

Watershed Modeling and Biomonitoring to Determine Optimal Restoration Strategies for Intermittent Transboundary Streams between Palestine and Israel

Prepared by

Dr. Amjad Aliewi

Eng. Muath Abu Sadah

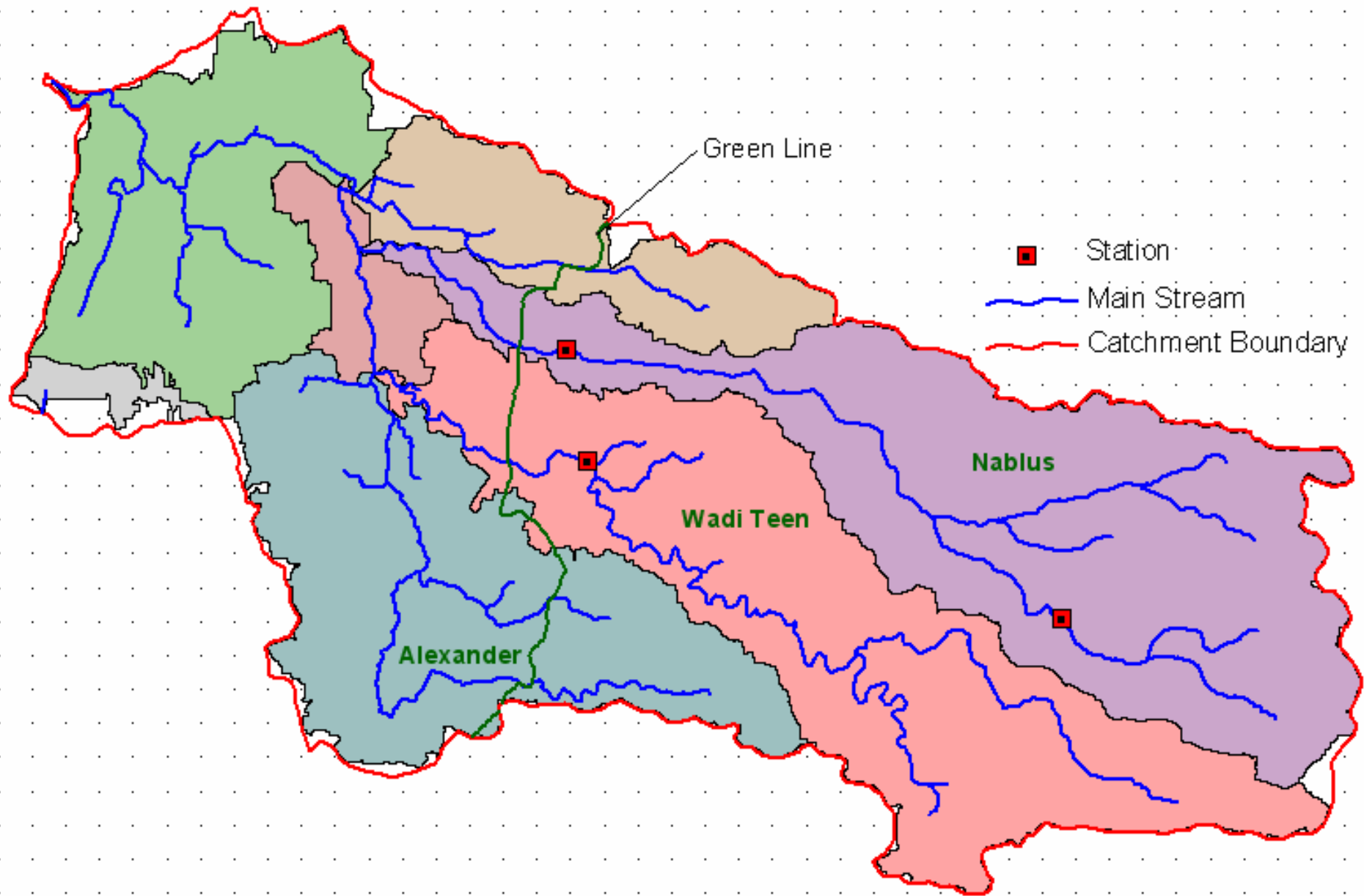
Eng. Amjad Assi



House of Water and Environment

Stage One : Selection the Monitored Streams

- The Palestinian-Israeli research teams selected sites and streams.
- They drew up an inventory of wastewater treatment facilities discharging into the transboundary streams, finalized monitoring protocols and timetable.
- The selected streams in the two catchments are:-
 - Alexander Catchment: (Wadi Alexander Wadi Zeimar and Wadi Al Teen) in the North of the West Bank.
 - Besor Catchment: (Wadi Hebron) in the South of the West Bank.
- It has been decided that we are going to model Wadi Zeimar and Wadi Al Teen in Alexander Catchment.



Three main sub basins (Zeimar, Wadi Teen and Alexander) were defined to be modeled.

Stage Two : Collection and Inventory of all Available Monitoring Data

- The main flow of Wadi Zeimar is wastewater discharged from the localities along the wadi mainly from Nablus City (in winter, the wastewater mixes with rainfall runoff), so the following data were collected:
 - Wastewater generation from the Palestinian localities and Israeli Settlements.
 - Their water quality.
- There are many point sources of pollution in Alexander Catchment that are highly polluting the water, these:
 - Stone cutting.
 - Dumping Sites (mainly Tulkarem Dumping Site).
 - Olive mills.
 - Gas Stations.
 - Cesspits.
- The coordinates of most of these point sources of pollution were determined by using MAGELLAN /eXplorist 100 GPS, with accuracy ranges between 3-20 meters.



Tulkarem Dumping Site



The Effect of Stone Cutting

Wastewater Wadis as Hotspots

- Wastewater Wadis Versus wells
- Effect of Zeimar on GW in the WAB
- Wadis affect wells of Eastern Basin (AL FAR'A)

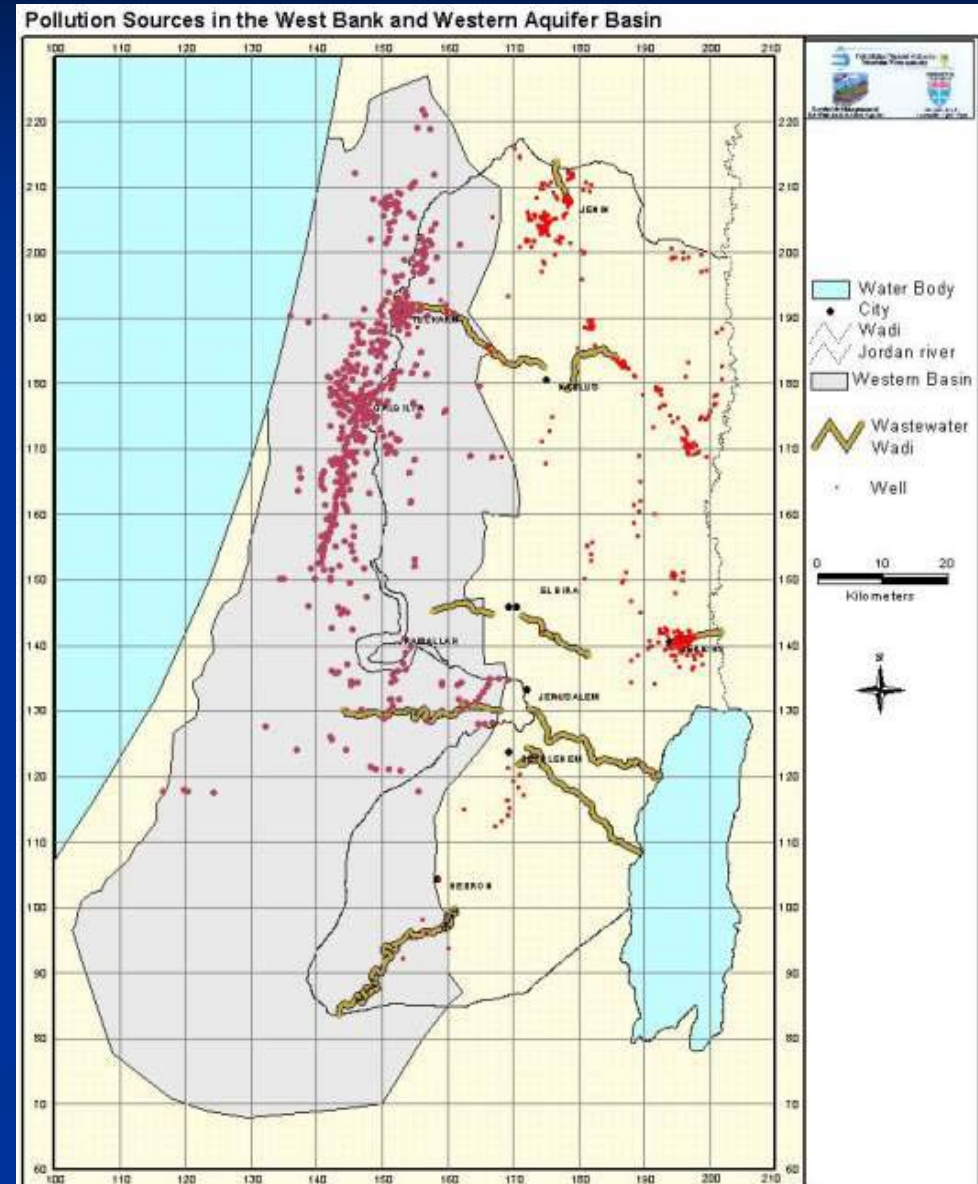
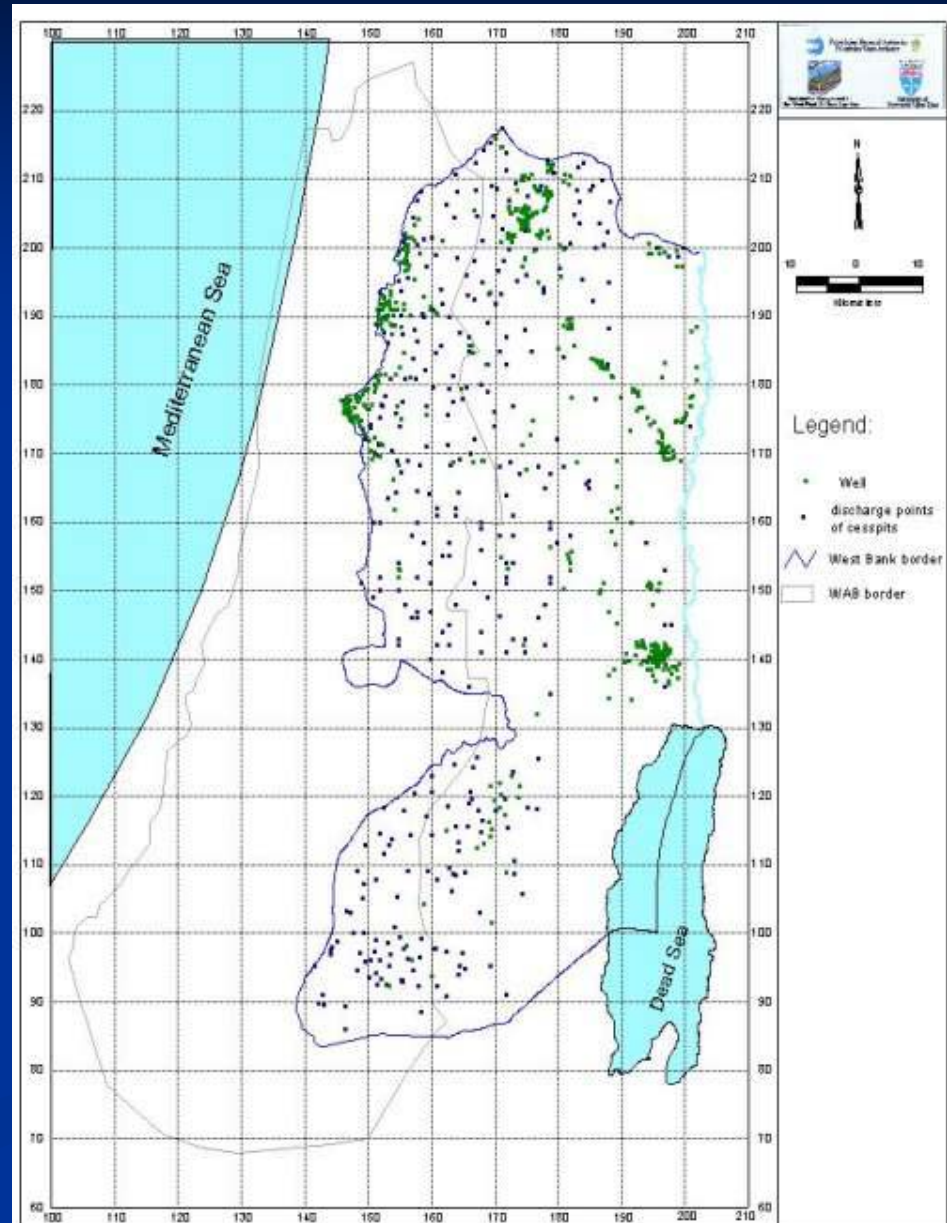


Figure 5: Wastewater Wadis versus Wells in the Study Area

Discharge Points of Cesspits

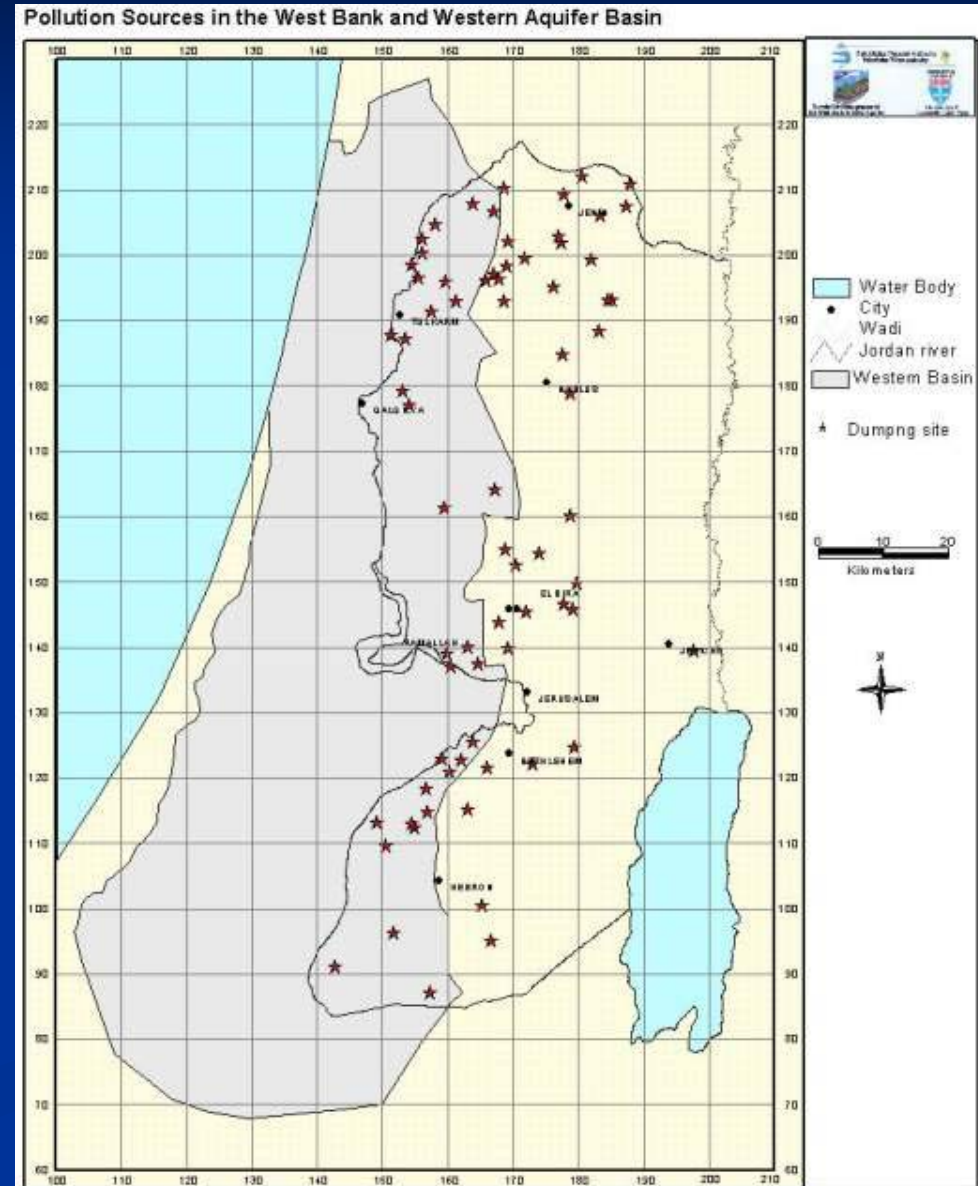
Intensive, could affect water quality specially for shallow aquifers such as Pleistocene in Jericho, Eocene in Jenin and Quaternary in Qalqilya and Tulkarem



Map 6: Discharge points of cesspits vs wells in West Bank

Location of the Dumping Sites

Characterized by diversity of pollutants from the solid wastes



Location of the WW Networks

There are just some points of sewer discharge points from networks,

But

with relatively high discharge since they are connected to the main cities.

