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Quantitative Microbial Risk Assessment Tutorial

Using NLDAS and NCDC Meteorological Data

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Summary

This tutorial reviews how screens, icons, and basic functions of the SDMProjectBuilder (SDMPB) use NLDAS and NCDC meteorological (MET) data to support microbial fate and transport, in a watershed, by the HSPF watershed model. The application is performed using watersheds of different scales, including HUC-8, HUC-12 and pour-point delineations. A discussion of the procedure for accessing and retrieving MET data from NOAA's NCDC web site is also provided.

Using NLDAS and NCDC Meteorological Data

PURPOSE

Automate data acquisition for data input requirements of a confederation of models

OBJECTIVE

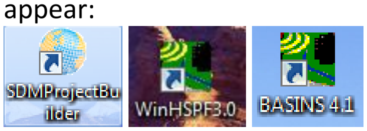
Use NLDAS and NCDC meteorological data to support microbial fate and transport in a watershed for use in the WinHSPF model (a.k.a. HSPF).

DEMONSTRATION

This tutorial reviews how screens, icons, and basic functions of the SDMProjectBuilder (SDMPB) use NLDAS and NCDC meteorological (MET) data to support microbial fate and transport, in a watershed, for use by the HSPF watershed model. The application is performed using watersheds of different scales, including HUC-12 and pour-point delineations. A discussion of the procedure for accessing and retrieving MET data from NOAA's NCDC web site is also provided.

SOFTWARE ACCESS, RETRIEVAL, AND DOWNLOAD

Instructions for accessing, retrieving, and downloading the SDMProjectBuilder, HSPF, and BASINS software products are provided by Whelan et al. (2015a). When installed, three desktop icons should appear:



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POST-2009 NCDC MET DATA

REMOTE-SENSING/RADAR SATELLITE AND GAUGE METEOROLOGICAL DATA

Meteorological (MET) data required by watershed assessments have traditionally been provided by land-based National Climatic Data Center (NCDC) weather (gauge) stations, although they may not be the most appropriate for describing adequate spatial and temporal resolution if MET stations are too few, too far away, or operating improperly. To complement land-based stations, remote sensing and radar satellite data are increasingly used to obtain synoptic data with the spatial and temporal resolution required for site-specific and/or event-based assessments.

Price et al. (2013) investigated whether NEXRAD (NEXt generation RADar) Multisensor Precipitation Estimates (MPE) data improve the accuracy of streamflow simulations using the Soil and Water Assessment Tool watershed model, compared to rain gauge data. MPE contains data reviewed by human forecasters, combines radar-based estimates with hourly gauge station data on a 4-km grid, and provides all spatial data by time increment. MPE is GRIdded-Binary (GRIB)-based data which is difficult to access and retrieve for individual locations. Across watersheds and time steps, the authors found that total gauge precipitation was greater than radar precipitation, but radar data showed a conditional bias of higher rainfall estimates during large events (>25–50 mm/day). Radar-based simulations were more accurate than gauge-based simulations for high flows, however. At coarser time steps, differences were less pronounced which suggest that modeling efforts in watersheds with poor rain gauge coverage can be improved with MPE radar data, especially at short time steps.

Kim et al. (2014) performed a follow-up study and compared the viability of automating use of radar satellite data and land-based gauge stations to support MET data collection for modeling applications, especially where gauge stations were inadequate. They compared MPE and the North American Land Data Assimilation System (NLDAS) to gauge data at Milwaukee and Manitowoc, Wisconsin USA. NLDAS contains automatic quality control, uses hourly gauge station data and modeled precipitation, provides estimates at hourly intervals with a 1/8th-degree resolution, and provides time series at specified locations. Unlike MPE's dataset, NLDAS is directly accessible and provides time series at a location. The comparison showed excellent correlation between gauge and radar data at Milwaukee, while Manitowoc results strongly suggested using radar over gauge data. Based partly on these and similar studies, and because a large number of watersheds are ungauged, are too far from gauging stations or operate improperly, the SDMProjectBuilder was reconfigured to allow using NCDC datasets or NLDAS datasets coupled with NCDC to compile MET data.

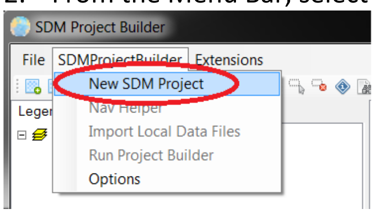
After subwatersheds are determined, SDMProjectBuilder determines the MET data station closest to each subwatershed, eliminating those that might not have appropriate meteorological information or the needed date span, and downloads data for that station. Because not all MET stations will have the information needed to model the desired HSPF processes, SDMProjectBuilder automatically finds at least one with all HSPF MET information. Data for all stations are combined into a single met WDM file to use in HSPF.

