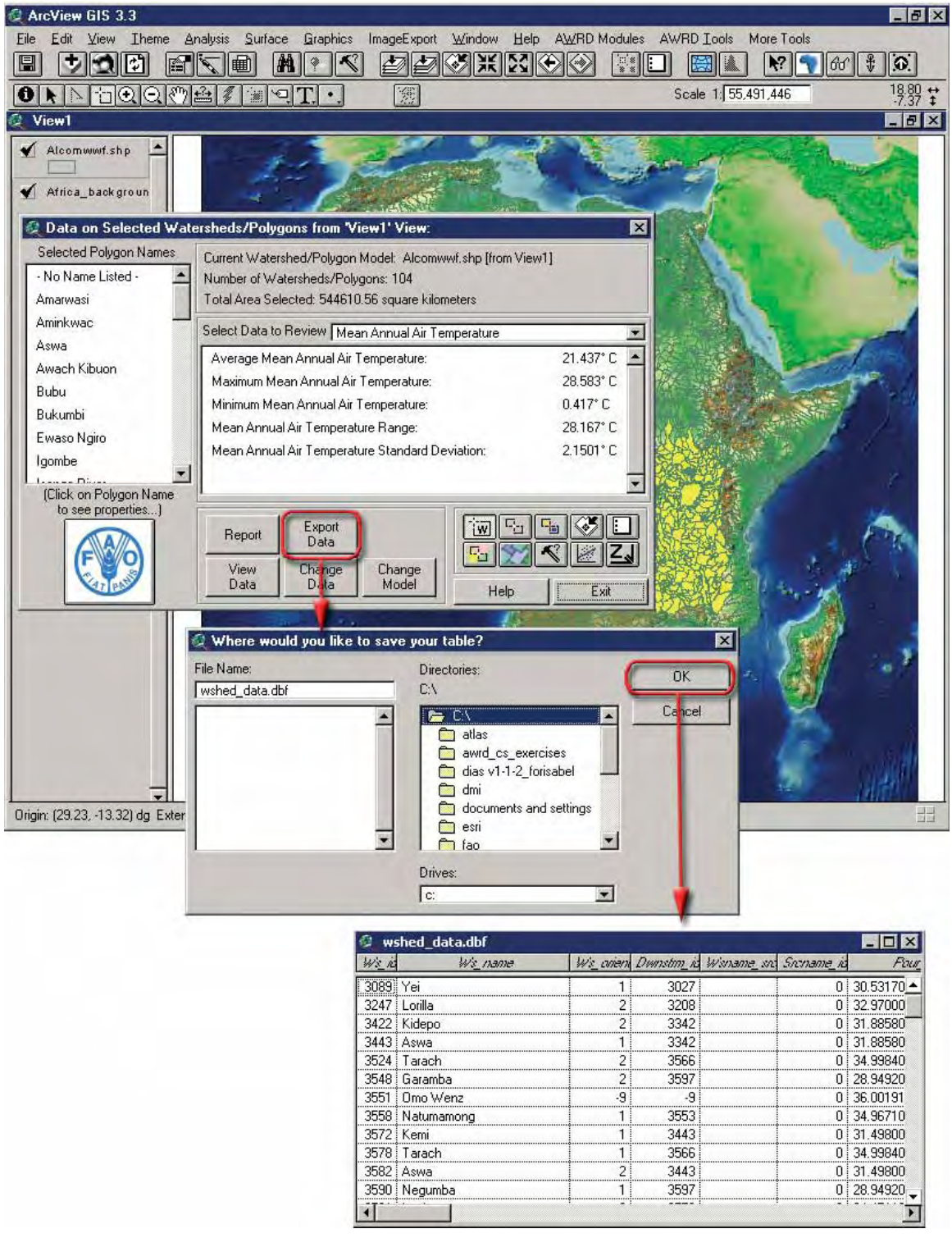


After clicking the "Export Data" button 

the user will be prompted to specify the location to save the table. After clicking the "OK" button, the table will be exported to a dBASE table and then opened in the ArcView project (Figure 1.31). This file that is generated for export is a "dbf" file that can opened in Excel for review and analysis.