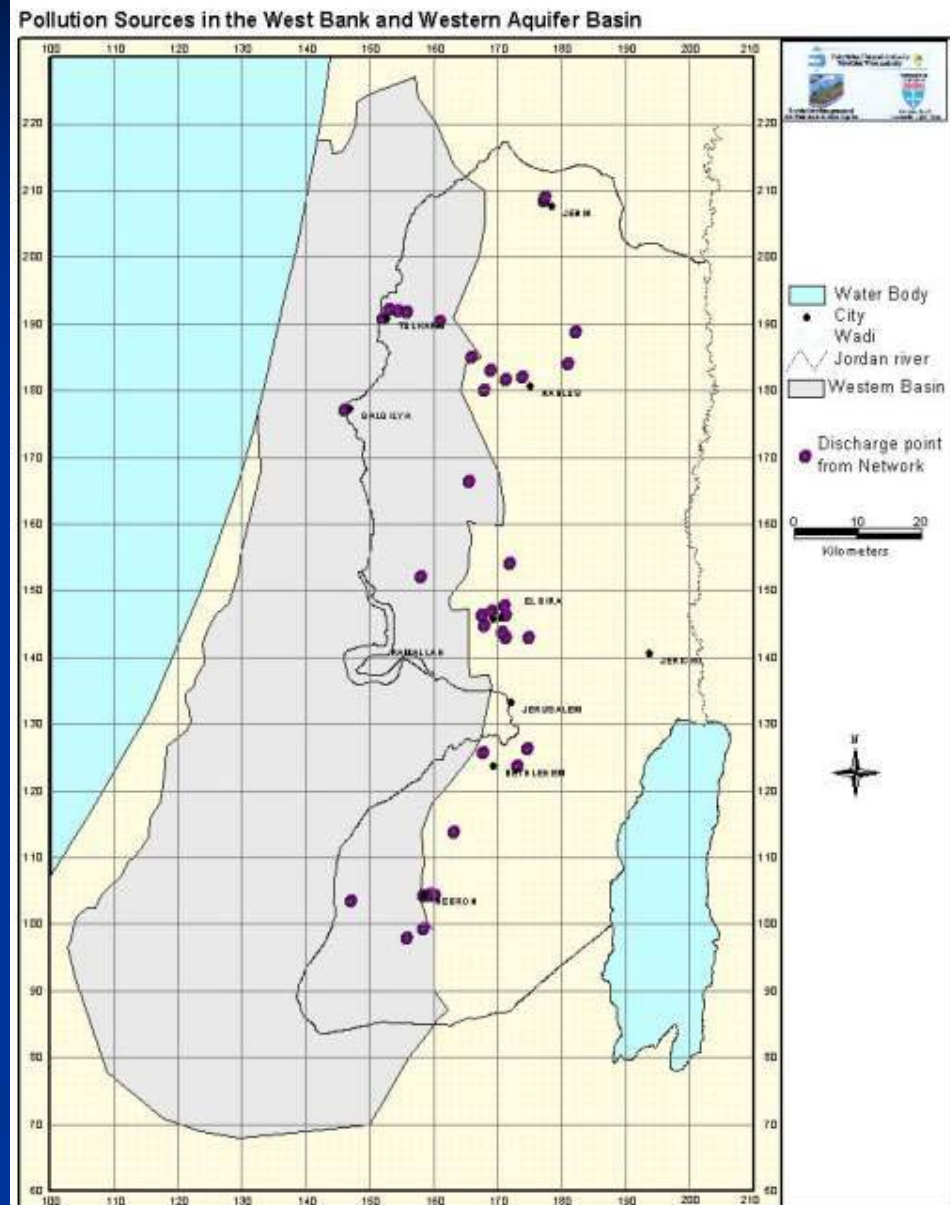


Figure 2: Discharge points from Networks

Pollution inputs in relation to Abstractions

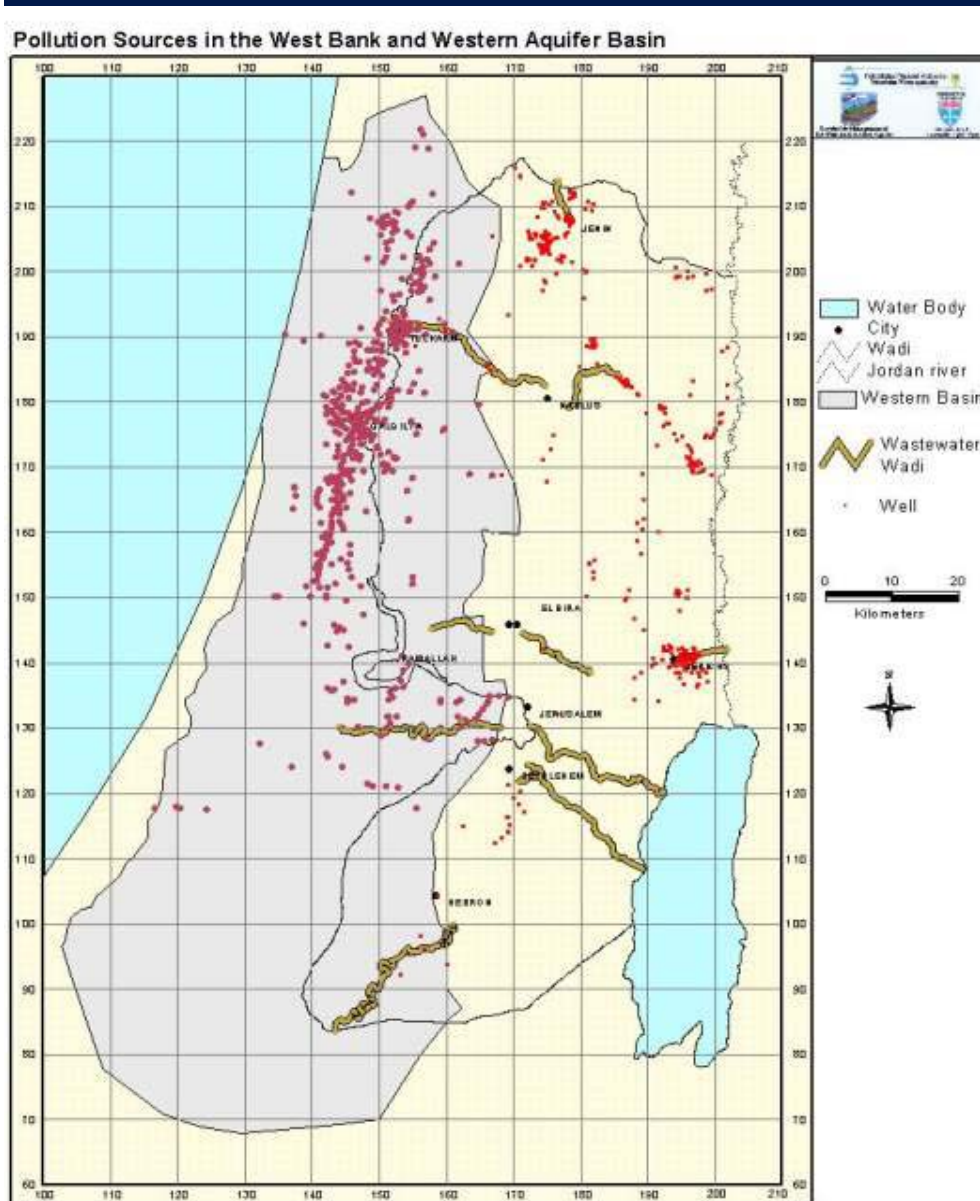
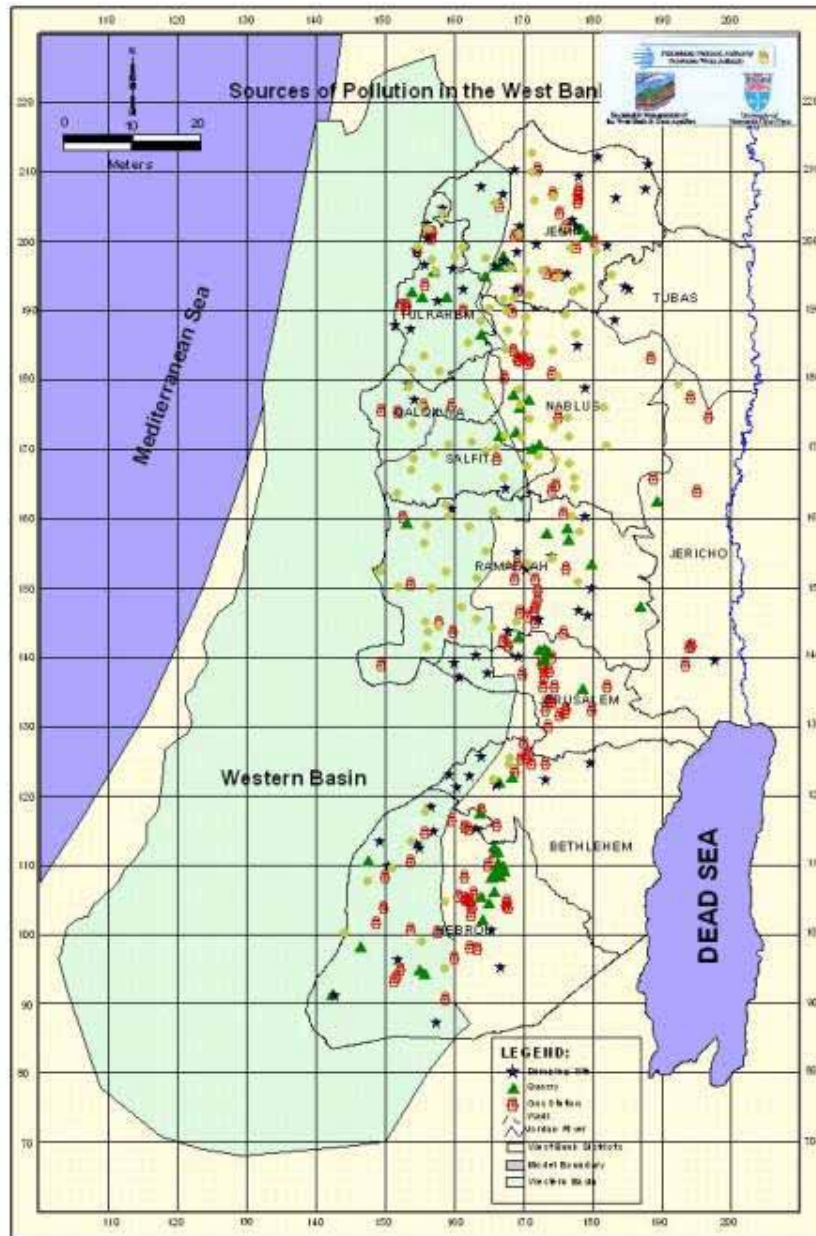
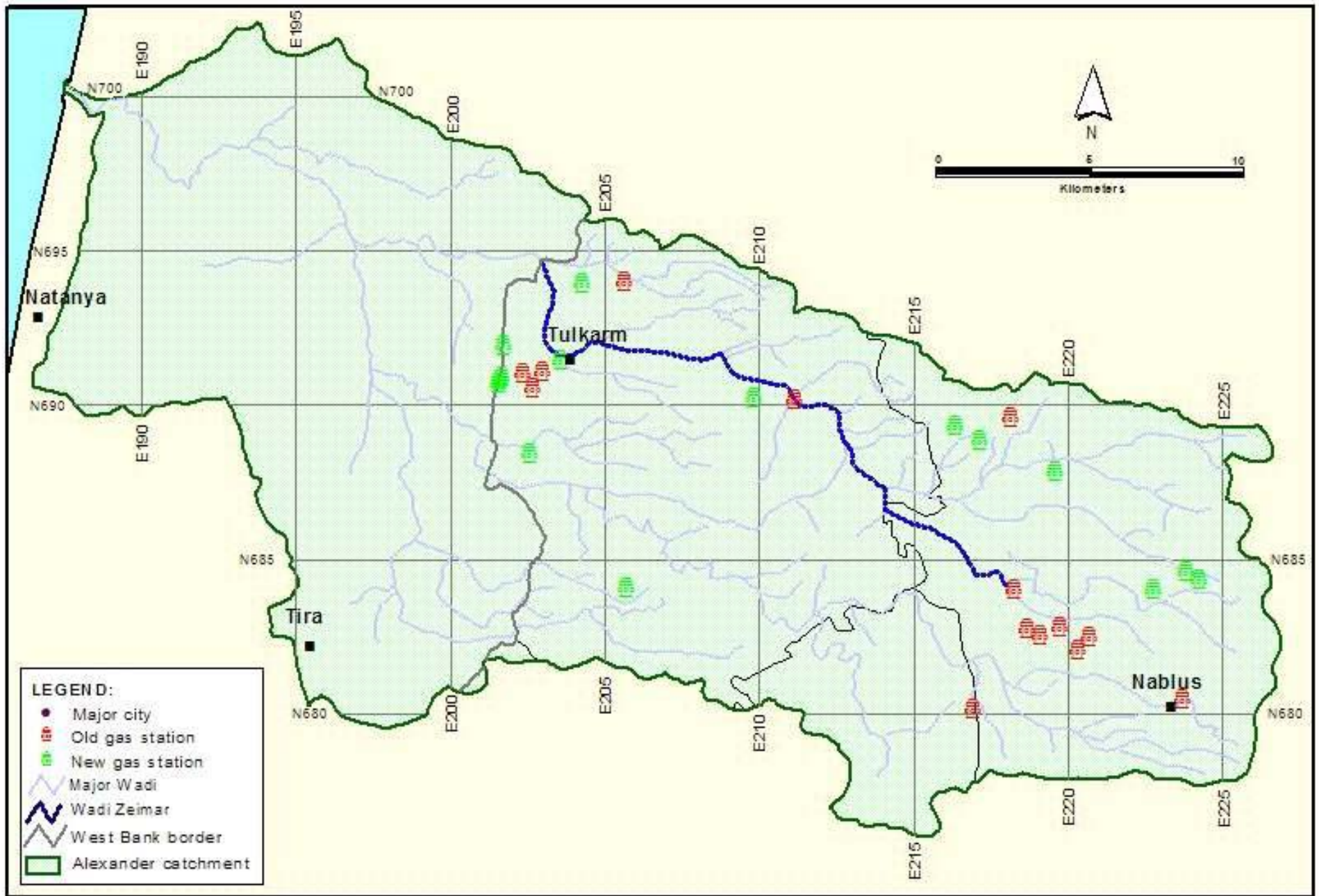


Figure 5: Wastewater Wadis versus Wells in the Study Area

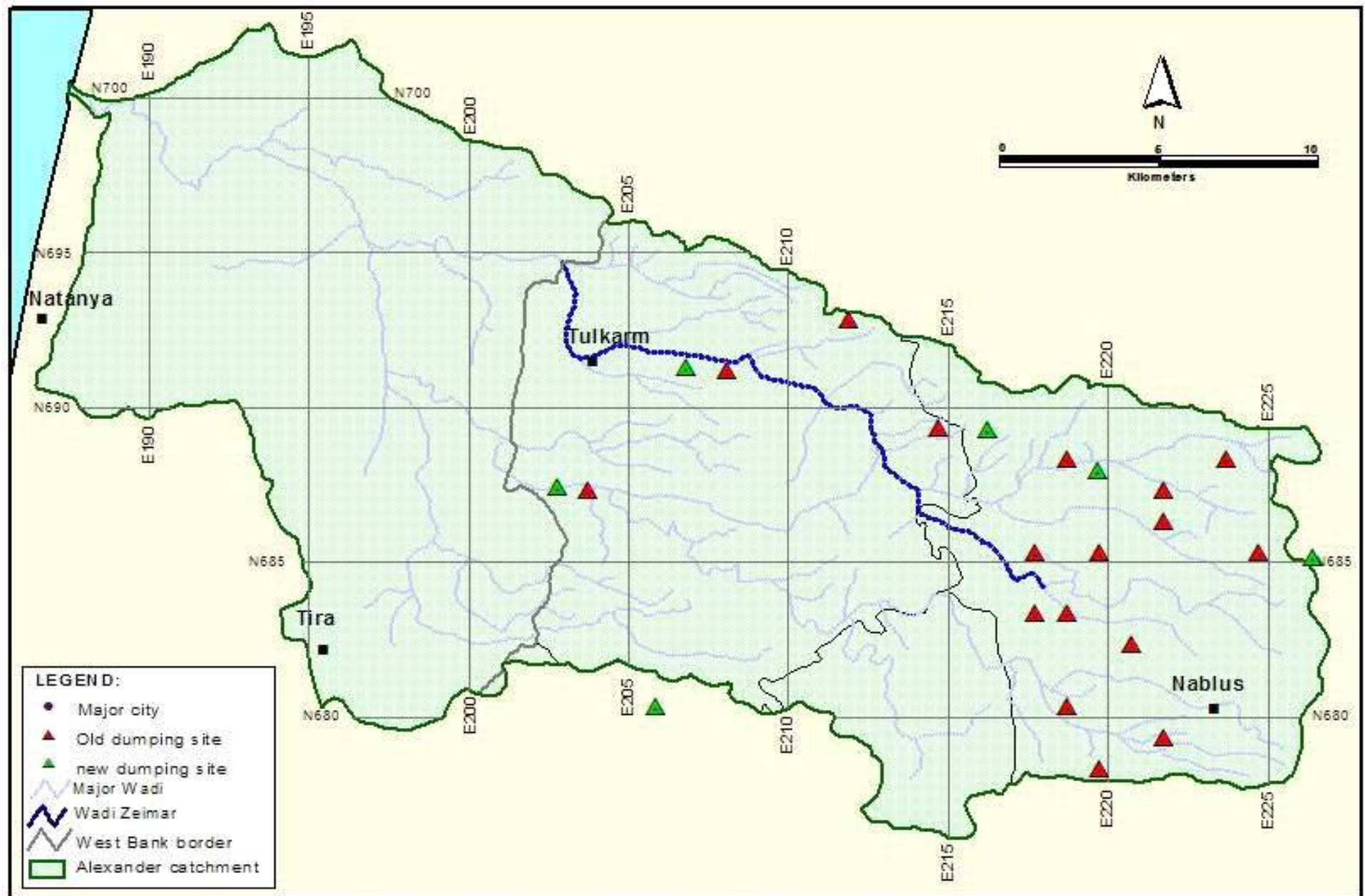
Hazard hot spots occur where pollution sources are in sensitive areas in proximity to abstractions



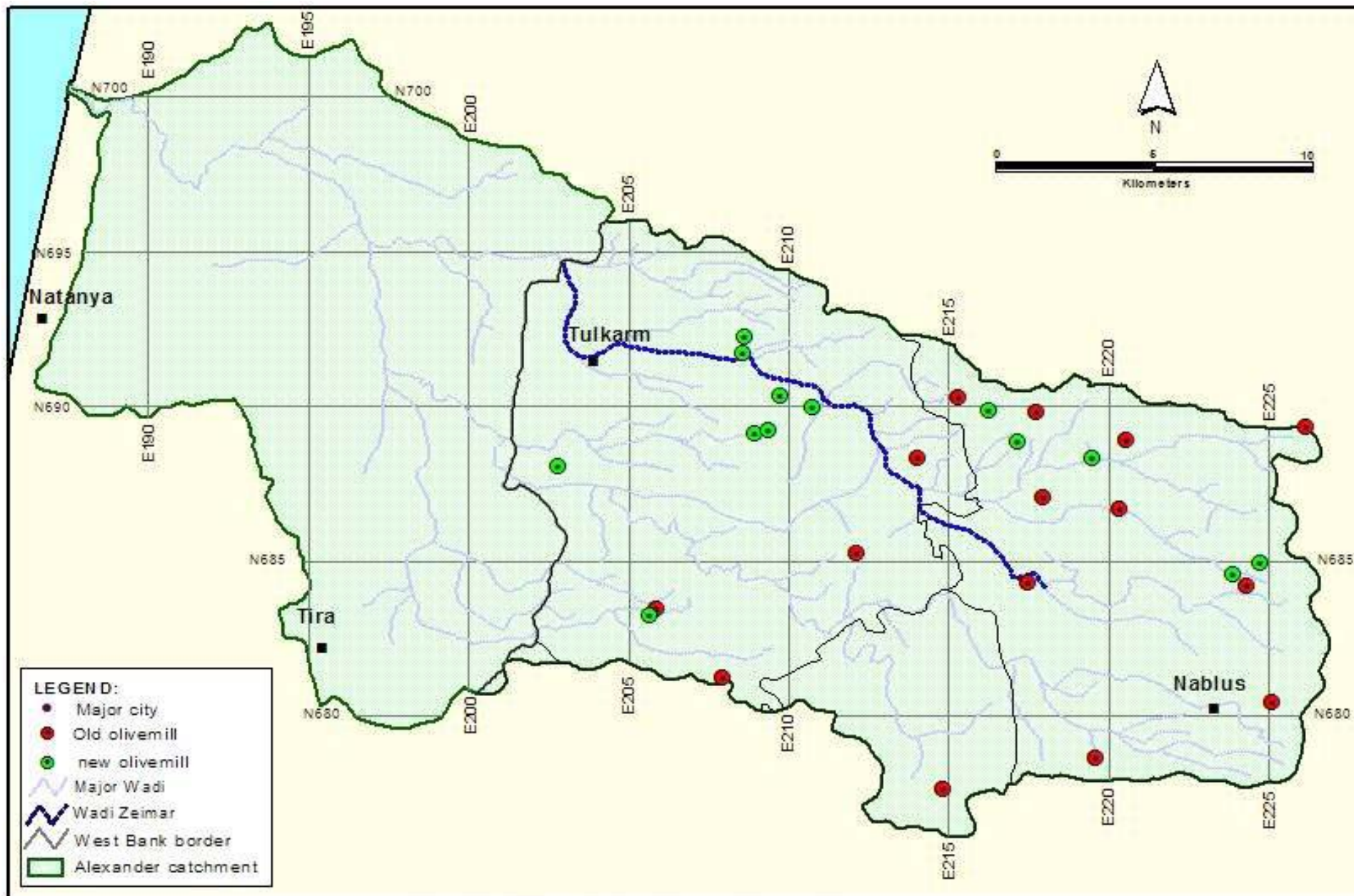
Locations of Gas stations, quarries, dumping sites and olive mills in the WB