NLDAS MET DATA FOR HUC-12

Pre-2009 NCDC MET data have been cached within the BASINS infrastructure. The example below uses BASINS MET to illustrate how the nearest MET gauge station is assigned to different areas of a HUC-12. Following an abbreviated procedure for identifying a HUC-12 (see Whelan et al., 2015c), a distribution of MET stations is illustrated.

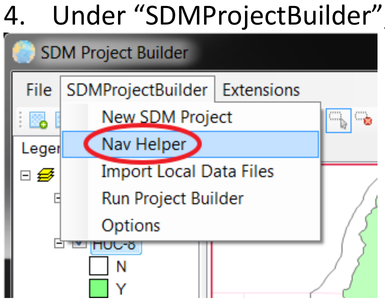
1. Execute the SDMProjectBuilder (SDMPB) by clicking on the shortcut icon displayed on the computer screen, and create a folder where you have administrative rights:

2. From the Menu Bar, select "SDMProjectBuilder", then "New SDM Project".

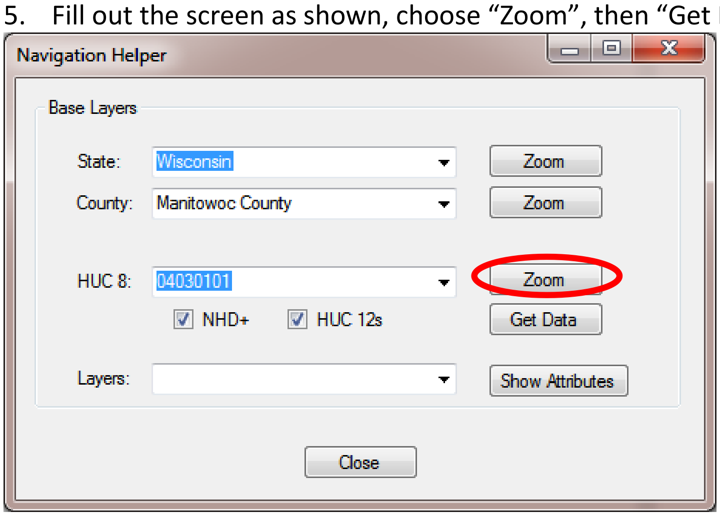


3. Create a new file within the working folder.

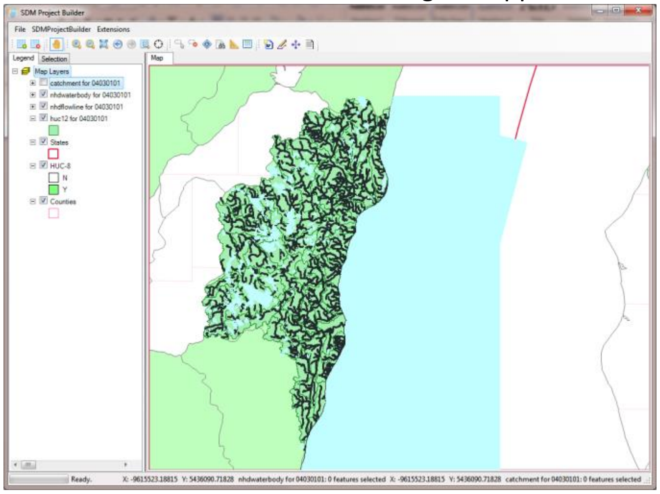
4. Under "SDMProjectBuilder", select "Nav Helper".



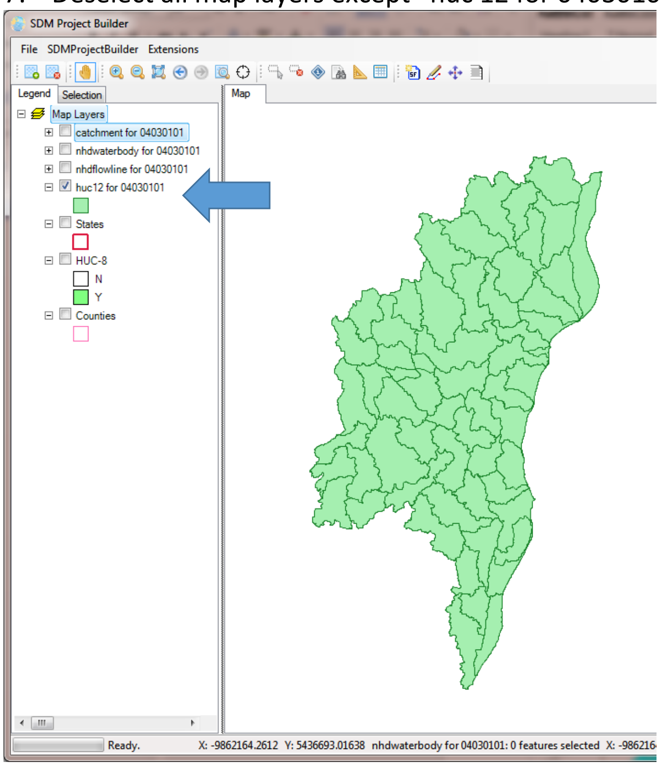
5. Fill out the screen as shown, choose "Zoom", then "Get Data".