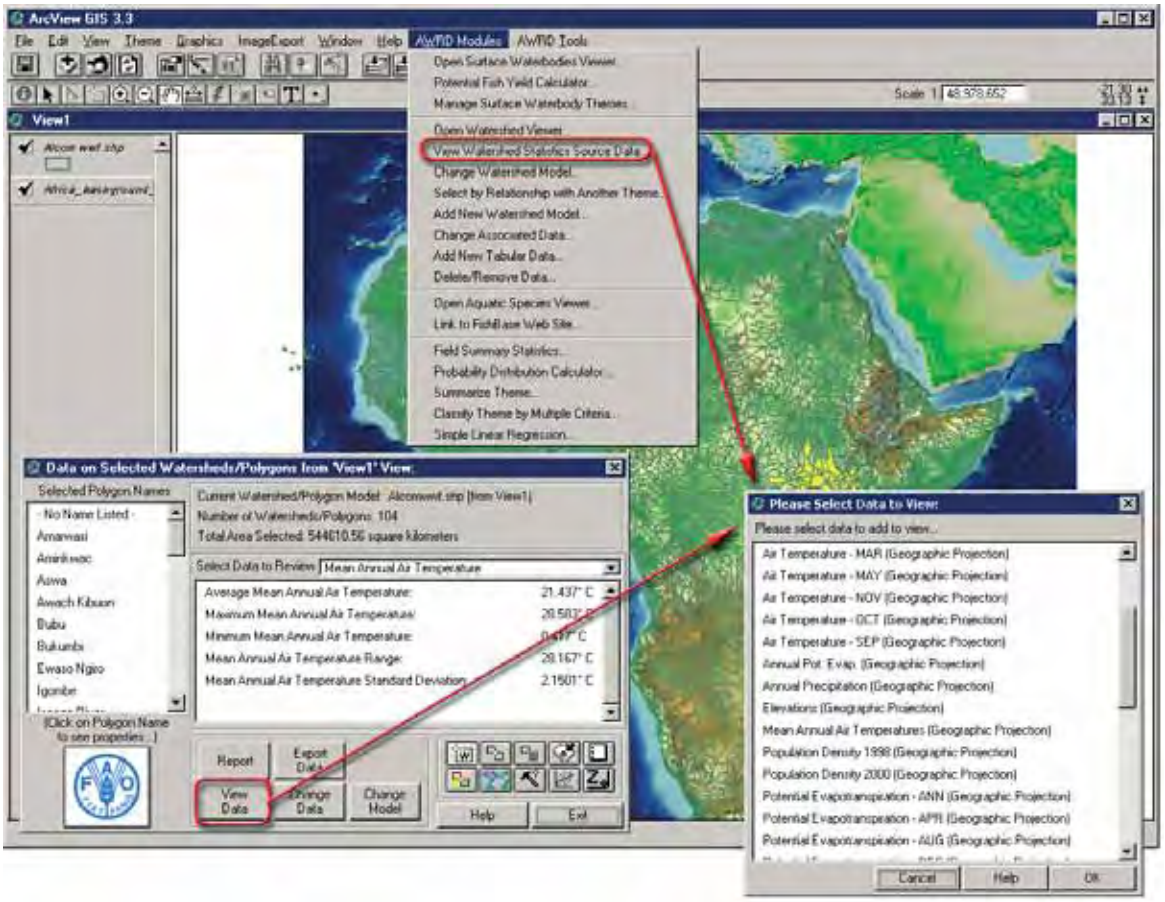
FIGURE 1.31
**Saving the new dataset to a new dBASE table and viewing the dBASE table in the ArcView Project**



After clicking on the "View Data" button 

or selecting the "*View Watershed Statistics Source Data...*" menu option in the AWRD Modules menu the user is prompted to specify which data layers should be added to the view (Figure 1.32).