Location of Gas stations at the catchment area



Location of dumping sites at the catchment area



Location of olivemills in the catchment area

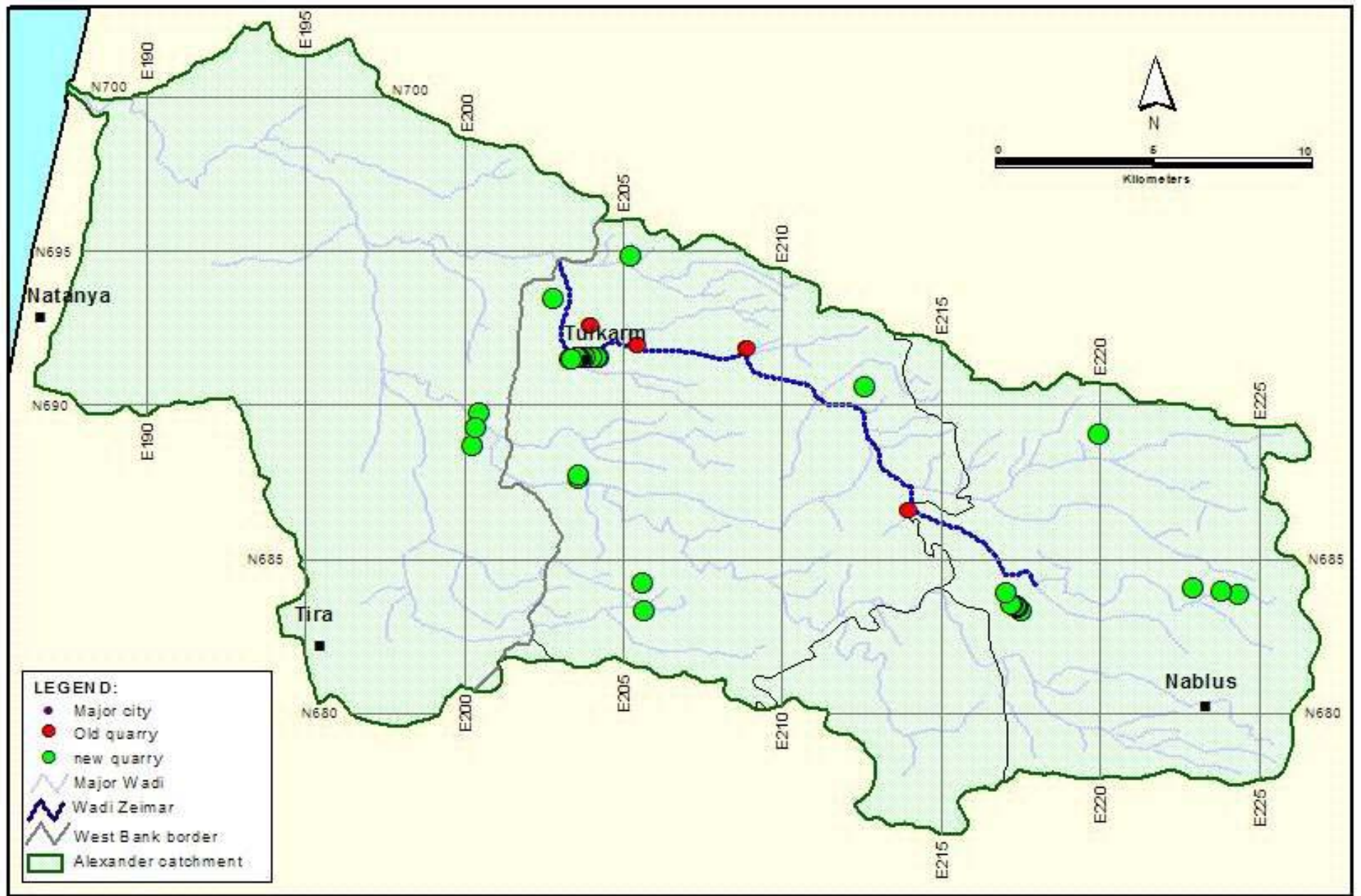


Figure5: Location of quarries at the catchment area

Stage Three : Preparing Data-base Framework

- The collected data are to be organized in a data-base framework as shown below

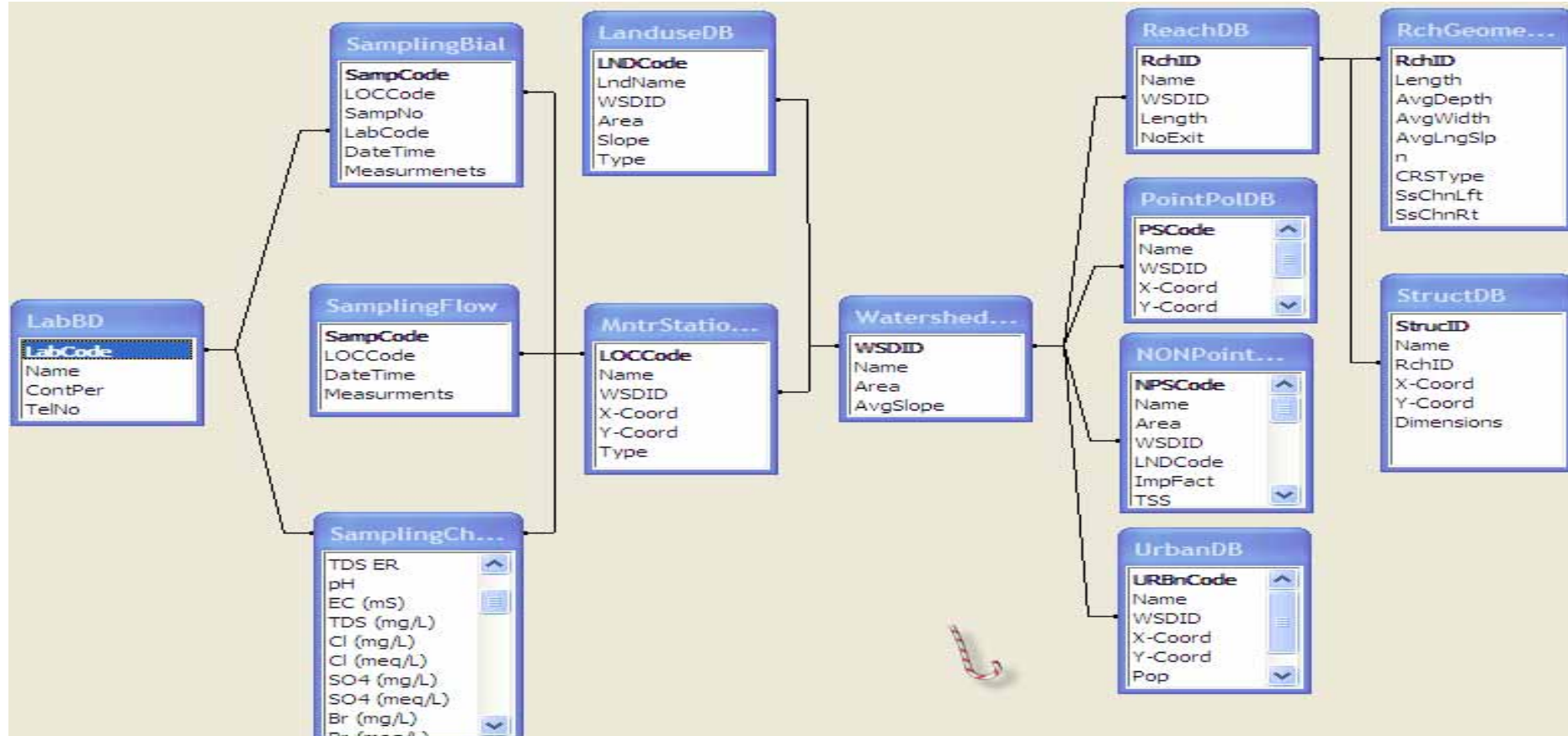


Table 1 (WatershedDB): Watershed database, Contains information of all sub-watersheds within the main watershed.

The screenshot displays a software window titled "WatershedDB : Table" with a table and a "Field Properties" section. The table lists fields: WSDID (Text, Watershed ID), Name (Text), Area (Text), and AvgSlope (Text). The "Field Properties" section includes tabs for "General" and "Lookup", with various settings like Field Size (50), Format, Input Mask, Caption, Default Value, Validation Rule, Validation Text, Required, Allow Zero Length, Indexed, Unicode Compression, IME Mode, IME Sentence Mode, and Smart Tags. A note on the right states: "A field name can be up to 64 characters long, including spaces. Press F1 for help on field names." The map on the right shows a watershed boundary with a sub-watershed highlighted in orange.

| Field Name | Data Type | Description |
|------------|-----------|--------------|
| WSDID | Text | Watershed ID |
| Name | Text | |
| Area | Text | |
| AvgSlope | Text | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

Field Properties

General Lookup

Field Size: 50
Format:
Input Mask:
Caption:
Default Value:
Validation Rule:
Validation Text:
Required: No
Allow Zero Length: Yes
Indexed: Yes (No Duplicates)
Unicode Compression: Yes
IME Mode: No Control
IME Sentence Mode: None
Smart Tags:

A field name can be up to 64 characters long, including spaces. Press F1 for help on field names.

Table 2 (ReachDB): Reach (river segment) database

ReachDB : Table

| Field Name | Data Type | Description |
|------------|-----------|-----------------|
| RchID | Text | Reach code |
| Name | Text | |
| WSDID | Text | Watershed Code |
| Length | Number | |
| NoExit | Number | Number of exits |

Field Properties

General Lookup

| | |
|---------------------|---------------------|
| Field Size | 50 |
| Format | |
| Input Mask | |
| Caption | |
| Default Value | |
| Validation Rule | |
| Validation Text | |
| Required | No |
| Allow Zero Length | Yes |
| Indexed | Yes (No Duplicates) |
| Unicode Compression | Yes |
| IME Mode | No Control |
| IME Sentence Mode | None |
| Smart Tags | |

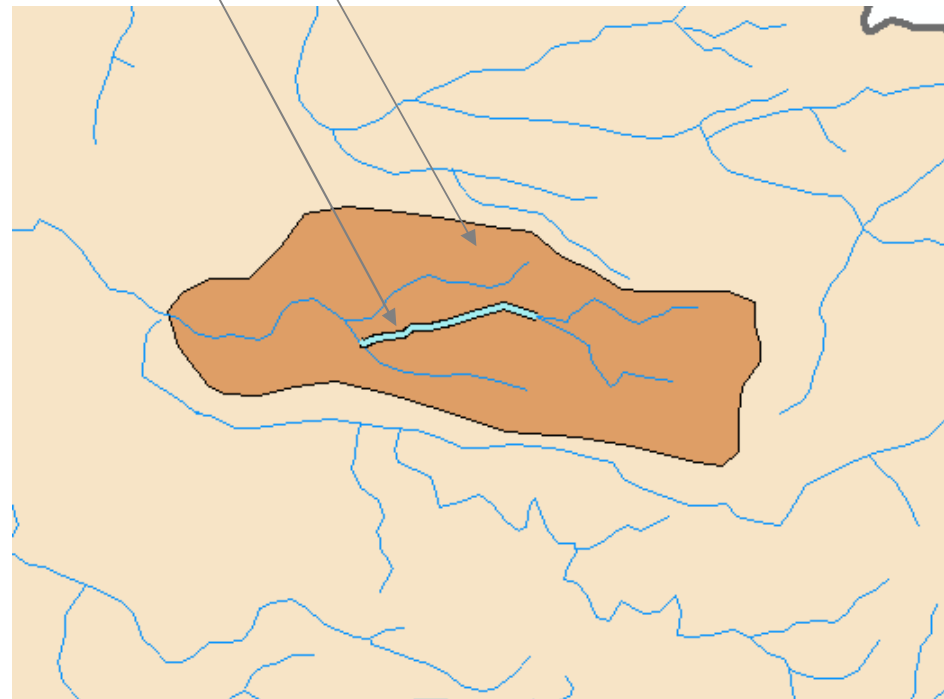


Table 3 (RchGeometryDB): Geometrical description of Reaches (river segments) within the main watershed

The image shows a screenshot of the 'RchGeometryDB : Table' dialog box in a GIS application. The dialog box is divided into two main sections: a table of field properties and a 'Field Properties' section.

| Field Name | Data Type | Description |
|------------|-----------|---|
| RchID | Text | Reach Code |
| Length | Text | |
| AvgDepth | Text | |
| AvgWidth | Text | |
| AvgLngSlp | Text | Average long slope |
| n | Text | Mannings Roughness Coeff. |
| CRSType | Text | Type of x-section (Trapezoidal, Rectangular, ...) |
| SsChnLft | Text | Side slope of channel left |
| SsChnRt | Text | Side slope of channel Right |

Below the table is the 'Field Properties' section, which is currently on the 'General' tab. It contains a list of properties and their values:

| | |
|---------------------|---------------------|
| Field Size | 50 |
| Format | |
| Input Mask | |
| Caption | |
| Default Value | |
| Validation Rule | |
| Validation Text | |
| Required | No |
| Allow Zero Length | Yes |
| Indexed | Yes (No Duplicates) |
| Unicode Compression | Yes |
| IME Mode | No Control |
| IME Sentence Mode | None |
| Smart Tags | |

To the right of the dialog box is a map of a watershed with a network of blue lines representing rivers. A specific reach is highlighted in brown. A callout box points to this reach with the text: 'A field name can be up to 64 characters long, including spaces. Press F1 for help on field names.'

Table 4 (StructDB): Structural database: Locations and Description of all structures within all reaches.

| Field Name | Data Type | Description |
|------------|-----------|--|
| StrucID | Text | Structure Code |
| Name | Text | |
| RchID | Text | Reach code (Where the structure located) |
| X-Coord | Number | Eastern Coordinates |
| Y-Coord | Number | Northern Coordinates |
| Dimensions | Text | Structural dimensions |

Field Properties

General Lookup

Field Size: 50

Format:

Input Mask:

Caption:

Default Value:

Validation Rule:

Validation Text:

Required: No

Allow Zero Length: Yes

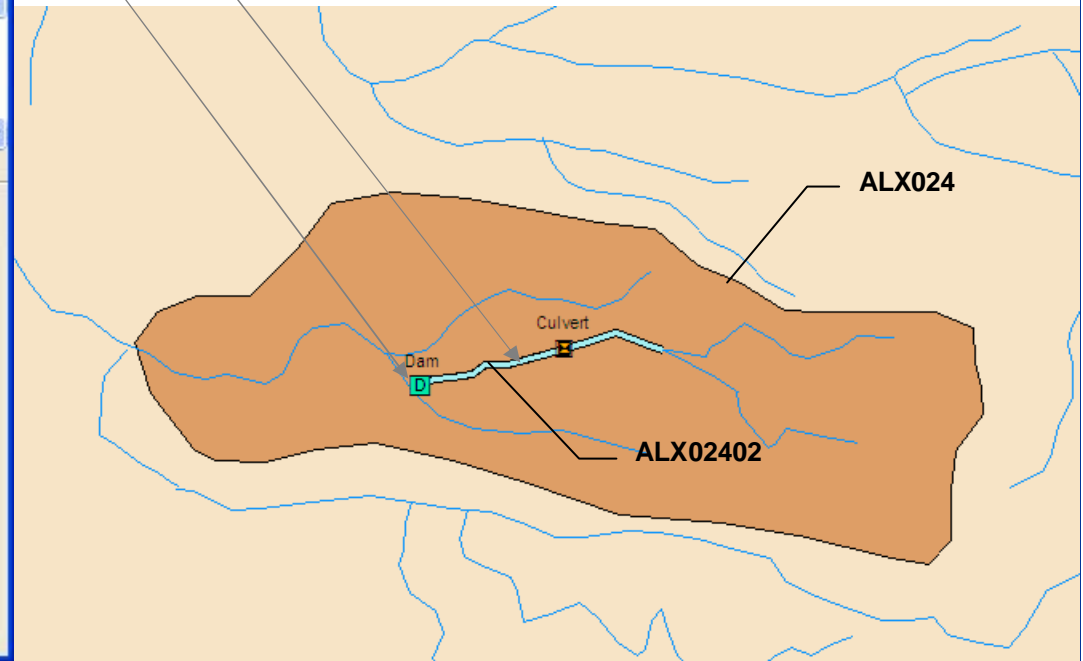
Indexed: Yes (No Duplicates)

Unicode Compression: Yes

IME Mode: No Control

IME Sentence Mode: None

Smart Tags:



**Table 5 (PointPolDB): point source of pollution database:
Locations and pollution loads of all point sources of pollutions
within watershed.**

PointPolDB : Table

| Field Name | Data Type | Description |
|------------|-----------|--|
| PSCode | Text | Code of point source of pollution |
| Name | Text | |
| WSDID | Text | Watershed ID |
| X-Coord | Number | Eastern Coordinate |
| Y-Coord | Number | Northern Coordinate |
| Type | Text | Type of pollutant (Solids, total suspended |
| Load | Number | rate of pollutant (kg/hr) |

Field Properties

General

| | |
|---------------------|---------------------|
| Field Size | 50 |
| Format | |
| Input Mask | |
| Caption | |
| Default Value | |
| Validation Rule | |
| Validation Text | |
| Required | No |
| Allow Zero Length | Yes |
| Indexed | Yes (No Duplicates) |
| Unicode Compression | Yes |
| IME Mode | No Control |
| IME Sentence Mode | None |
| Smart Tags | |

A field name can be up to 64 characters long.