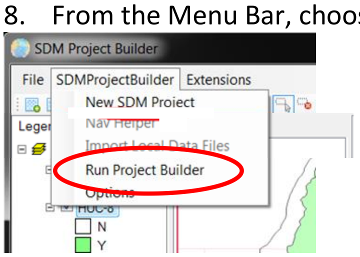
6. A screen similar to the following will appear.



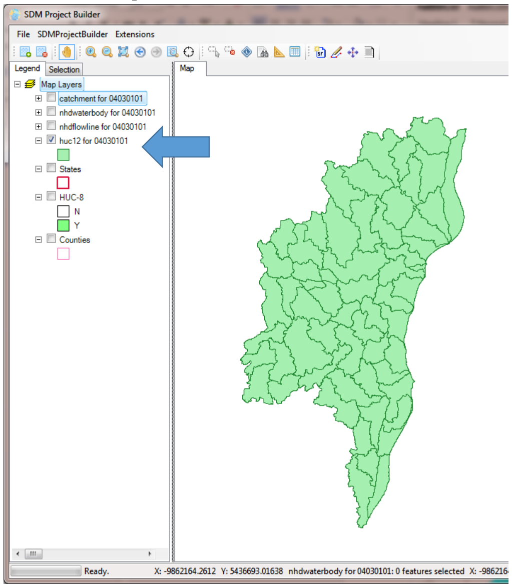
7. Deselect all map layers except “huc 12 for 04030101” and “Close” the “Navigation Helper”.



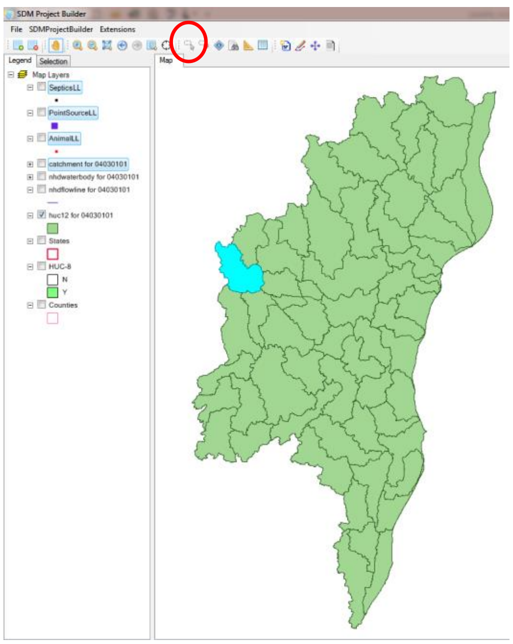
8. From the Menu Bar, choose “SDMProjectBuilder”, then “Run Project Builder”.



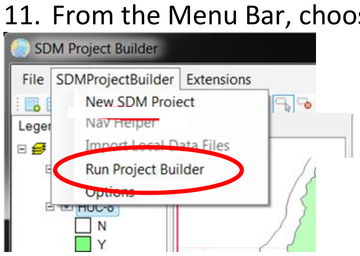
9. After repeating Steps 1 through 7 above, the HUC-12 corresponding to the Hydrologic Unit Code (HUC) Catalog Unit (CU) of 04030101 is defined as follows [see Whelan et al. (2015b) for more details]:



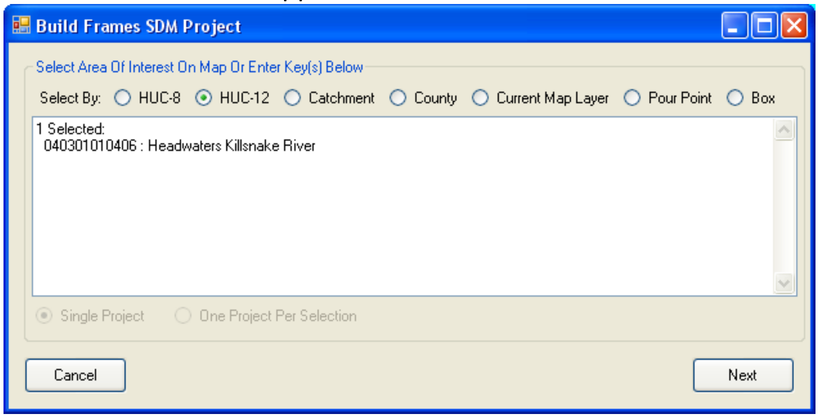
10. Select the HUC-12 noted below:



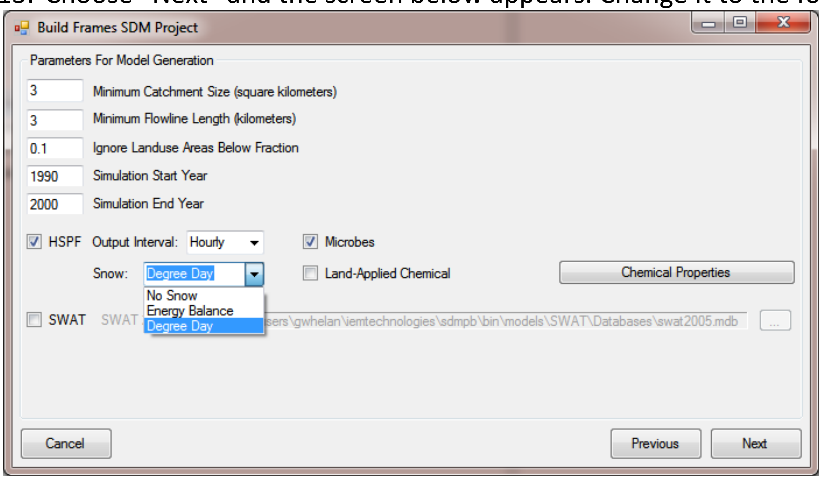
11. From the Menu Bar, choose “SDMProjectBuilder”, then “Run Project Builder”.



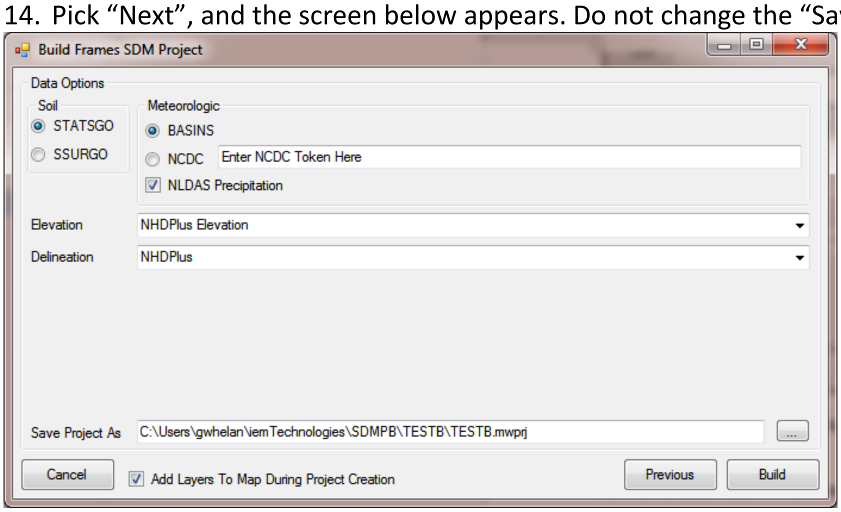
12. The screen below appears. Choose “HUC-12”.



13. Choose “Next” and the screen below appears. Change it to the following:



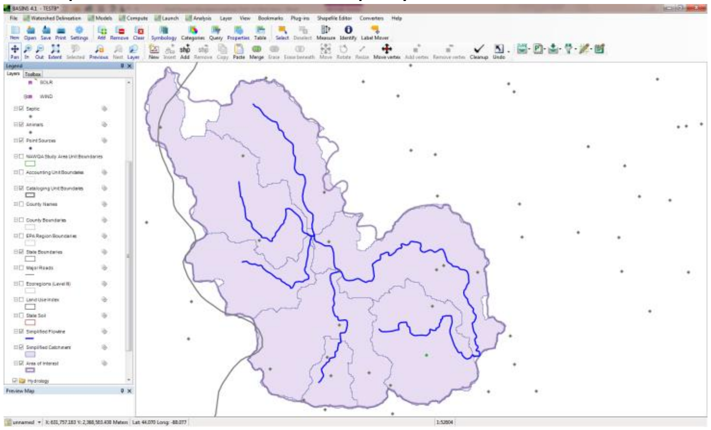
14. Pick “Next”, and the screen below appears. Do not change the “Save Project As” text box.