FIGURE 1.32
**Selection of the data layers**



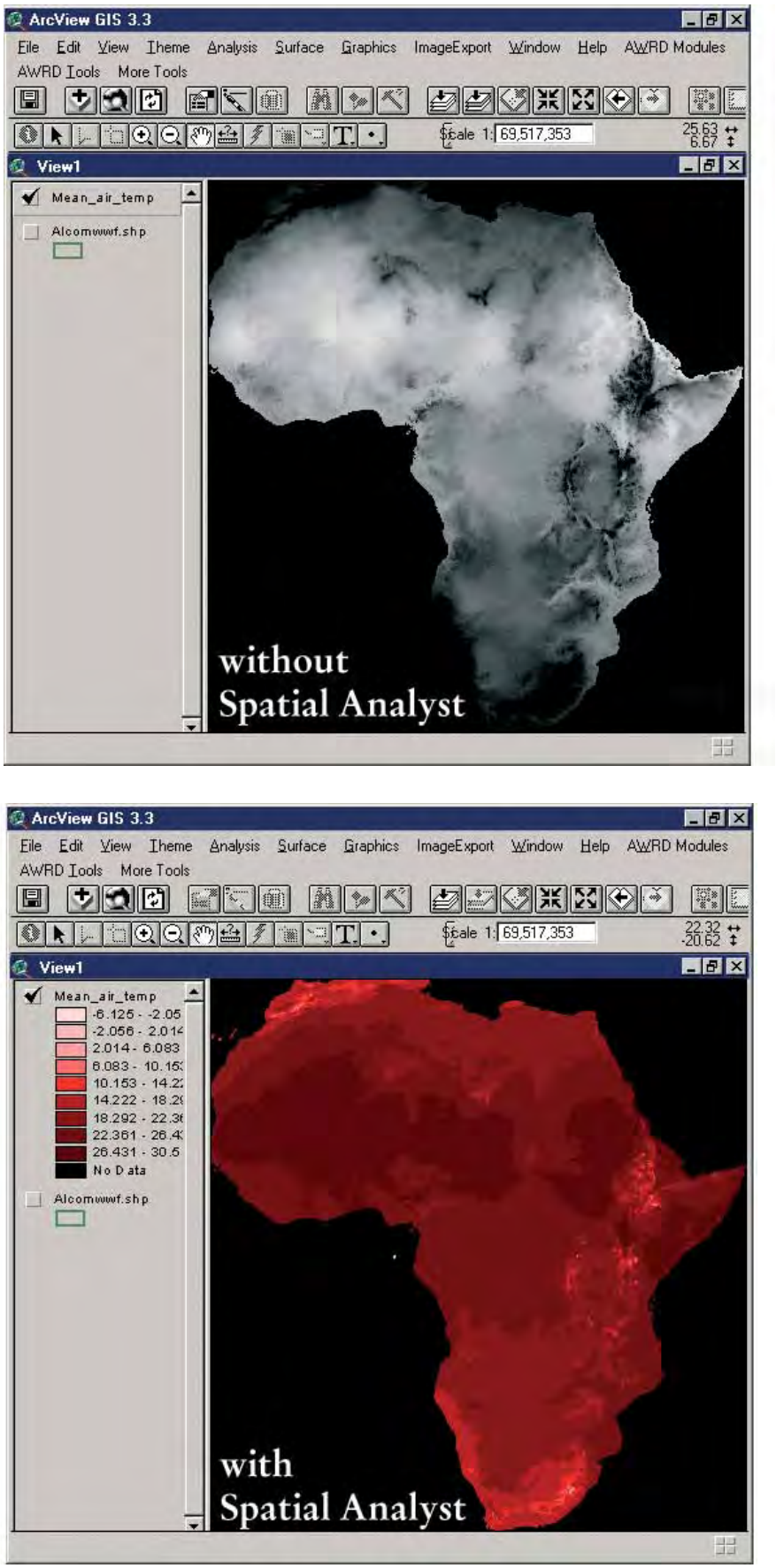

These original data layers are in Grid format so they require Spatial Analyst to be viewed properly. If the user does not have Spatial Analyst, then the "grids" will be added to the view as grey-scale images with the colour ranging from White at the highest values to Black at the lowest values. If the user does have Spatial Analyst, however, then the data layers will appear as Grids and the user can analyse and manipulate them using all the normal grid functions offered by Spatial Analyst. In this example, the "Mean Annual Air Temperature" dataset was selected (Figure 1.33).