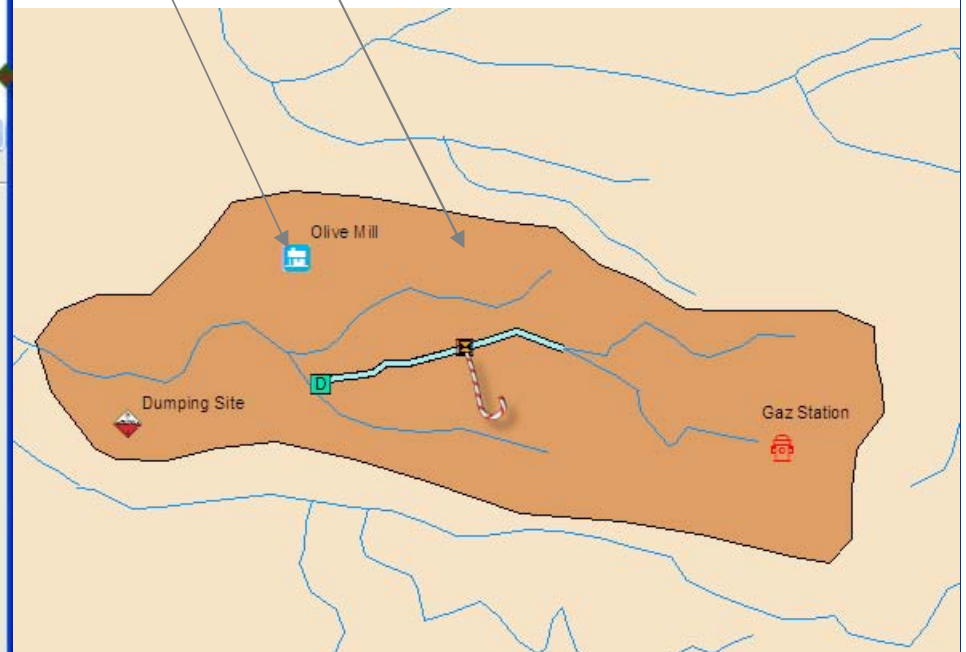


Table 6 (NONPointPoIDB): non-point source of pollution database: Locations and pollution load rates of all non-point source of pollutions within watershed.

| Field Name | Data Type | Description |
|----------------|-----------|--|
| NPSCode | Text | Code of non-point source of pollution |
| Name | Text | |
| Area | Number | |
| WSDID | Text | Watershed ID |
| LNDCode | Text | Code of landuse area |
| ImpFact | Number | Percentage of imperviousness for each land use |
| TSS | Memo | |
| TDS | Number | |
| BOD | Number | |
| COD | Number | |
| Phosph | Number | Phosphorous |
| Nitrogen | Number | |
| Nitrate | Number | |
| Nitrite | Number | |
| TKN | Number | |
| Ammonia | Number | |
| FcClfrm | Number | Feacal Coliform |
| Lead | Number | |
| Zinc | Number | |

| Field Properties | |
|---------------------|---------------------|
| General | Lookup |
| Field Size | 50 |
| Format | |
| Input Mask | |
| Caption | |
| Default Value | |
| Validation Rule | |
| Validation Text | |
| Required | No |
| Allow Zero Length | Yes |
| Indexed | Yes (No Duplicates) |
| Unicode Compression | Yes |
| IME Mode | No Control |
| IME Sentence Mode | None |
| Smart Tags | |



Table 7 (UrbanDB): Urban areas database: Locations of urban areas within watershed.

The image displays a GIS software interface. On the left, a window titled "UrbanDB : Table" shows a table with the following fields:

| Field Name | Data Type | Description |
|------------|-----------|----------------------------|
| URBnCode | Text | Code of the Urbanized area |
| Name | Text | |
| WSDID | Text | Watershed ID |
| X-Coord | Number | Eastern Coordinate |
| Y-Coord | Number | Northern Coordinate |
| Pop | Number | Population |
| PopGth | Number | population Growth |

Below the table, the "Field Properties" section is visible, with the "General" tab selected. The "Field Size" is set to 50. Other properties include Format, Input Mask, Caption, Default Value, Validation Rule, Validation Text, Required (No), Allow Zero Length (Yes), Indexed (Yes (No Duplicates)), Unicode Compression (Yes), IME Mode (No Control), IME Sentence Mode (None), and Smart Tags.

On the right, a map shows a watershed boundary in brown. Inside the watershed, there are several features: "Anabta" (a green polygon), "Olive Mill" (a blue icon), "Dumping Site" (a red diamond icon), "Grasslands" (a green patterned area), and "Gaz Station" (a red gas pump icon). Blue lines represent water bodies or roads. A line from the "URBnCode" field in the table points to the "Anabta" feature on the map.

Table 8 (LanduseDB): Landuse database

| Field Name | Data Type | Description |
|------------|-----------|--|
| LNDCode | Text | Code of landuse area |
| LndName | Text | Landuse name (Forest, Agricultural, Urban, . |
| WSDID | Text | Watershed ID |
| Area | Number | |
| Slope | Number | |
| Type | Text | Impervious or Pervious |

| Field Properties | |
|---------------------|---------------------|
| Field Size | 50 |
| Format | |
| Input Mask | |
| Caption | |
| Default Value | |
| Validation Rule | |
| Validation Text | |
| Required | No |
| Allow Zero Length | Yes |
| Indexed | Yes (No Duplicates) |
| Unicode Compression | Yes |
| IME Mode | No Control |
| IME Sentence Mode | None |
| Smart Tags | |

A field name can be up to 64 characters long, including spaces. Press F1 for help on field names.

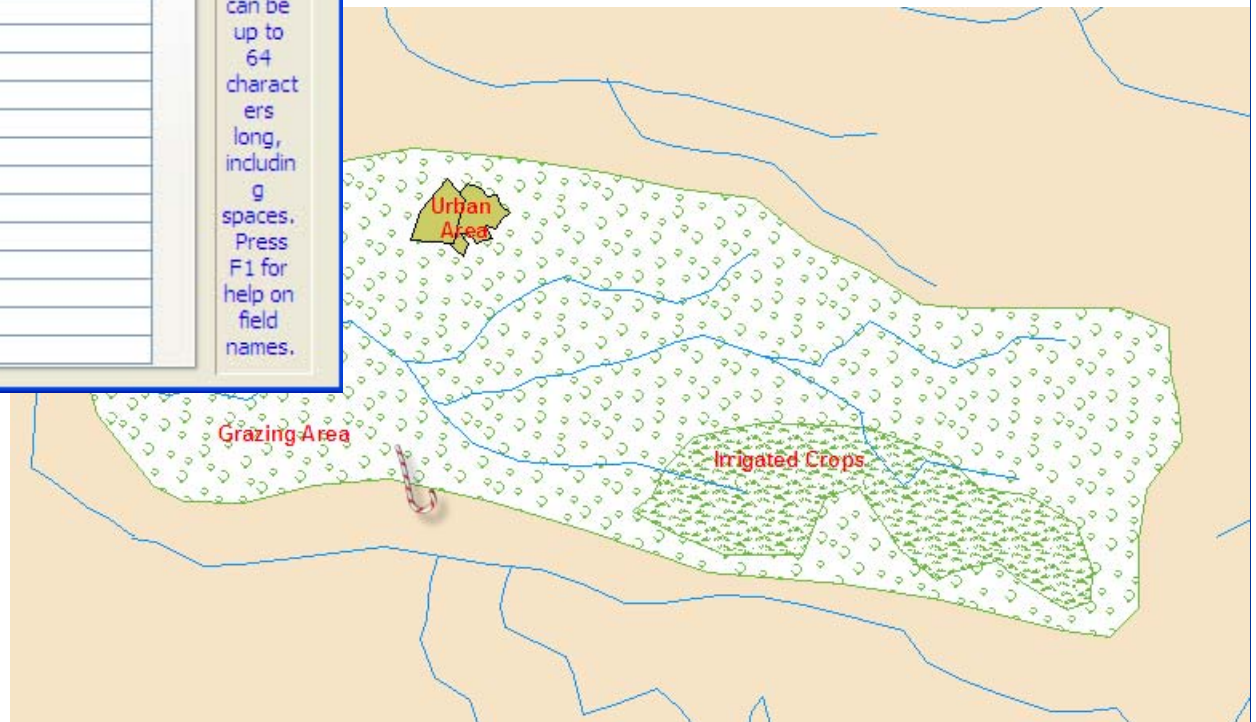


Table 9 (MntrStationsDB): Location of Monitoring stations

Table 10 (SamplingBial): Biological Sampling

MntrStationsDB : Table

| Field Name | Data Type | Description |
|------------|-----------|---|
| LOCCode | Text | Location Code (e.g TulAnb01: Tulkarem, Anabta, station nu |
| Name | Text | Name of Location |
| WSDID | Text | Watershed ID |
| X-Coord | Number | Easten Coordinates |
| Y-Coord | Number | Northern Coordinates |
| Type | Text | Type of collecting data (Major Ions, Trace Elements, Flow,, |

Field Properties

General Lookup

| | |
|---------------------|---------------------|
| Field Size | 50 |
| Format | |
| Input Mask | |
| Caption | |
| Default Value | |
| Validation Rule | |
| Validation Text | |
| Required | No |
| Allow Zero Length | Yes |
| Indexed | Yes (No Duplicates) |
| Unicode Compression | Yes |
| IME Mode | No Control |
| IME Sentence Mode | None |
| Smart Tags | |

SamplingBial : Table

| Field Name | Data Type | Description |
|--------------|-----------|---|
| SampCode | Text | Sampling Code |
| LOCCode | Text | Location Code |
| SampNo | Text | number of samplings in the station |
| LabCode | Text | Laboratory Code number |
| DateTime | Date/Time | Date of sampling (YY:MM:DD HH:MM:SS) |
| Measurmenets | Number | General Count, Coliform bacteria, Fecal coliform bacteria,, |

Field Properties

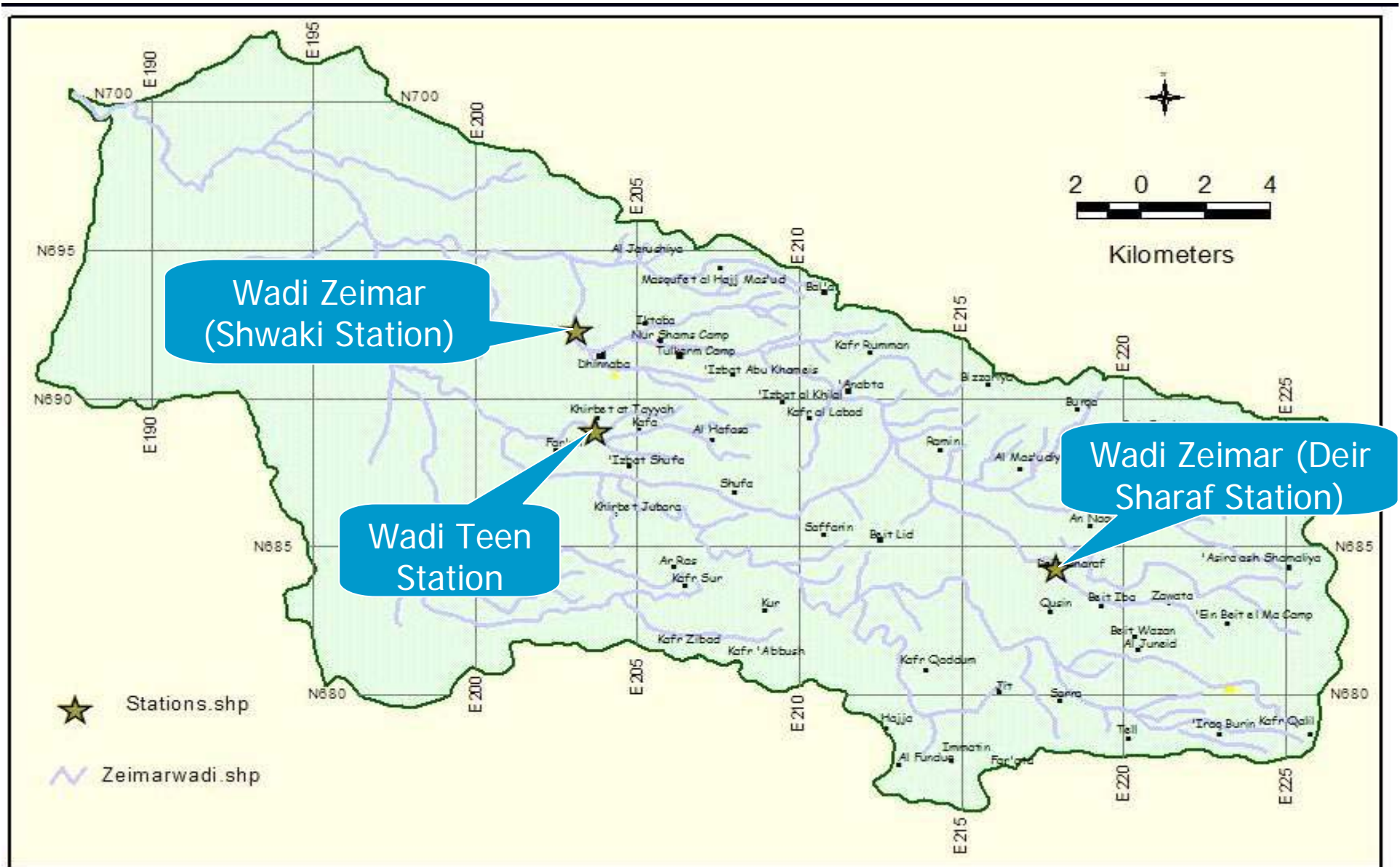
General Lookup

| | |
|---------------------|---------------------|
| Field Size | 50 |
| Format | |
| Input Mask | |
| Caption | |
| Default Value | |
| Validation Rule | |
| Validation Text | |
| Required | No |
| Allow Zero Length | Yes |
| Indexed | Yes (No Duplicates) |
| Unicode Compression | No |
| IME Mode | No Control |
| IME Sentence Mode | None |
| Smart Tags | |

A field name can be up to 64 characters long, including spaces. Press F1 for help on field names.

Stage Four : Monitoring for HSPF Parameters Commences

- Three monitoring stations were installed in the Alexander Catchment - Palestinian side , two of them were at Wadi Zeimar, and the other was at Wadi Al Teen.
- Some preparations were made for the three sites before installing the devices as shown in the following pictures.
- The installed device is “Sigma 900 MAX Portable Sampler”
- Three sensors were installed in the wadis:
 - Submerged Pressure Sensor – to measure height of water in the wadis.
 - Electric Conductance (EC) probe.
 - Strainer (for the pump to take samples from the wadi in fluid time)
- The device has a modem so that we can get the data by connecting the modem by telephone.



Monitoring Stations at Alexander Catchment

Wadi Zeimar (Shwaki Station) - Preparation of the Site

- Situation before and after installing the devices in the Wadi

before



after



Wadi Zeimar (Shwaki Station) Installation and Calibration of the Device



Wadi Zeimar (Deir Sharaf Station) -Preparation of the Site

- Situation before and after installing the devices in the Wadi

before



after



Wadi Zeimar (Deir Sharaf Station) Installation and Calibration of the Device



Wadi Teen Station - Preparation of the Site



Gathering the Data from the Devices

- We use *Insight Suite, V5.6.5 program* which was published by HACH Company to connect with the modems of the installed **Sigma 900 MAX Portable Samplers** in the Wadis.
- The following slides show how this software works.
- After installing the data from the Samplers, we prepare Excel sheets to calculate the discharges in the wadis during rainfall storms. So as to understand the response of the wadis to rainfall.

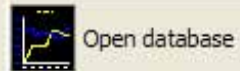
Insight Suite, V5.6.5

Insight For Windows

Site Connect Advanced Help Quit

| | | | | | | | |
|--|---|--|--|---|--|--|---|
|  Flowmeter |  Rainlogger |  900 max |  DTU-I |  DTU-II |  Flowmeter |  Modem |  Site Files |
|--|---|--|--|---|--|--|---|

Database



Open database



Import into database



Export To Ascii



Help

Speed Group

STATUS (F7)

DOWNLOAD (F8)

EVENTS (F9)

Use with 9xx Series, RS232 only.

Collected Data

Insight For Windows

Site Connect Advanced Help Quit

Flowmeter Rainlogger 900 max DTU-I

Database

Oper database

Import into database

Site Data

Data Directories:

C:\HWE\RiverRestorationProject\Tulkaren\Mega W

| Site ID | Range |
|----------|---------------------|
| 40000001 | 000 1/2/6 - 1/9/6 |
| 40000002 | 000 1/2/6 - 2/13/6 |
| 40000002 | 001 2/13/6 - 3/11/6 |

Settings (F2)

Events (F4)

Current Status (F5)

General info (F7)

Graph Data (F8) Plot, print, or save graphs

Report (F9) Create/Modify data report

Table (F10) View table of logged data

Edit (F11) Modify logged data

Return (ESC) Return to previous screen

900NAX VERSION: 7.5

SITE ID: 40000001

NUMBER OF BOTTLES: 24

BOTTLE VOLUME: 1000.00 ml

INTAKE TUBE LENGTH: 2500 cm

INTAKE TUBE TYPE: 3/8" VINYL

PROGRAM LOCK: OFF

SAMPLE COLLECTION:

40000001.000

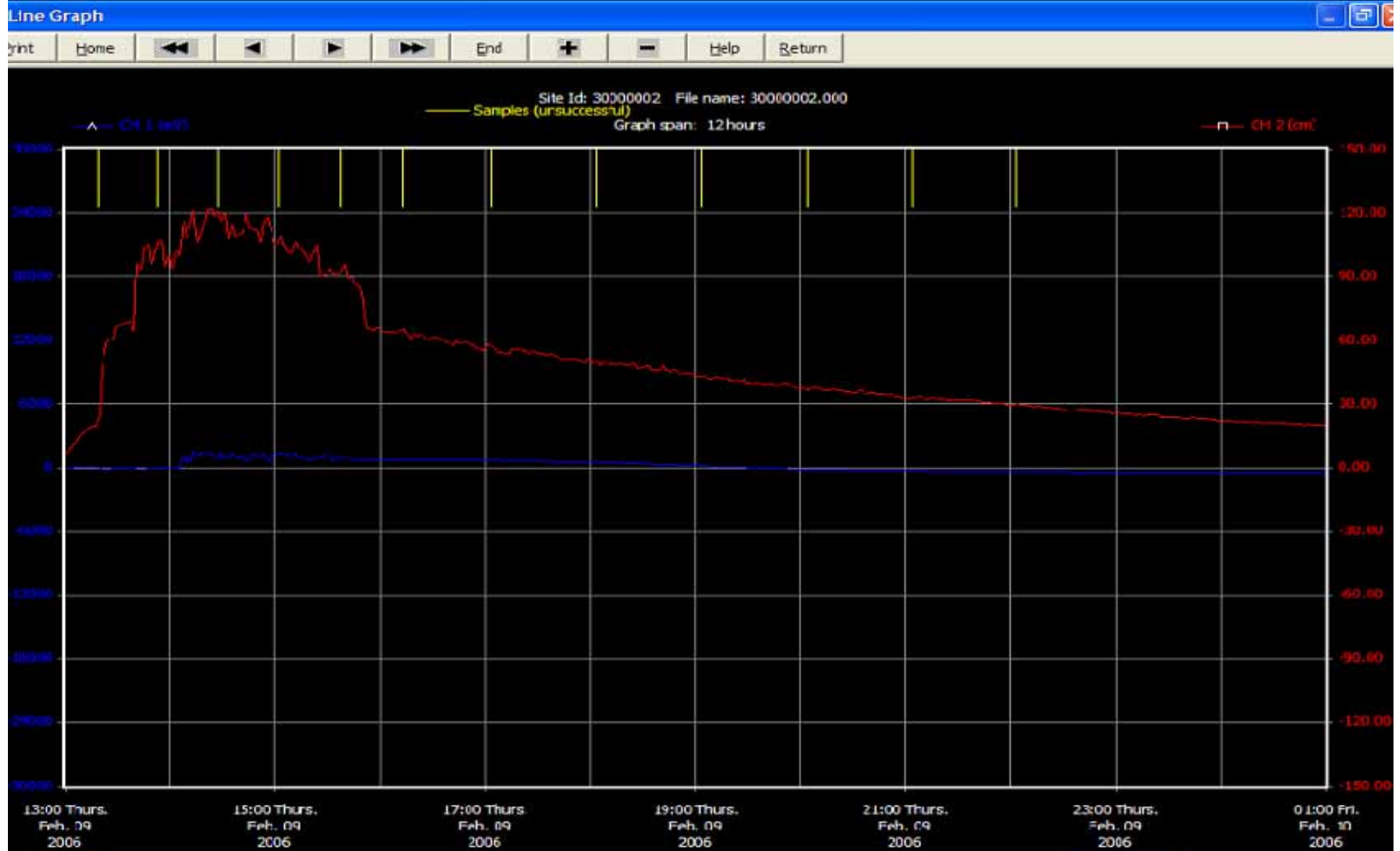
| Date | Time | Channel 2 (cm) |
|--------------|-------|----------------|
| Jan. 2, 2006 | 11:24 | -0.0935 |
| Jan. 2, 2006 | 11:26 | -0.0935 |
| Jan. 2, 2006 | 11:28 | -0.0935 |
| Jan. 2, 2006 | 11:30 | -0.0935 |
| Jan. 2, 2006 | 11:32 | -0.0935 |
| Jan. 2, 2006 | 11:34 | -0.0935 |
| Jan. 2, 2006 | 11:36 | -0.0935 |
| Jan. 2, 2006 | 11:38 | 0.0970 |
| Jan. 2, 2006 | 11:40 | -0.0935 |
| Jan. 2, 2006 | 11:42 | -0.0935 |
| Jan. 2, 2006 | 11:44 | 0.0970 |
| Jan. 2, 2006 | 11:46 | 0.0970 |
| Jan. 2, 2006 | 11:48 | 0.0970 |
| Jan. 2, 2006 | 11:50 | 0.0970 |
| Jan. 2, 2006 | 11:52 | 0.0970 |
| Jan. 2, 2006 | 11:54 | 0.2874 |
| Jan. 2, 2006 | 11:56 | 0.0970 |
| Jan. 2, 2006 | 11:58 | 0.2874 |
| Jan. 2, 2006 | 12:00 | 0.0970 |
| Jan. 2, 2006 | 12:02 | 0.2874 |
| Jan. 2, 2006 | 12:04 | 0.2874 |
| Jan. 2, 2006 | 12:06 | 0.2874 |