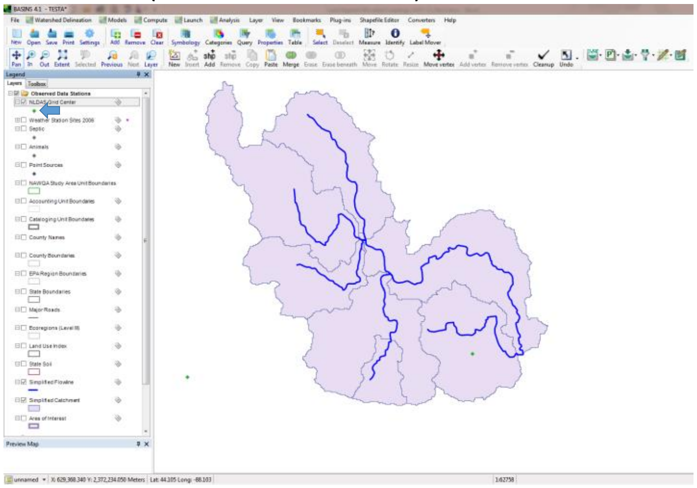
15. Choose ”Build” which may take several minutes to complete, depending on the computer.

16. Some computers may ask several times if the re-project map layer should match the map coordinate system; choose “Yes” each time.

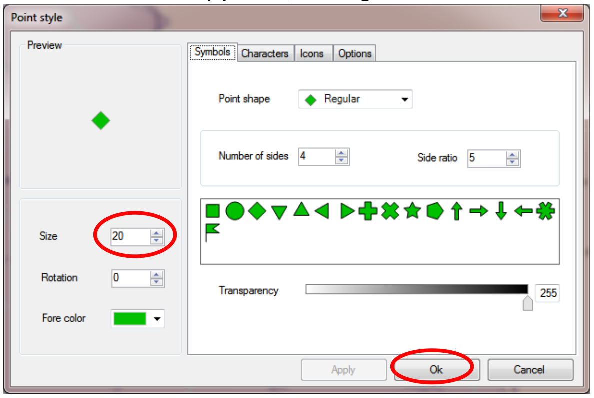
17. When the SDMPB has finished running, choose “Open in BASINS” and BASINS will automatically open with the SDMPB map layers for this assessment. The following screen appears:



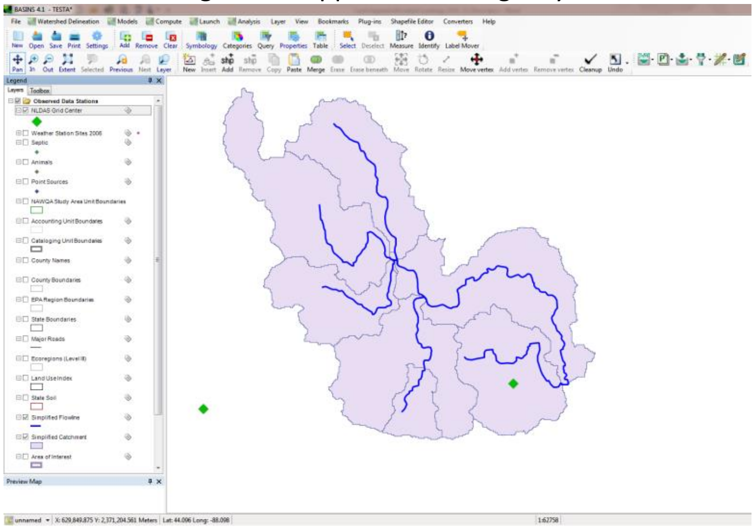
18. It may be difficult to differentiate NLDAS MET stations from other points on the map layer, (e.g., domestic animal/septic locations), so
    - uncheck other map layers since NLDAS symbols may be hidden behind other symbols and
    - increase the size of the NLDAS symbol by double-clicking on the NLDAS Grid Center symbol (see blue arrow below):



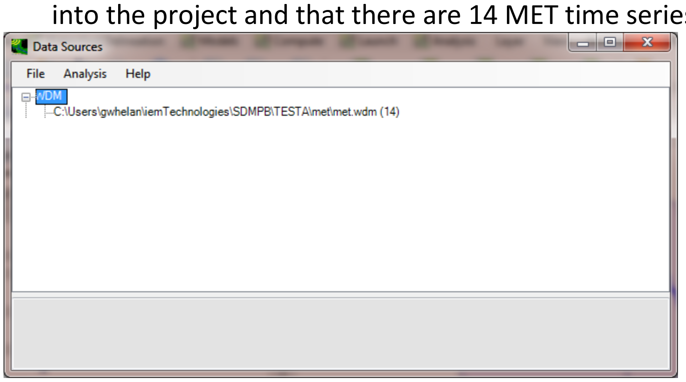
19. This screen appears; change the “Size” to 20, and click “Ok”.