The "Change Data" button 

allows the user to customize which data themes (e.g. elevation, precipitation, population densities, etc.) the AWRD should calculate statistics for. This function can also be accessed by selecting the "*Change Associated Data...*" menu option from the main AWRD Modules menu in a View.

Both the button and menu option will open a dialog that allows the user to change which data tables are available for calculating ancillary statistics based on the current selection set of watersheds under the main AWRD Watershed Module dialog. In general–the watershed statistics tool-set will become less responsive and run more slowly with each additional data table a user has selected, so it may be advantageous to avoid including data tables if a user is not interested in them.

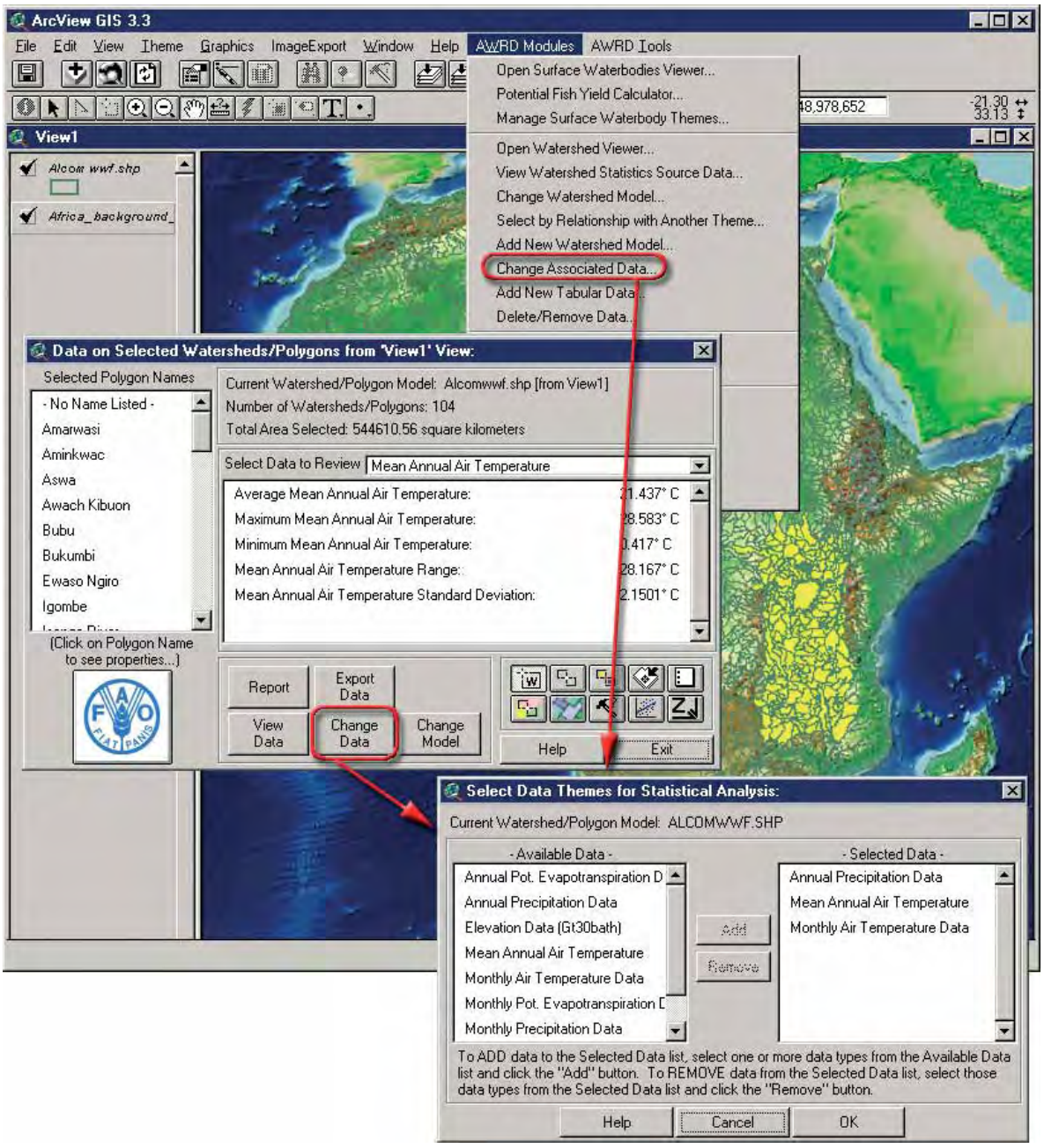
FIGURE 1.33
**Viewing watershed statistics source data (e.g. mean annual air temperature) without Spatial Analyst (on the left) and with Spatial Analyst (on the right)**