Return (ESC)

Copyright (c) 2004 American Sigma Inc. All rights reserved. Version: 5.7

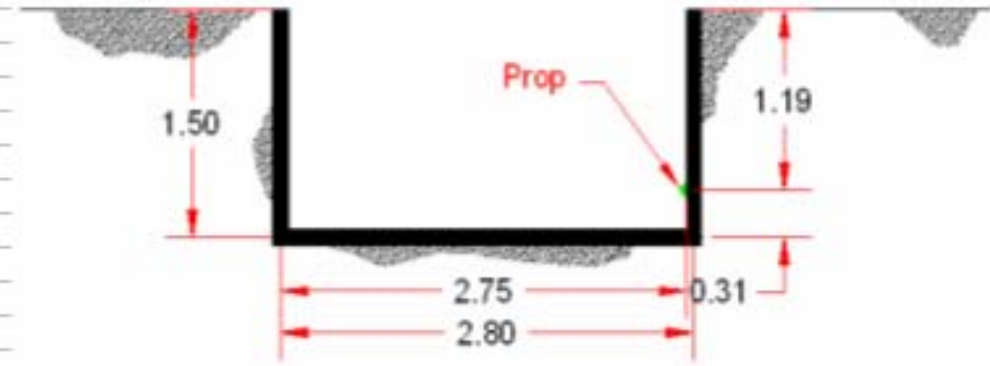
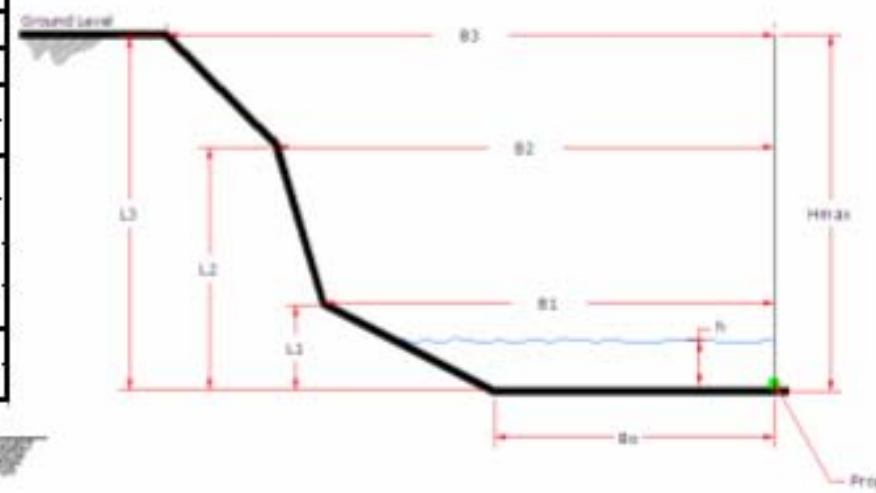
Data Directory: C:\HWE\

Graph of H & EC Values (Obtained from Wadi Al Teen Station)



Calculating Discharge of Wadi Zeimar (Deir Sharaf Station)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|----|-----------------------|-----------|-----------|------------------------|-----------|-----------|----------------------------|----------------------|---|----|----|----|----|----|----|
| 1 | Left Hand Side | | | Right Hand Side | | | Manning Coefficient | S_c | | | | | | | |
| 2 | Node | Li | Bi | Node | Li | Bi | | | | | | | | | |
| 3 | 0 | 0 | 2.75 | 0 | 0 | 0.05 | 0.015 | 0.02 | | | | | | | |
| 4 | 1 | 1.19 | 2.75 | 1 | 1.19 | 0.05 | BaseFlow Parameters | | | | | | | | |
| 5 | 2 | 999 | 999 | 2 | 999 | 999 | Max. Head (m)= | 0.31 | | | | | | | |
| 6 | 3 | 999 | 999 | 3 | 999 | 999 | Min. Head (m)= | 0.25 | | | | | | | |
| 7 | 4 | 999 | 999 | 4 | 999 | 999 | A _{ave} = | 0.87 | | | | | | | |
| 8 | 5 | 999 | 999 | 5 | 999 | 999 | P _{ave} = | 3.42 | | | | | | | |
| 9 | | | | | | | A _{min} = | 0.70 | | | | | | | |
| 10 | | | | | | | P _{min} = | 3.30 | | | | | | | |
| 11 | | | | | | | Max. Baseflow= | 3.78 | | | | | | | |
| 12 | | | | | | | Min. Baseflow= | 3.36 | | | | | | | |

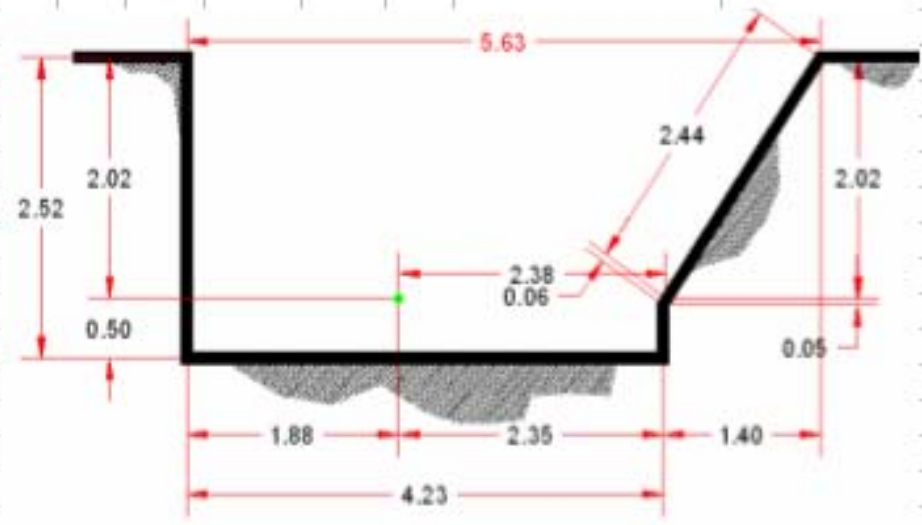
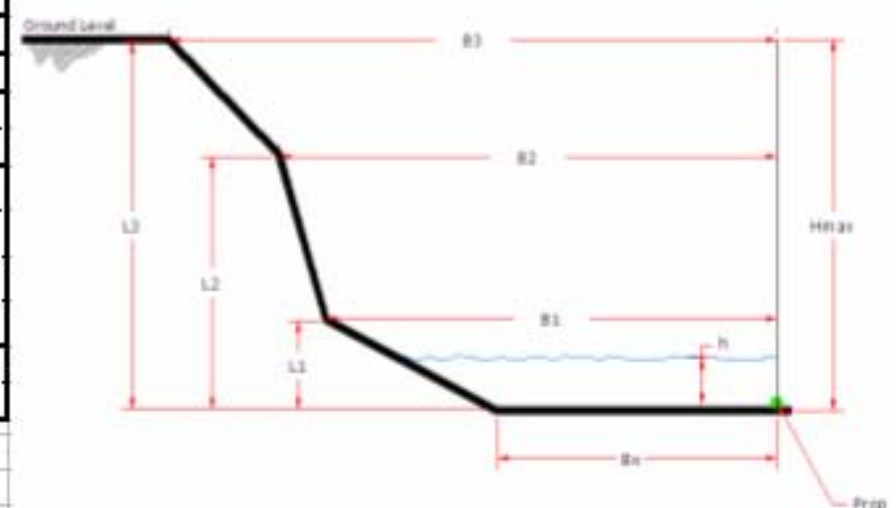


Note: all dimensions are in meter

[Click here to import the head file and convert it to flow](#)

Calculating Discharge of Wadi Zeimar (Shwaki Station)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|----|-----------------------|-----------|-----------|------------------------|-----------|-----------|----------------------------|-----------|---|----|----|----|----|----|----|
| 1 | Left Hand Side | | | Right Hand Side | | | Manning Coefficient | S. | | | | | | | |
| 2 | Node | Li | Bi | Node | Li | Bi | | | | | | | | | |
| 3 | 0 | 0 | 1.88 | 0 | 0 | 2.38 | 0.015 | 0.02 | | | | | | | |
| 4 | 1 | 2.02 | 1.88 | 1 | 2.02 | 3.75 | BaseFlow Parameters | | | | | | | | |
| 5 | 2 | 999 | 999 | 2 | 999 | 999 | Max. Head (m)= | 0.5 | | | | | | | |
| 6 | 3 | 999 | 999 | 3 | 999 | 999 | Min. Head (m)= | 0.1 | | | | | | | |
| 7 | 4 | 999 | 999 | 4 | 999 | 999 | A _{max} = | 2.12 | | | | | | | |
| 8 | 5 | 999 | 999 | 5 | 999 | 999 | P _{max} = | 5.23 | | | | | | | |
| 9 | | | | | | | A _{min} = | 0.42 | | | | | | | |
| 10 | | | | | | | P _{min} = | 4.43 | | | | | | | |
| 11 | | | | | | | Max. Baseflow= | 5.16 | | | | | | | |
| 12 | | | | | | | Min. Baseflow= | 1.97 | | | | | | | |



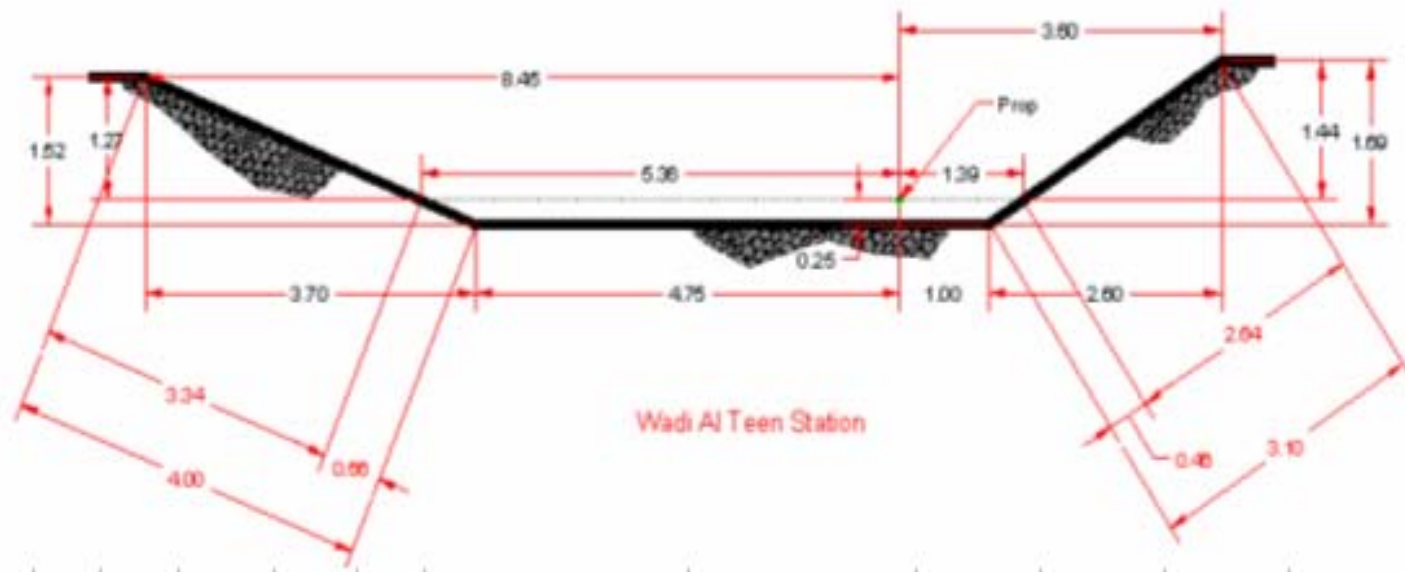
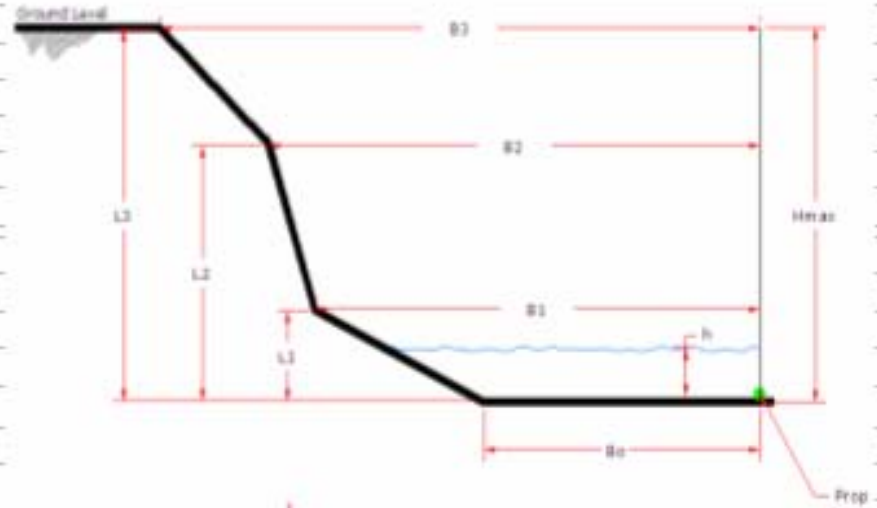
Meqa Station

Note: all dimensions are in meter

Click here to import the head file and convert it to flow

Calculating Discharge of Wadi Al Teen

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|----|-------------------------------------|------|-------|-----------------|------|------|---|----------------|---|----|----|----|----|----|----|
| 1 | Left Hand Side | | | Right Hand Side | | | Manning Coefficient | S _c | | | | | | | |
| 2 | Node | Li | Bi | Node | Li | Bi | | | | | | | | | |
| 3 | 0 | 0 | 5.359 | 0 | 0 | 1.39 | 0.02 | 0.02 | | | | | | | |
| 4 | 1 | 1.27 | 8.45 | 1 | 1.44 | 3.6 | | | | | | | | | |
| 5 | 2 | 999 | 999 | 2 | 999 | 999 | | | | | | | | | |
| 6 | 3 | 999 | 999 | 3 | 999 | 999 | | | | | | | | | |
| 7 | 4 | 999 | 999 | 4 | 999 | 999 | | | | | | | | | |
| 8 | 5 | 999 | 999 | 5 | 999 | 999 | | | | | | | | | |
| 10 | Base flow parameters | | | | | | | | | | | | | | |
| 11 | A= 0.3125 m ² | | | | | | | | | | | | | | |
| 12 | P= 5.88 m | | | | | | | | | | | | | | |
| 13 | | | | | | | 0 : Dry period (all summer days and most low rainfall events) | | | | | | | | |
| 14 | Baseflow = 0 - 5.489 m ³ | | | | | | Baseflow max: very wet events (h>0) | | | | | | | | |



Click here to import the head file and convert it to flow

Note: all dimensions are in meter

9.9432

Quality of Water in Wadi Zeimar

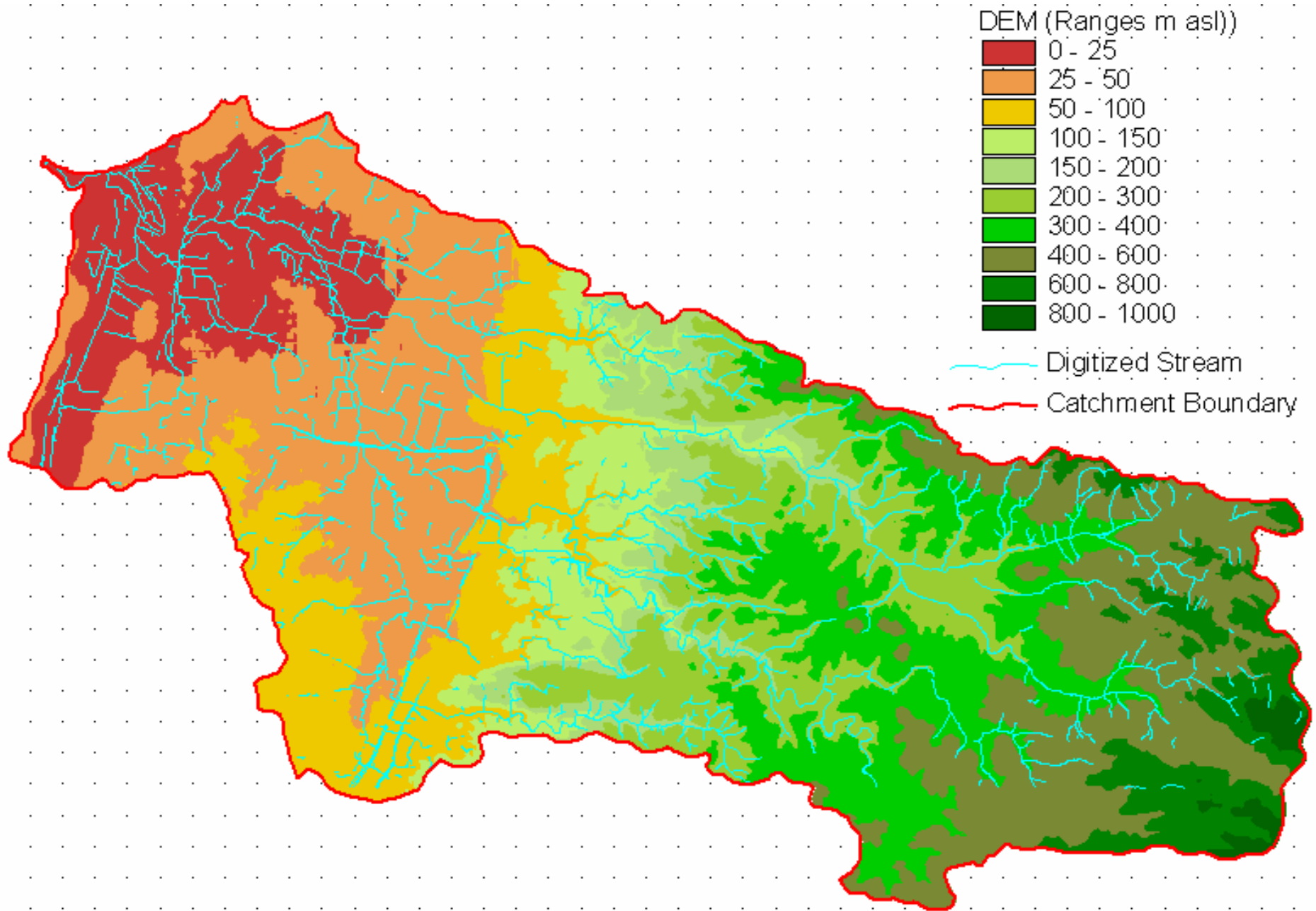
| No.sample | Date | TDS | pH | EC | TDS | Cl | SO4 | Br | HCO3 | Na | K | Ca | Mg | alkalinity | CO3 | NO3 | PO4 | NH4 |
|-----------|-----------|------|------|-------|------|------|------|------|------|------|------|------|------|------------|------|------|------|------|
| | | ER | | mS | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mgCaCO3 | mg/L | mg/L | mg/L | mg/L |
| TUL 0001 | 3/15/2005 | 608 | 7.23 | 0.950 | 666 | 67.0 | 24.3 | 0 | 408 | 75.4 | 14.0 | 65.2 | 12.4 | 334 | 0 | 4.92 | 14.6 | 21.6 |
| TUL 0002 | 3/15/2005 | 849 | 7.16 | 1.326 | 826 | 130 | 26.8 | 0 | 459 | 108 | 16.4 | 72.5 | 12.9 | 376 | 0 | 20.2 | 11.1 | 33.9 |
| TUL 0003 | 3/15/2005 | 1696 | 7.26 | 2.650 | 1561 | 427 | 43.6 | 4.68 | 664 | 285 | 29.7 | 83.4 | 23.2 | 544 | 0 | 67.2 | 20.6 | 72.8 |
| TUL 0007 | 6/15/2005 | 1585 | 7.02 | 2.48 | 1558 | 345 | 65.5 | 0 | 755 | 276 | 21.9 | 76.9 | 18.1 | 619 | 0 | 3.5 | 30.2 | 87.5 |
| TUL 0008 | 6/19/2005 | 1555 | 7.37 | 2.43 | 1570 | 370 | 35.6 | 0 | 741 | 298 | 23.0 | 83.2 | 18.7 | 607 | 0 | 46.2 | 28.2 | 61.8 |
| TUL 0009 | 6/19/2005 | 1920 | 7.24 | 3.00 | 1908 | 430 | 73.7 | 0 | 915 | 384 | 19.2 | 79.4 | 7.10 | 750 | 0 | 13.5 | 17.2 | 101 |