20. The following screen appears with larger symbols for the NLDAS stations:

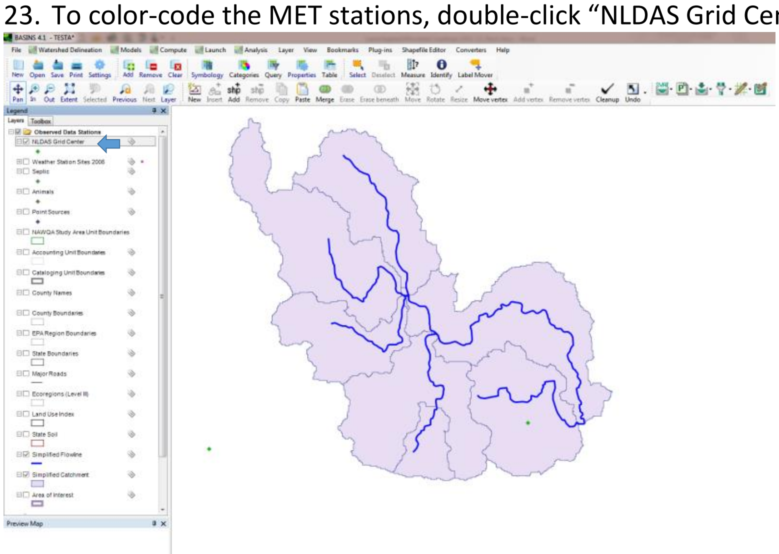


21. By clicking “File,” then “Manage Data” on the menu bar, we can see that the MET data are loaded into the project and that there are 14 MET time series in the file.

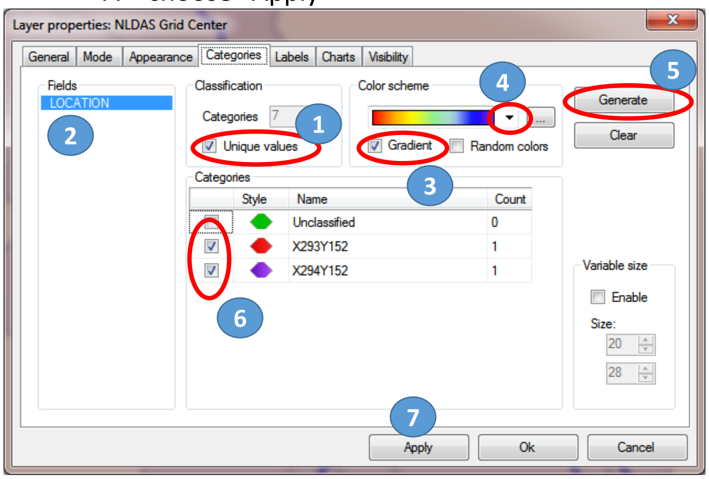


22. Choose “File”, then “Exit” to return to the main screen.

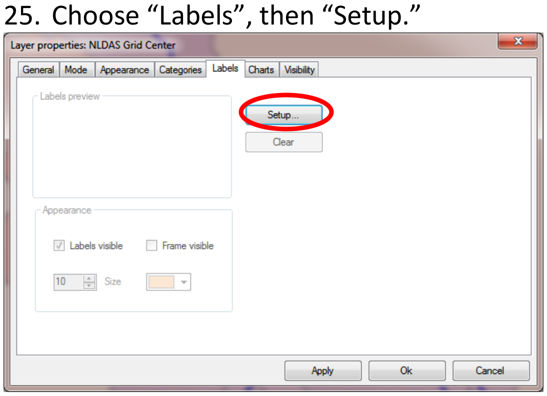
23. To color-code the MET stations, double-click “NLDAS Grid Center” label (see blue arrow below)



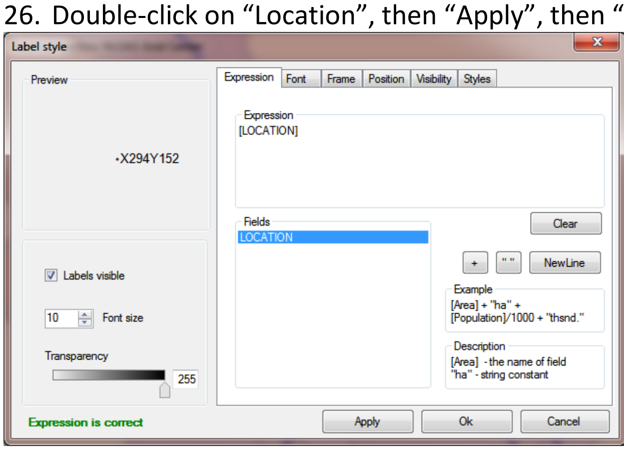
24. Choose “Categories” tab and
    1. check “Unique values”
    2. select “LOCATION”
    3. check “Gradient”
    4. choose “Color scheme”
    5. click “Generate”
    6. check the boxes with non-zero counts
    7. choose “Apply”