Clicking the button or the menu option opens the "Select Data Themes for Statistical Analysis:" dialog. The list on the left shows all the data tables that are available for the selected watershed model. The list on the right shows which of those data tables the user currently has selected for the generation of statistics (Figure 1.34).

FIGURE 1.34

**Changing data for calculating statistics on the selected watersheds**



The user may add to the data tables selected by clicking on any or all of the items in the "–Available Data–" list and clicking the "Add" button. These items will immediately appear in the "–Selected Data–" list.

Similarly, a user may remove any selected data tables by selecting any or all of them from the "–Selected Data–" list and clicking the "Remove" button. Hitting the "Remove" button here does not delete the data, but rather simply tells the Watershed Statistics Module not to calculate statistics for those data. If the user wants to truly delete any of these data, then the "*Delete/Remove Data…*" menu option must be used. The user must hit the "OK" button to apply any changes.

The "Change Model" button 

allows the user to change or switch analyses between watershed models. The AWRD currently has three complex watershed models and two simple watershed delineations "registered" with the interface. This extension comes with several options and provides users the ability to customize the AWRD by adding their own data.

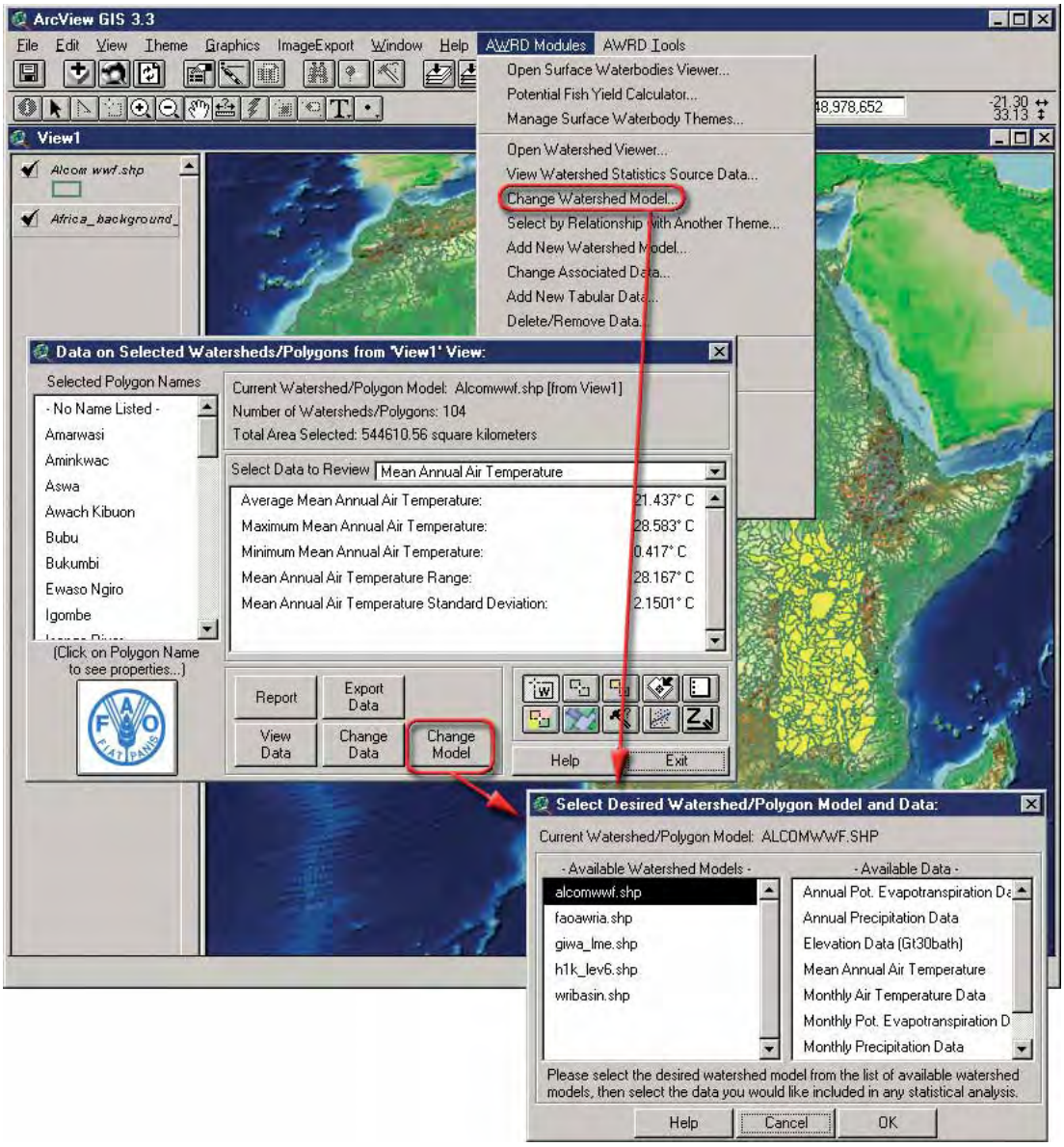
The custom menus and dialogs associated with the Change WS Model function provide the means whereby watershed or other data layers can be "registered" for analysis using the AWRD. Many of the watershed and data analysis tools available in the AWRD are designed to function only if a properly encoded WS model is available. Three such models are provided with the AWRD, along with a default set of core elevation and sample climatological data layers so that the base statistical functions are enabled. However, only one WS model may be analysed at a time, and these Watershed Model Maintenance Tools provide users with the means to change the default WS model, add new watershed models, add new data layers, change processing preferences and modify which analytical layers are examined, and lastly, to remove data from consideration.