| No.sample | Date | TSS | total N | total P | COD | COD | total BOD | filter TOC |
|-----------|-----------|------|---------|---------|--------|--------|-----------|------------|
| | | mg/L | mg/L | mg/L | mgO2/L | mgO2/L | mgO2/L | mg/L |
| TUL 0001 | 3/15/2005 | 78.0 | 29.9 | 4.71 | 119 | 92.5 | 51.5 | 105 |
| TUL 0002 | 3/15/2005 | 14.0 | 43.2 | 5.31 | 146 | 124 | 47.9 | 105 |
| TUL 0003 | 3/15/2005 | 25.0 | 72.0 | 8.63 | 250 | 255 | 82.7 | 175 |
| TUL 0007 | 6/15/2005 | 40 | 66.6 | 10.3 | 392 | | | 35.7 |
| TUL 0008 | 6/19/2005 | 40 | 52.7 | 7.88 | 260 | | | 43.2 |
| TUL 0009 | 6/19/2005 | 14 | 75.1 | 9.63 | 363 | | | 42.6 |

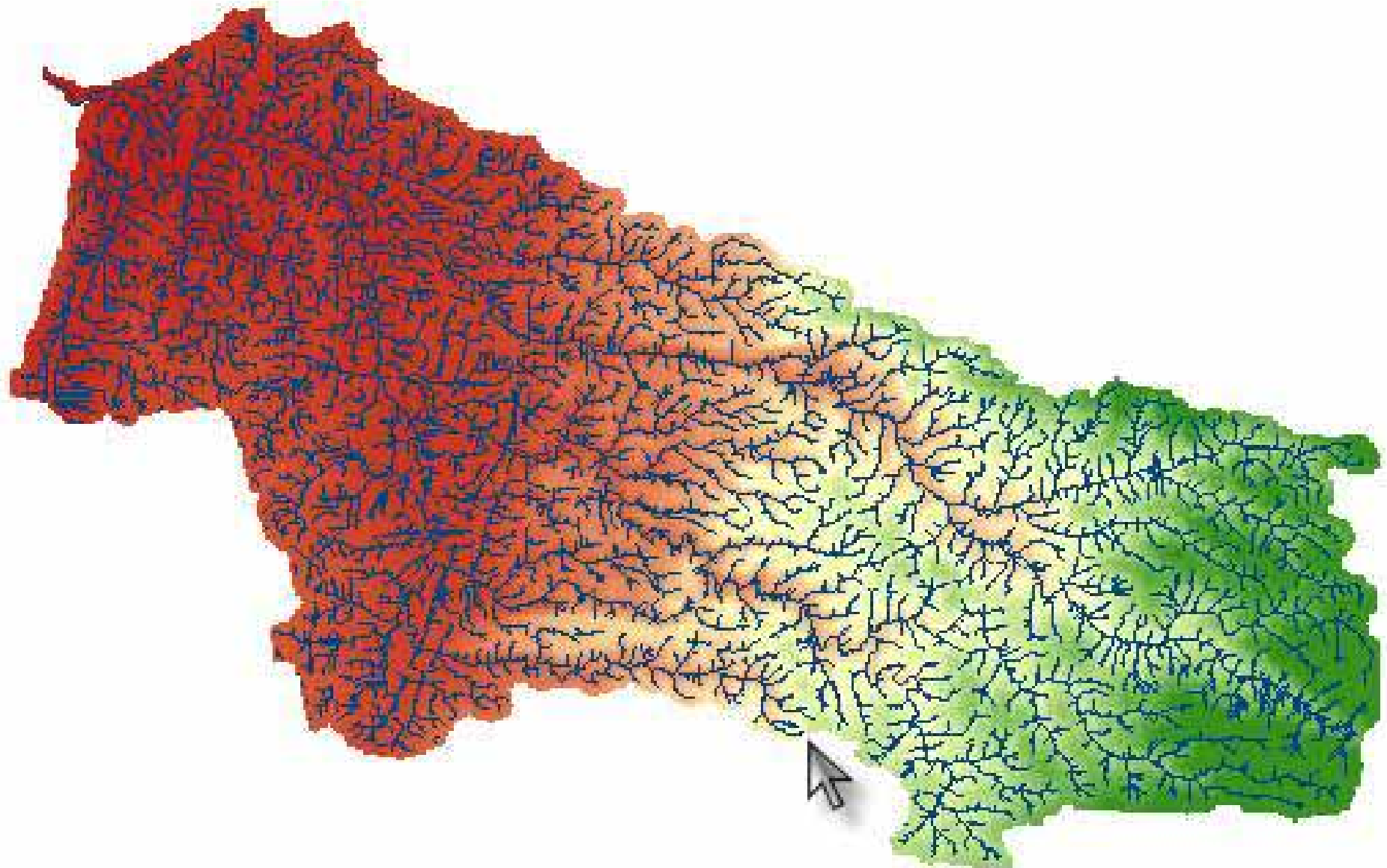
| No.sample | Date | CO3 | NO2 | PO4 | NH4 | NO3 | Cl | SO4 | Br | HCO3 | Na | K | Ca | Mg | ΣA meq | ΣK meq | ΣA/ΣK | EC |
|-----------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|-------|-------|
| | | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | meq/L | | mS |
| TUL 0001 | 3/15/2005 | 0.0 | 0.0 | 0.30 | 1.20 | 0.08 | 1.89 | 0.51 | 0.00 | 6.69 | 3.28 | 0.36 | 3.25 | 1.02 | 9.47 | 9.11 | -0.02 | 0.950 |
| TUL 0002 | 3/15/2005 | 0.0 | 0.0 | 0.23 | 1.88 | 0.33 | 3.67 | 0.56 | 0.00 | 7.52 | 4.70 | 0.42 | 3.62 | 1.06 | 12.3 | 11.67 | -0.03 | 1.326 |
| TUL 0003 | 3/15/2005 | 0.0 | 0.0 | 0.43 | 4.04 | 1.08 | 12.05 | 0.91 | 0.06 | 10.88 | 12.40 | 0.76 | 4.16 | 1.91 | 25.41 | 23.26 | -0.04 | 2.650 |
| TUL 0007 | 6/15/2005 | 0.0 | 0.0 | 0.63 | 4.9 | 0.06 | 9.73 | 1.36 | 0.00 | 12.37 | 12.01 | 0.56 | 3.84 | 1.49 | 24.16 | 22.74 | -0.03 | 2.48 |
| TUL 0008 | 6/19/2005 | 0.0 | 0.0 | 0.59 | 3.4 | 0.75 | 10.44 | 0.74 | 0.00 | 12.14 | 12.96 | 0.59 | 4.15 | 1.54 | 24.66 | 22.67 | -0.04 | 2.43 |
| TUL 0009 | 6/19/2005 | 0.0 | 0.0 | 0.36 | 5.6 | 0.22 | 12.13 | 1.53 | 0.00 | 15.00 | 16.70 | 0.49 | 3.96 | 0.58 | 29.24 | 27.34 | -0.03 | 3.00 |

Stage Five : Building HSPF Model

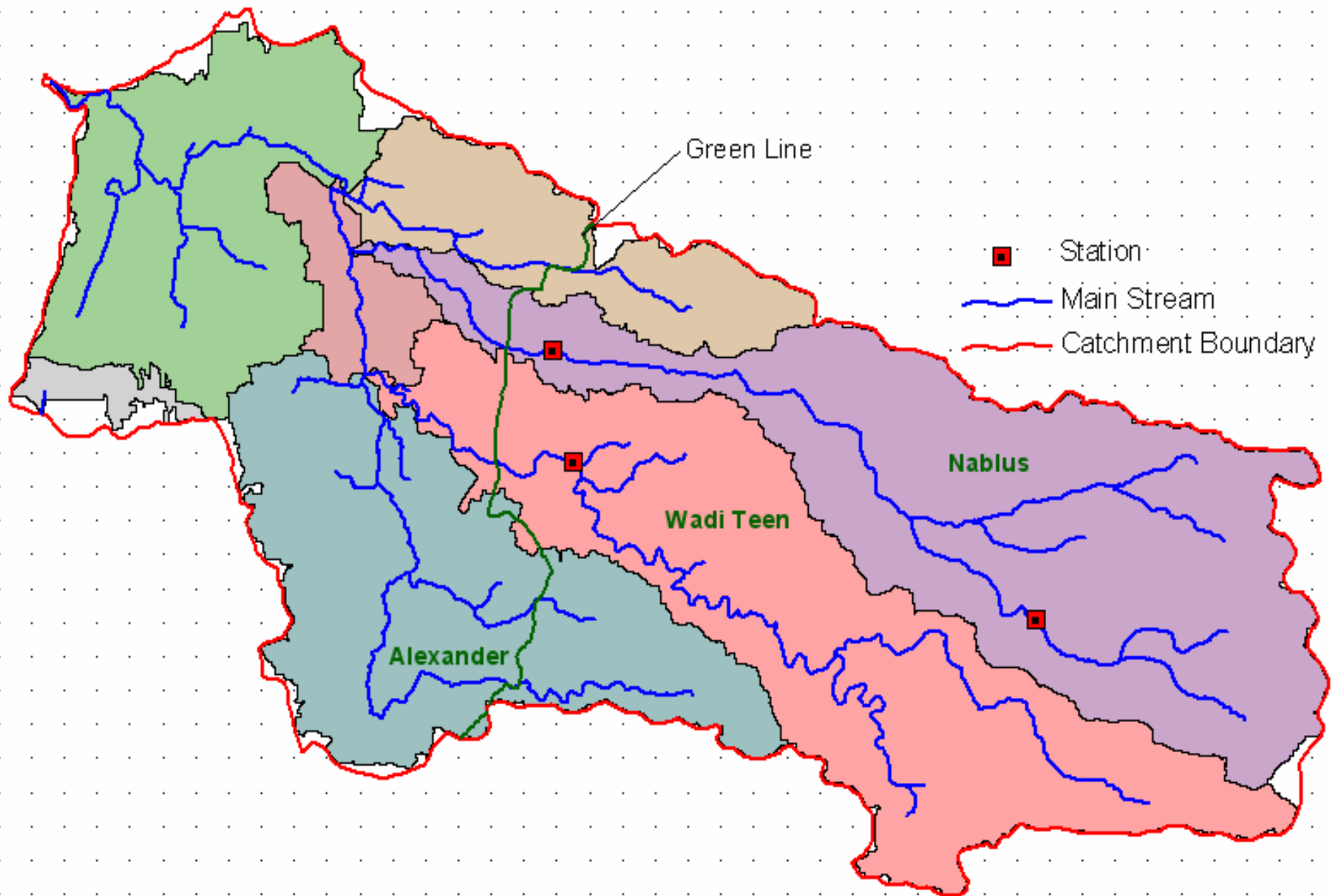
- HSPF has many parameters to prepare data for;
- The following analysis were prepared:
 - DEM Analyses
 - Divide the Alexander basin in sub-watersheds.
 - Divide the Alexander watersheds into drainage segments.
 - Estimating LSUR and SLSUR and other basin parameters
 - LSUR : Length of assumed overland flow plane
 - SLSUR: Average slope assumed overland flow plane
- Metrological Analysis
 - Building a Watershed Data Management (WDM) file.



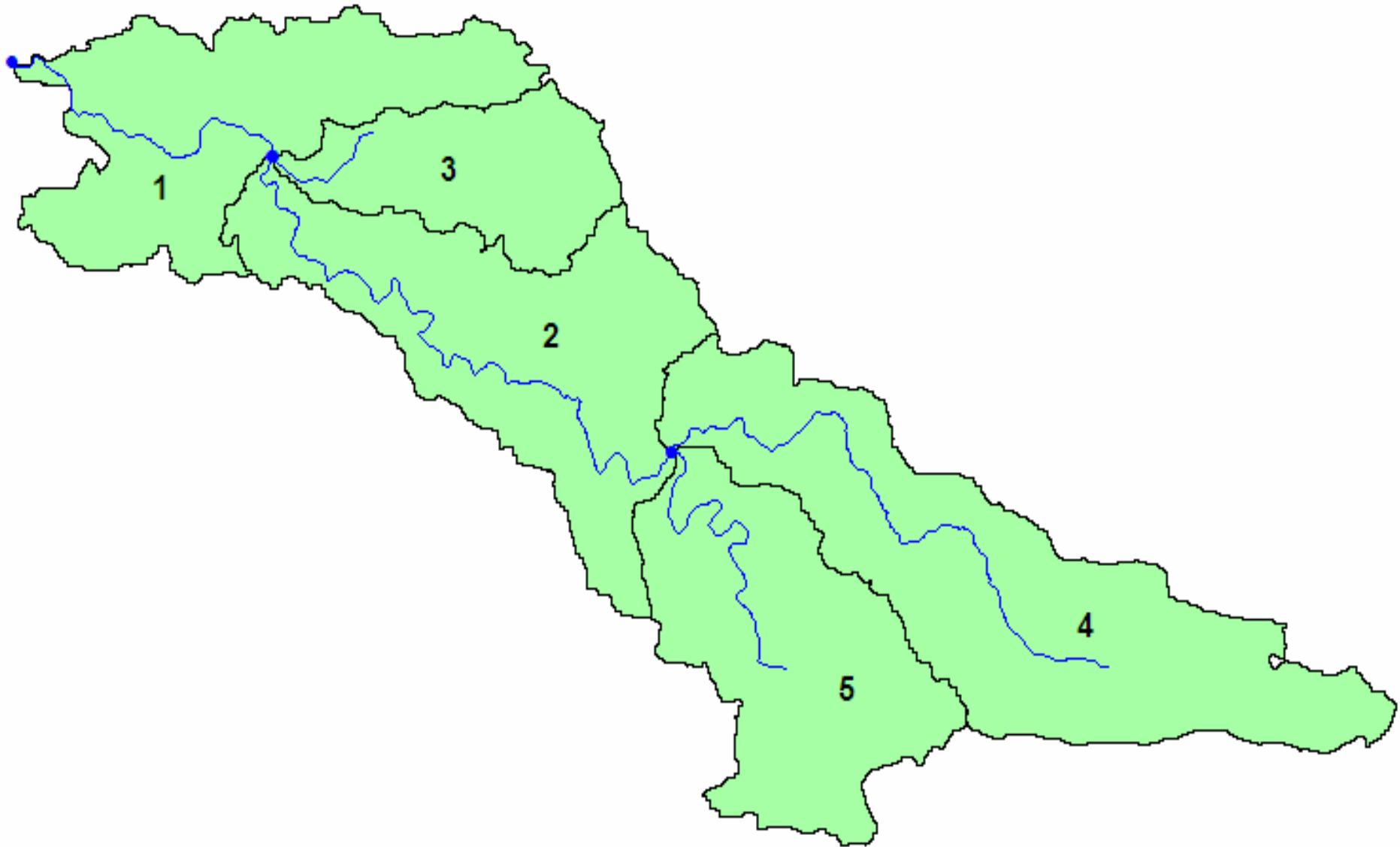
From DEM and the digitized stream and using the Arc Hydro software, very detailed streams network have been obtained. (Next Slide)



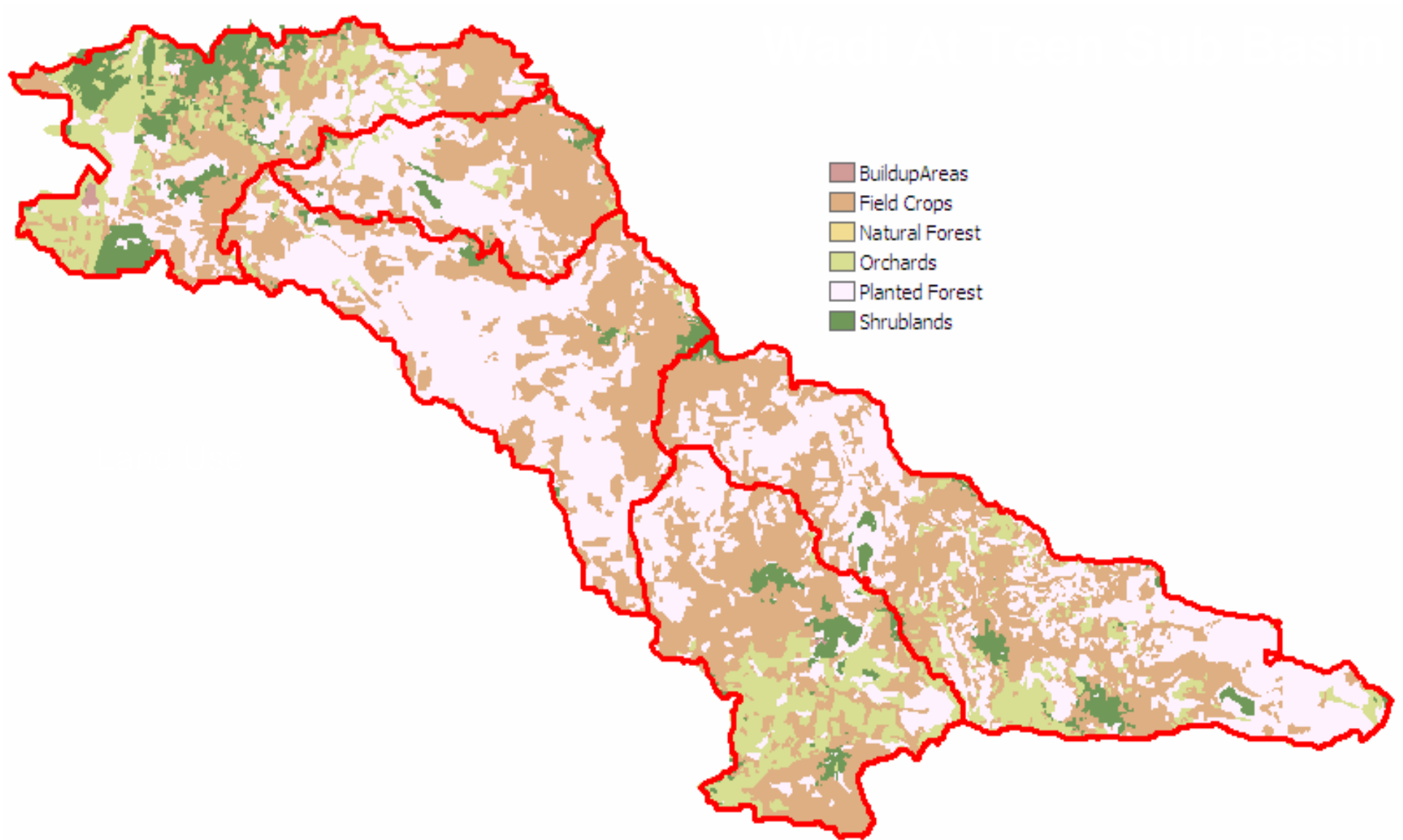
This detailed stream network will be useful in estimating the LSUR parameter for the HSPF model.