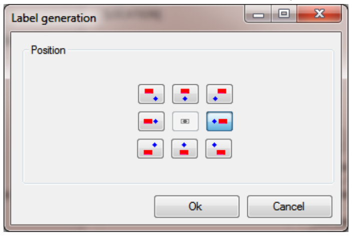
25. Choose “Labels”, then “Setup.”



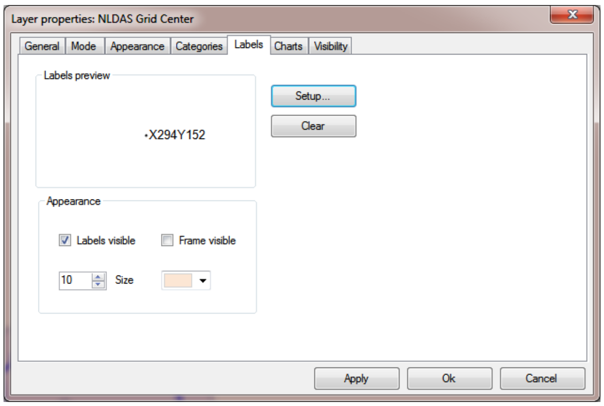
26. Double-click on “Location”, then “Apply”, then “Ok.”



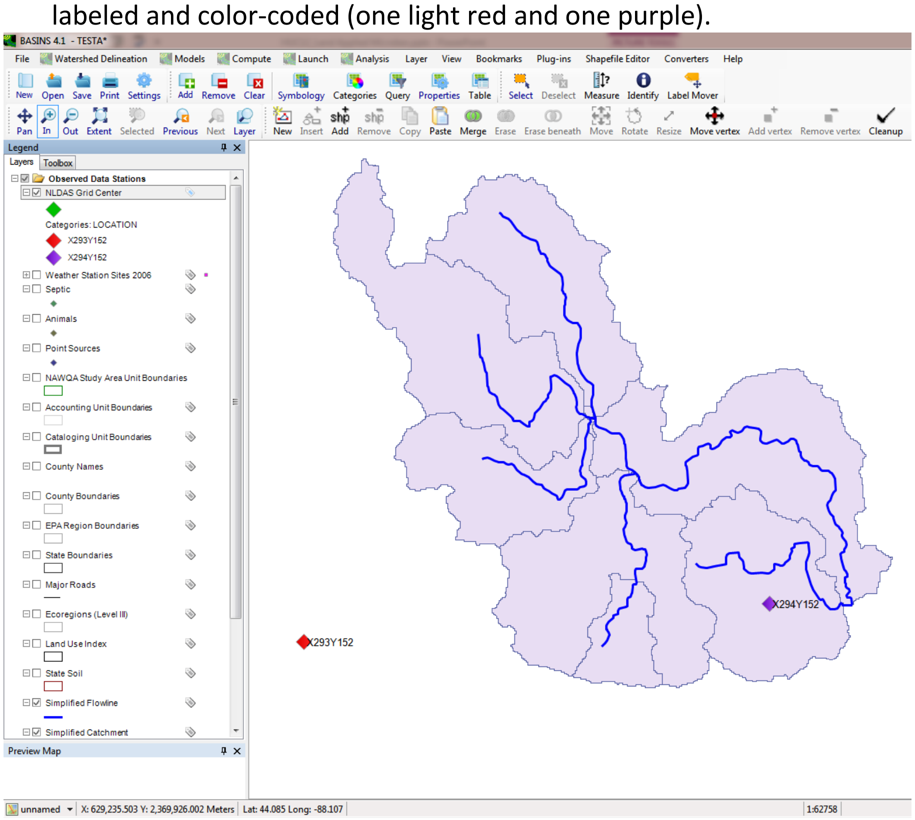
27. Choose the Position, then click “Ok.”