The statistical data for the watersheds (e.g. elevation, precipitation, air temperature, water temperature and population densities) are derived from Grid datasets. In order for a particular grid of data to be useful for a particular watershed model, we must conduct statistical analyses on the grid to determine the relevant statistics for each watershed in the model. These statistics are then saved to a table, and this table is joined to the watershed model when the Watershed Statistics Viewer is opened. The Watershed Statistics Viewer works by checking the current selection of watersheds and then looking up the associated statistical data from the data tables, then calculating overall statistics based on the data for each watershed and the sizes of those watersheds.

This extension is designed to enable users to switch among a variety of watershed models or to add additional watershed models and then generate statistical data. Because the statistical data are drawn from Grid themes, users must have ESRI's Spatial Analyst extension in order to revise or generate new statistical data. However, because the relevant summary tables have already been generated from the GTopo30 baseline elevation layer and the sample climatological data layers for each of the three WS models currently registered in the AWRD, even users lacking access to Spatial Analyst will be able to fully utilize the AWRD tool-sets.

This function can be also accessed selecting the "*Change Watershed Model…*" menu option from the main AWRD Modules menu, which opens the "Select Desired Watershed/Polygon Model and Data:" dialog (Figure 1.35).

FIGURE 1.35
**Changing the watershed model to analyse**




At the left of the opened dialog there is an illustrative list of watershed models currently recognized by the interface. If the user would like to switch to a custom watershed model that is not in this list, then the model must first be registered with the interface via the "*Add New Watershed Model...*" menu option. Otherwise the user needs only select one of the existing models by clicking on it.

At the right of the dialog there is a list of available data tables. These are statistical data that have already been generated from the respective grids for this watershed model.

If a user wishes to add new data to this list, the "*Add New Tabular Data…*" menu option should be clicked; the user must have Spatial Analyst installed or this option will not be available. Otherwise, the user needs only to select any or all of the data tables required. Users may find that the Watershed Statistics Viewer runs faster when fewer of these data sets are selected, so it may be advantageous to limit selections of ancillary data. The watershed and ancillary data selections made by the user are applied when the "OK" button is clicked. After this, the chosen watershed model will become the new default model utilized by the AWRD each time it is opened, until such time as a new model is chosen.