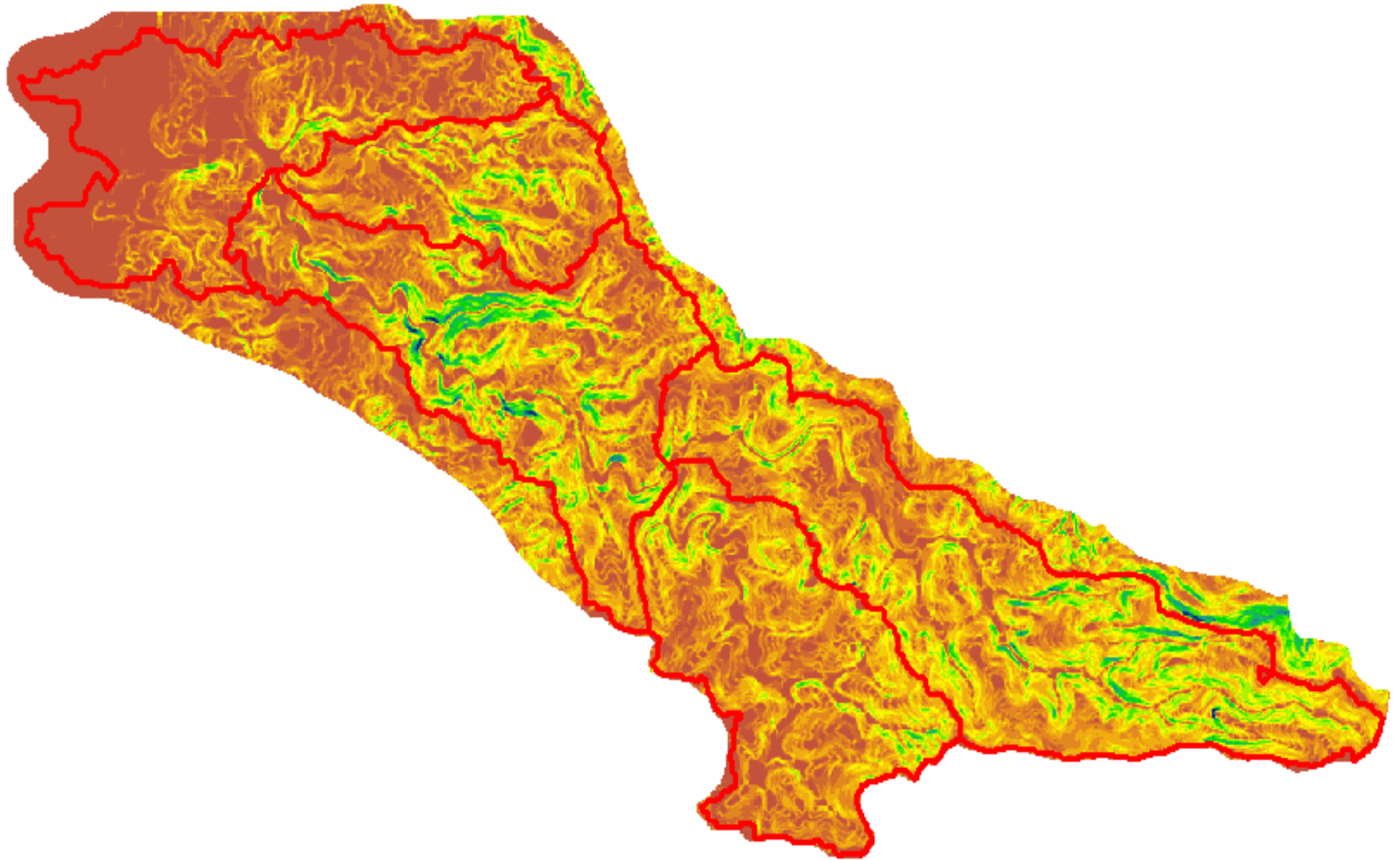
Three main sub basins (Nablus, Wadi Teen and Alexander) were defined to be modeled.



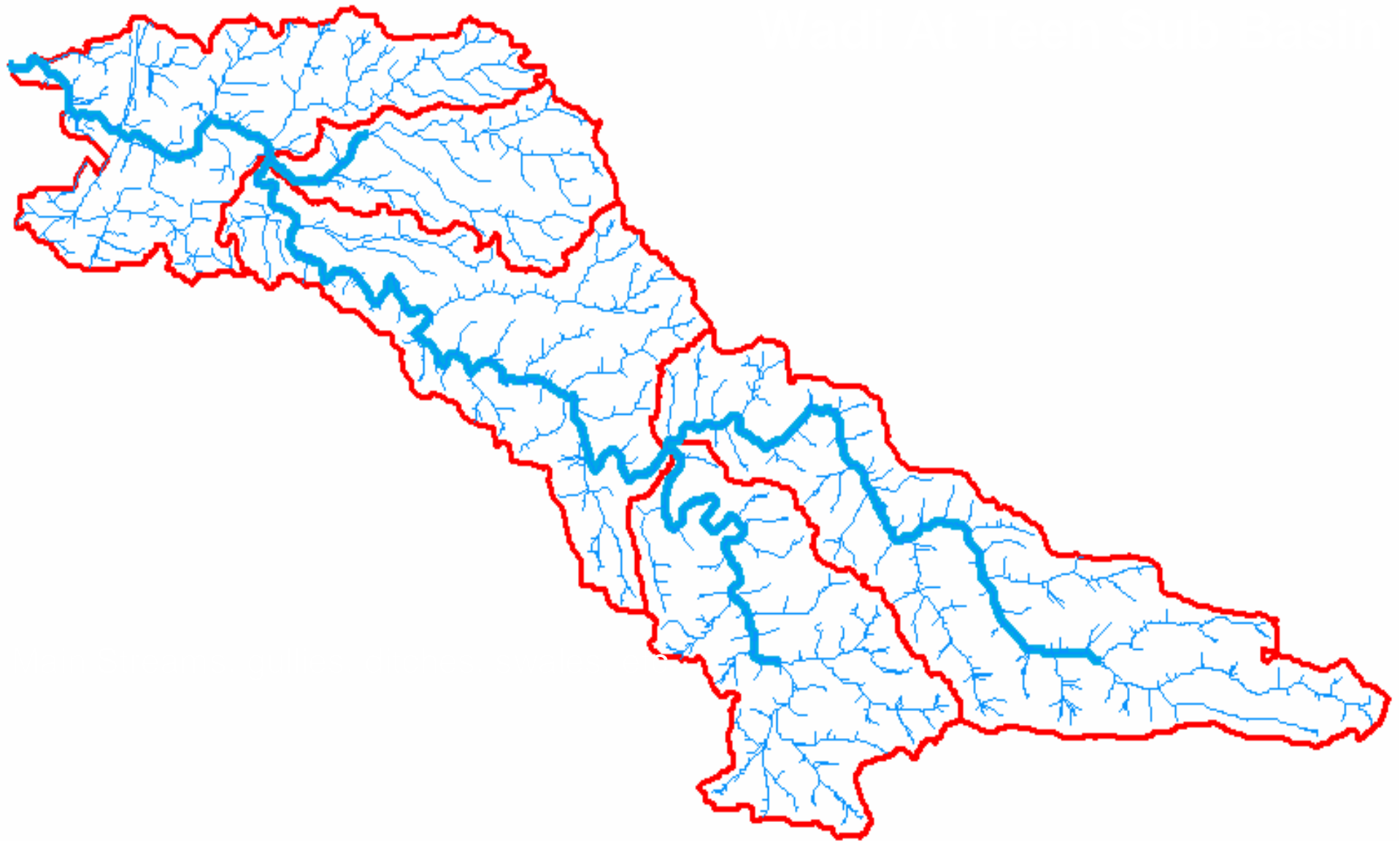
Wadi At Teen Case: simple delineation has been developed using (DEM, Detailed digitized stream network)



Estimating the LSUR and SLSUR parameters: using the Draft land use map, the generated Slope map and the generated detailed stream network.



Estimating the LSUR and SLSUR parameters: using the Draft land use map, the generated Slope map and the generated detailed stream network.



Estimating the LSUR and SLSUR parameters: using the Draft land use map, the generated Slope map and the generated detailed stream network.

LSUR

- LSUR: length of assumed overland flow plane (ft), the LSUR approximates the average length of travel for water to reach the stream reach.
- Typical values range from 200ft to 500ft for slopes ranging from 15% to 1%
- LSUR is inversely proportional to slope

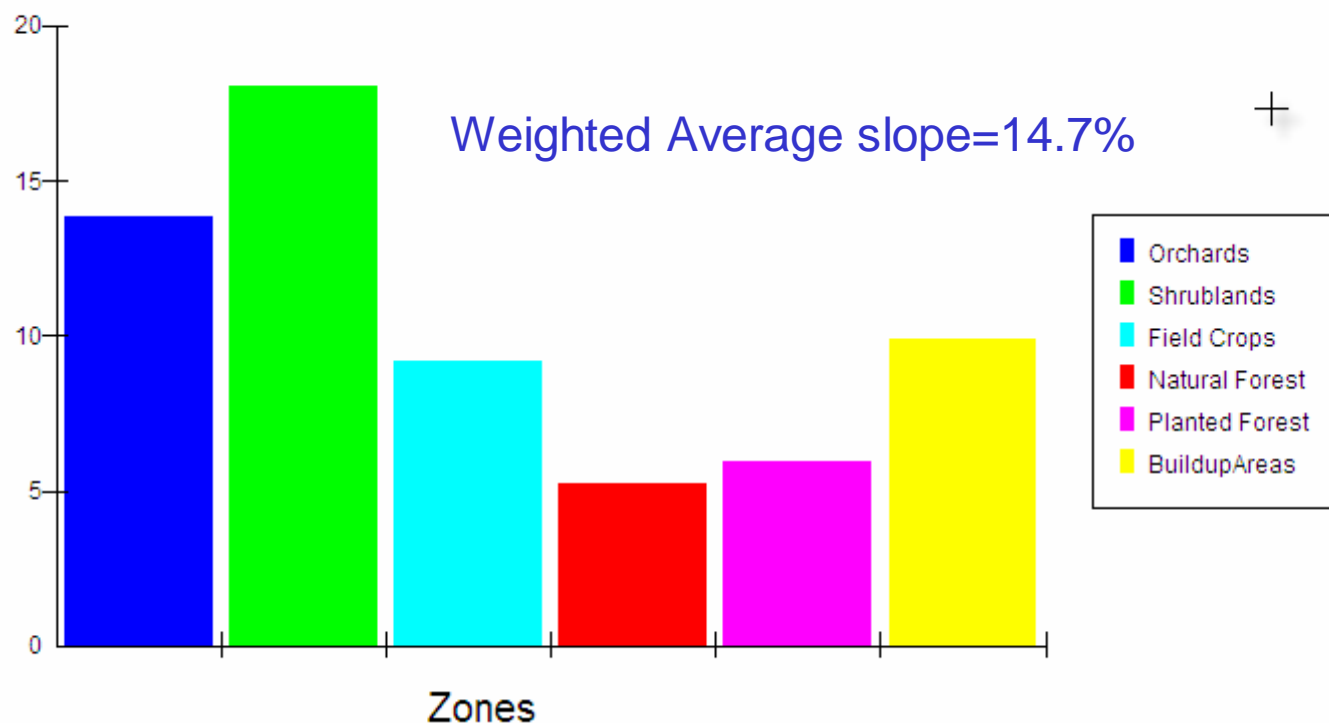
$$LSUR_i = \frac{(Watershed Area)_i}{2 \times (\text{length of all small streams in the watershed area})_i}$$

Where: i = Landuse type i

Stats of "Slope_WT" Within Zones of "lu_wtraster"

| LULC | COUNT | AREA | MIN | MAX | RANGE | MEAN | STD |
|----------------|-------|-------------|----------|---------|---------|---------|---------|
| Orchards | 90898 | 5.68112E+07 | 0 | 72.5439 | 72.5439 | 13.8598 | 8.86602 |
| Shrublands | 83861 | 5.24131E+07 | 0 | 86.7332 | 86.7332 | 18.0621 | 11.2471 |
| Field Crops | 25550 | 1.59688E+07 | 0 | 58.0978 | 58.0978 | 9.21231 | 8.49743 |
| Natural Forest | 38 | 23750 | 0.72111 | 22.5621 | 21.841 | 5.22546 | 6.74016 |
| Planted Forest | 186 | 116250 | 0.316225 | 17.1261 | 16.8099 | 5.93567 | 4.65749 |
| BuildupAreas | 14587 | 9116880 | 0 | 86.511 | 86.511 | 9.90675 | 8.13698 |

Mean of "Slope WT" Within Zones of "lu_wtraster"



Wadi At Teen case: note that the slopes for different landuse types are almost within the accepted range (5.2-18%)

- Main streams length = 47109.8 m = 143590.6 ft
- All types of streams = 399995.1m = 1219185.1 ft
- Net length of all small streams = 1219185.1- 143590.6
= 1075594.5 ft
- Area = 131224375 m² = 1219114.3 ft²
- LSUR= $1219114.3 / (2 * 1075594.5) = 566.7$ ft
- (Average Slope =14.7%)

| Landuse | COUNT | AREA | MIN | MAX | RANGE | MEAN | STD | Mean*Count | LSUR | SLSUR |
|---------------------------|--------|------------|-----|------|-------|------|------|------------|-------|-------|
| Orchards | 90898 | 56811200.0 | 0.0 | 72.5 | 72.5 | 13.9 | 8.9 | 1259828.1 | 535.4 | 0.14 |
| Shrublands | 83861 | 52413100.0 | 0.0 | 86.7 | 86.7 | 18.1 | 11.2 | 1514705.7 | 697.8 | 0.18 |
| Field Crops | 25550 | 15968800.0 | 0.0 | 58.1 | 58.1 | 9.2 | 8.5 | 235374.5 | 355.9 | 0.09 |
| Natural Forest | 38 | 23750.0 | 0.7 | 22.6 | 21.8 | 5.2 | 6.7 | 198.6 | 201.9 | 0.05 |
| Planted Forest | 186 | 116250.0 | 0.3 | 17.1 | 16.8 | 5.9 | 4.7 | 1104.0 | 229.3 | 0.06 |
| BuildupAreas | 14587 | 9116880.0 | 0.0 | 86.5 | 86.5 | 9.9 | 8.1 | 144509.8 | 382.7 | 0.10 |
| Sum | 215120 | | | | | | | 3155721 | | |
| Weighted Average Slope %= | | | | | | | | 14.7 | | |

Estimated LSUR and SLSUR Values for different land use types.

Preparing the WDM File

- Row data: 8-15/2/2006, 5 minutes intervals

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|----------|------|----------|---------|----------|-----|-----|------------|-----|----------|---------|---------|------------|------------|------|--------|------|-----------|----------|----------|---------|--------|-----------|---------|------------|-----------|
| Date | Time | Temp Out | Temp Hi | Temp Low | Hum | Dew | Wind Speed | Dir | Wind Run | Temp Hi | Temp Hi | Wind Chill | Heat Index | THW | Bar | Rain | Rain Rate | Heat D-D | Cool D-D | In Temp | In Hum | Wind Samp | Wind Tx | ISS Recept | Arc. Int. |
| 2/8/2006 | 0:05 | 14.4 | 14.4 | 14.4 | 44 | 2.3 | 0 | ESE | 0 | 3.2 | ESE | 14.4 | 13.1 | 13.1 | 1003.4 | 0 | 0 | 0.014 | 0 | 21.3 | 39 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:10 | 14.2 | 14.4 | 13.8 | 48 | 3.4 | 4.8 | W | 0.4 | 14.5 | W | 14 | 13.1 | 12.6 | 1003.4 | 0 | 0 | 0.014 | 0 | 21.3 | 39 | 113 | 1 | 99.1 | 5 |
| 2/8/2006 | 0:15 | 13.3 | 13.8 | 13.1 | 53 | 3.9 | 6.4 | W | 0.54 | 12.9 | WNW | 12.5 | 12.3 | 11.4 | 1003.8 | 0 | 0 | 0.018 | 0 | 21.3 | 39 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:20 | 13.2 | 13.4 | 12.9 | 49 | 2.7 | 4.8 | S | 0.4 | 16.1 | W | 12.8 | 12.1 | 11.5 | 1003.8 | 0 | 0 | 0.018 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:25 | 14 | 14.4 | 13.4 | 47 | 2.9 | 4.8 | SW | 0.4 | 12.9 | WSW | 13.8 | 12.8 | 12.3 | 1003.8 | 0 | 0 | 0.015 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:30 | 14.6 | 14.7 | 14.4 | 49 | 4 | 1.6 | SW | 0.13 | 6.4 | SW | 14.6 | 13.4 | 13.4 | 1004 | 0 | 0 | 0.013 | 0 | 21.3 | 39 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:35 | 14.9 | 15.1 | 14.7 | 50 | 4.5 | 3.2 | SW | 0.27 | 9.7 | SW | 14.9 | 13.8 | 13.7 | 1004 | 0 | 0 | 0.012 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:40 | 15.2 | 15.3 | 15.1 | 50 | 4.9 | 3.2 | SW | 0.27 | 8 | SW | 15.2 | 14.1 | 14 | 1004 | 0 | 0 | 0.011 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:45 | 15.4 | 15.4 | 15.4 | 52 | 5.6 | 0 | SW | 0 | 4.8 | SW | 15.4 | 14.4 | 14.4 | 1004 | 0 | 0 | 0.01 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:50 | 15.4 | 15.6 | 15.4 | 54 | 6.1 | 1.6 | S | 0.13 | 8 | S | 15.4 | 14.4 | 14.4 | 1004 | 0 | 0 | 0.01 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 0:55 | 15.7 | 15.7 | 15.6 | 53 | 6.1 | 3.2 | SW | 0.27 | 9.7 | SW | 15.7 | 14.7 | 14.6 | 1004 | 0 | 0 | 0.009 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:00 | 15.8 | 15.9 | 15.7 | 53 | 6.2 | 3.2 | S | 0.27 | 9.7 | SSE | 15.8 | 14.8 | 14.7 | 1003.6 | 0 | 0 | 0.009 | 0 | 21.2 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:05 | 16.2 | 16.3 | 15.9 | 52 | 6.3 | 4.8 | SSW | 0.4 | 12.9 | S | 16.2 | 15.2 | 14.9 | 1003.6 | 0 | 0 | 0.008 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:10 | 16.3 | 16.4 | 16.3 | 54 | 7 | 3.2 | S | 0.27 | 12.9 | S | 16.3 | 15.4 | 15.4 | 1003.6 | 0 | 0 | 0.007 | 0 | 21.3 | 40 | 113 | 1 | 99.1 | 5 |
| 2/8/2006 | 1:15 | 16.5 | 16.6 | 16.4 | 54 | 7.2 | 4.8 | S | 0.4 | 12.9 | S | 16.5 | 15.6 | 15.3 | 1003.7 | 0 | 0 | 0.006 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:20 | 16.6 | 16.6 | 16.6 | 54 | 7.3 | 4.8 | S | 0.4 | 11.3 | S | 16.6 | 15.7 | 15.5 | 1003.7 | 0 | 0 | 0.006 | 0 | 21.3 | 41 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:25 | 16.7 | 16.7 | 16.6 | 55 | 7.6 | 3.2 | S | 0.27 | 9.7 | S | 16.7 | 15.8 | 15.8 | 1003.7 | 0 | 0 | 0.006 | 0 | 21.3 | 40 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:30 | 16.6 | 16.7 | 16.2 | 57 | 8 | 3.2 | SW | 0.27 | 9.7 | SW | 16.6 | 15.8 | 15.8 | 1004.1 | 0 | 0 | 0.006 | 0 | 21.3 | 41 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:35 | 16.1 | 16.2 | 16 | 61 | 8.5 | 3.2 | S | 0.27 | 12.9 | SSE | 16.1 | 15.4 | 15.4 | 1004.1 | 0 | 0 | 0.008 | 0 | 21.2 | 41 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:40 | 16.1 | 16.2 | 16.1 | 61 | 8.6 | 4.8 | S | 0.4 | 12.9 | S | 16.1 | 15.5 | 15.2 | 1004.1 | 0 | 0 | 0.008 | 0 | 21.3 | 41 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:45 | 16.2 | 16.3 | 16.2 | 60 | 8.4 | 3.2 | S | 0.27 | 9.7 | SSW | 16.2 | 15.6 | 15.5 | 1004 | 0 | 0 | 0.007 | 0 | 21.2 | 41 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:50 | 16.4 | 16.5 | 16.3 | 60 | 8.6 | 4.8 | S | 0.4 | 11.3 | S | 16.4 | 15.7 | 15.4 | 1004 | 0 | 0 | 0.007 | 0 | 21.3 | 41 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 1:55 | 16.6 | 16.7 | 16.5 | 60 | 8.8 | 4.8 | S | 0.4 | 11.3 | SSE | 16.6 | 15.9 | 15.7 | 1004 | 0 | 0 | 0.006 | 0 | 21.2 | 41 | 114 | 1 | 100 | 5 |
| 2/8/2006 | 2:00 | 16.7 | 16.7 | 16.7 | 61 | 9.1 | 4.8 | S | 0.4 | 12.9 | S | 16.7 | 16.1 | 15.8 | 1004 | 0 | 0 | 0.006 | 0 | 21.3 | 41 | 114 | 1 | 100 | 5 |

Preparing the WDM File

- Data Preparation for WDM file

5 minutes Temperature, maximum and minimum temperatures, dew temperature, wind speed and precipitation

Hourly Temp, Max & Min Temps, Dew Temp, WS and Precip.

Daily Max & Min Temps

| Time | Temp | Tmax | Tmin | Tdew | WindSpeed | Precipitation | Time | HrTemp | HrTdew | HrWS | HrPrec | DlyTmax | DlyTmin |
|----------------|------|------|------|------|-----------|---------------|---------------|----------|----------|----------|--------|---------|---------|
| 2/8/2006 0:05 | 14.4 | 14.4 | 14.4 | 2.3 | 0 | 0 | | | | | | | |
| 2/8/2006 0:10 | 14.2 | 14.4 | 13.8 | 3.4 | 4.8 | 0 | | | | | | | |
| 2/8/2006 0:15 | 13.3 | 13.8 | 13.1 | 3.9 | 6.4 | 0 | | | | | | | |
| 2/8/2006 0:20 | 13.2 | 13.4 | 12.9 | 2.7 | 4.8 | 0 | | | | | | | |
| 2/8/2006 0:25 | 14 | 14.4 | 13.4 | 2.9 | 4.8 | 0 | | | | | | | |
| 2/8/2006 0:30 | 14.6 | 14.7 | 14.4 | 4 | 1.6 | 0 | | | | | | | |
| 2/8/2006 0:35 | 14.9 | 15.1 | 14.7 | 4.5 | 3.2 | 0 | | | | | | | |
| 2/8/2006 0:40 | 15.2 | 15.3 | 15.1 | 4.9 | 3.2 | 0 | | | | | | | |
| 2/8/2006 0:45 | 15.4 | 15.4 | 15.4 | 5.6 | 0 | 0 | | | | | | | |
| 2/8/2006 0:50 | 15.4 | 15.6 | 15.4 | 6.1 | 1.6 | 0 | | | | | | | |
| 2/8/2006 0:55 | 15.7 | 15.7 | 15.6 | 6.1 | 3.2 | 0 | | | | | | | |
| 2/8/2006 1:00 | 15.8 | 15.9 | 15.7 | 6.2 | 3.2 | 0 | 2/8/2006 1:00 | 14.675 | 4.383333 | 3.066667 | 0 | | |
| 2/8/2006 1:05 | 16.2 | 16.3 | 15.9 | 6.3 | 4.8 | 0 | | | | | | | |
| 2/8/2006 1:10 | 16.3 | 16.4 | 16.3 | 7 | 3.2 | 0 | | | | | | | |
| 2/8/2006 1:15 | 16.5 | 16.6 | 16.4 | 7.2 | 4.8 | 0 | | | | | | | |
| 2/8/2006 1:20 | 16.6 | 16.6 | 16.6 | 7.3 | 4.8 | 0 | | | | | | | |
| 2/8/2006 23:50 | 10.2 | 10.4 | 10.2 | 6 | 16.1 | 0 | | | | | | | |
| 2/8/2006 23:55 | 10.4 | 10.6 | 10.4 | 5.8 | 16.1 | 0 | | | | | | | |
| 2/9/2006 0:00 | 10.7 | 10.8 | 10.6 | 5.4 | 16.1 | 0 | 2/9/2006 0:00 | 9.908333 | 6.291667 | 19.03333 | 0.76 | 17.2 | 9.1 |
| 2/9/2006 0:05 | 10.9 | 11.1 | 10.8 | 5.7 | 16.1 | 0 | | | | | | | |
| 2/9/2006 0:10 | 11.2 | 11.2 | 11.1 | 5.9 | 12.9 | 0 | | | | | | | |
| 2/9/2006 0:15 | 11.5 | 11.7 | 11.2 | 6 | 16.1 | 0 | | | | | | | |
| 2/9/2006 0:20 | 11.7 | 11.8 | 11.7 | 6 | 14.5 | 0 | | | | | | | |
| 2/9/2006 0:25 | 11.8 | 12.1 | 11.8 | 5.8 | 14.5 | 0 | | | | | | | |

Preparing the WDM File

■ WDM file:

- PREC: measured “Hourly” precipitation
- ATEM: measured “Hourly” temperature
- WIND: measured “Hourly” wind speed
- DEWP: measured “Hourly” dew temperature

WDMUtil: WadiTeen

File Tools Scenarios Locations Constituents Time Series Help

Scenarios 0 of 2 All None

Locations 0 of 1 All None

Constituents 0 of 8 All None

COMPUTED
OBSERVED

MA'ABARO

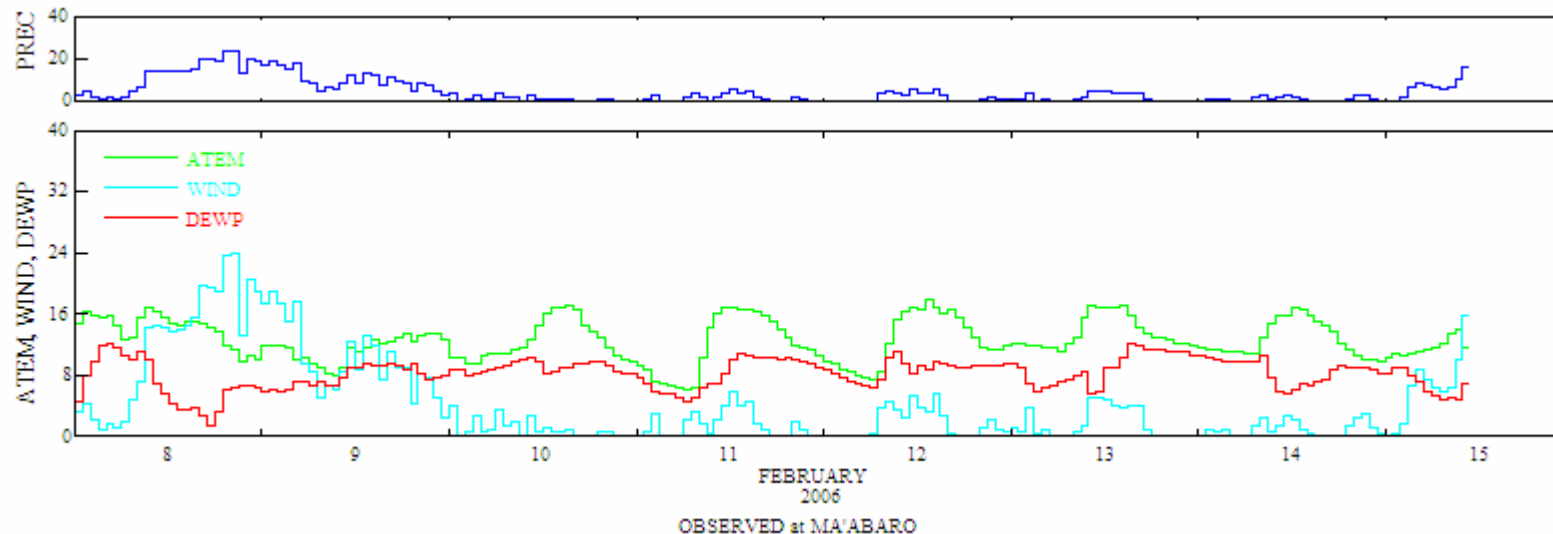
ATEM
DEVT
DEWP
PEVT
PREC
TMAX

Time Series - 8 of 8 available time series in list (0 not on WDM file): 0 selected.

| Type | File | DSN | Scenario | Location | Constituent | Start | SJDay | End | EJDay |
|------|----------|-----|----------|----------|-------------|----------|-------|-----------|------------------|
| WDM | WadiTeen | 11 | OBSERVED | MA'ABARO | PREC | 2006/2/8 | 53774 | 2006/2/15 | 53781.4583333333 |
| WDM | WadiTeen | 13 | OBSERVED | MA'ABARO | ATEM | 2006/2/8 | 53774 | 2006/2/15 | 53781.4583333333 |
| WDM | WadiTeen | 14 | OBSERVED | MA'ABARO | WIND | 2006/2/8 | 53774 | 2006/2/15 | 53781.4583333333 |
| WDM | WadiTeen | 17 | OBSERVED | MA'ABARO | DEWP | 2006/2/8 | 53774 | 2006/2/15 | 53781.4583333333 |

Dates
No Dates are available until Timeseries are Selected

Tools

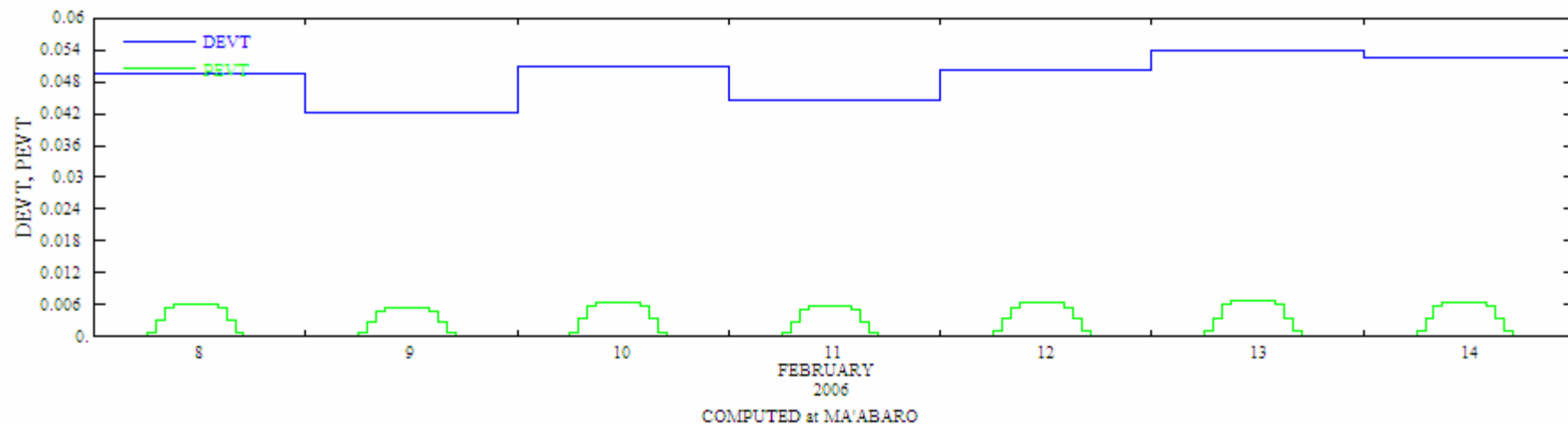


Preparing the WDM File

■ WDM file:

- TMAX: measured “Daily” maximum temperature.
- TMIN: measured “Daily” minimum temperature.
- DEVT: computed “Daily” potential evapotranspiration.
- PEVT: computed “Hourly” potential evapotranspiration.

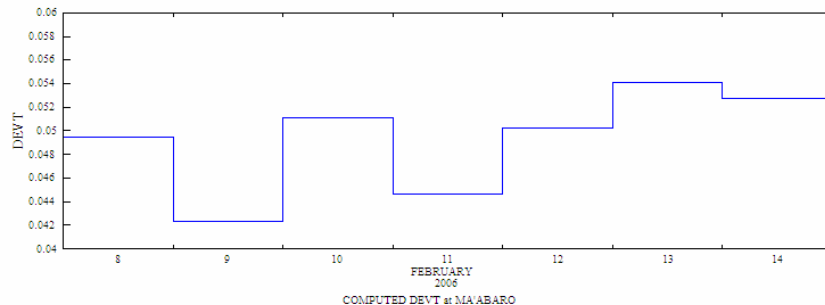
| Type | File | DSN | Scenario | Location | Constituent | Start | SJDay | End | EJDay |
|------|----------|-----|----------|----------|-------------|----------|-------|-----------|-------|
| WDM | WadiTeen | 19 | OBSERVED | MA'ABARO | TMAX | 2006/2/8 | 53774 | 2006/2/14 | 53781 |
| WDM | WadiTeen | 20 | OBSERVED | MA'ABARO | TMIN | 2006/2/8 | 53774 | 2006/2/14 | 53781 |
| WDM | WadiTeen | 25 | COMPUTED | MA'ABARO | DEVT | 2006/2/8 | 53774 | 2006/2/14 | 53781 |
| WDM | WadiTeen | 16 | COMPUTED | MA'ABARO | PEVT | 2006/2/8 | 53774 | 2006/2/14 | 53781 |



Preparing the WDM File

Estimating “Daily” potential evapotranspiration using “Hamon Method” by using:

- TMAX: measured “Daily” maximum temperature.
- TMIN: measured “Daily” minimum temperature.
- Latitude of the metrological station (32:22:7.15)



WDMUtil Compute

Operation: Compute Disaggregate

Compute Functions:

Solar Radiation Penman Pan Evaporation
 Jensen PET Wind Travel
 Hamon PET Percent Cloud Cover

Compute Daily PET (in) using monthly coefficients, latitude (d,m,s) and time series for min and max air temperature [F or C].

Timeseries

| Output: | Constituent | Location | Scenario | DSN |
|---------|-------------|----------|----------|-----|
| DEVT | MA'ABARO | COMPUTED | 25 | |

Input(s):

| | | | | |
|---------------|------|----------|----------|----|
| Min Air Temp: | TMIN | MA'ABARO | OBSERVED | 20 |
| Max Air Temp: | TMAX | MA'ABARO | OBSERVED | 19 |

Additional Inputs

Latitude (d,m,s): 32 22 7.15 Temperature Units: Fahrenheit Celsius

Monthly Coefficients:

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |

Dates

Reset Start End

Current 2006 2 8 0 0 0 to 2006 2 14 0 0 0

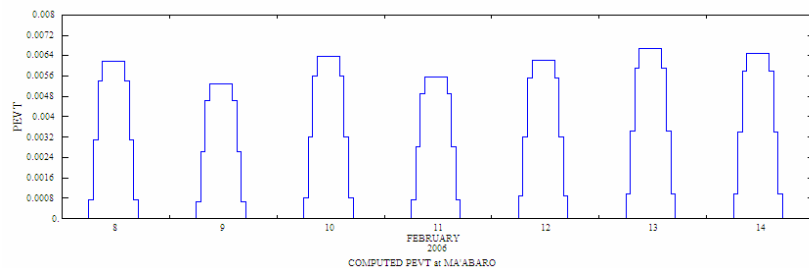
Common 2006 2 8 0 0 0 to 2006 2 14 0 0 0

Perform Operation Close

Preparing the WDM File

Disaggregate the estimated the
“Daily” Potential
Evapotranspiration using:

- DEVT: computed “Daily” Potential Evapotranspiration
- Latitude of the metrological station (32:22:7.15)



WDMUtil Compute

Operation
 Compute Disaggregate

Disaggregate Functions
 Solar Radiation Evapotranspiration
 Temperature Wind Travel
 Dewpoint Temperature Precipitation

Disaggregate Daily PET (in or cm) to Hourly (assumes a distribution based on latitude [d,m,s] and time of year).

Timeseries

| | Constituent | Location | Scenario | DSN |
|---------------|-------------|----------|----------|-----|
| Output: | PEVT | MA'ABARO | COMPUTED | 16 |
| Input(s): | | | | |
| Potential ET: | DEVT | MA'ABARO | COMPUTEC | 25 |

Additional Inputs
Latitude (d,m,s): 32 22 7.15

Dates
Reset Start End
Current 2006 2 8 0 0 0 to 2006 2 14 0 0 0
Common 2006 2 8 0 0 0 to 2006 2 14 0 0 0

Perform Operation Close