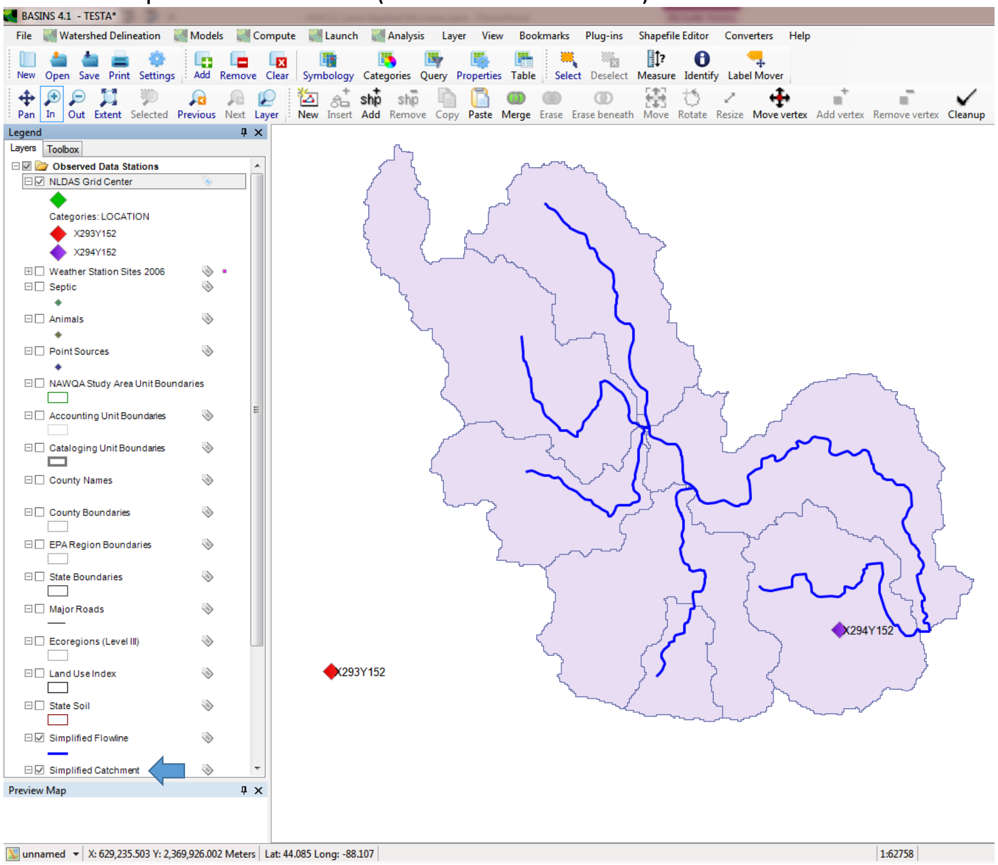
28. Click “Ok.”



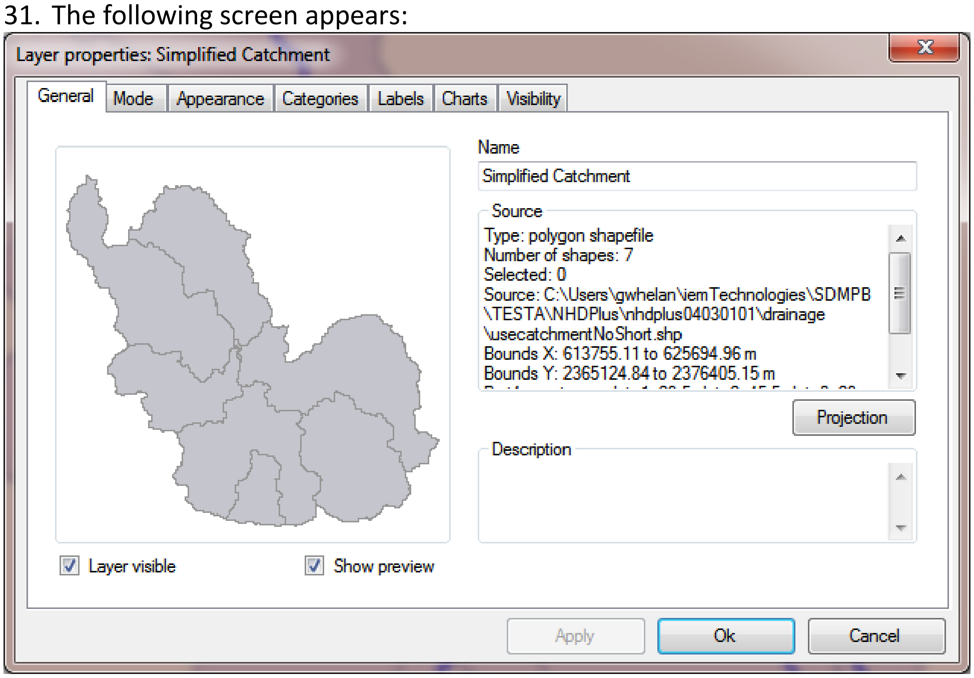
29. The two MET stations (diamond symbols below) that influence the seven subwatersheds are now labeled and color-coded (one light red and one purple).



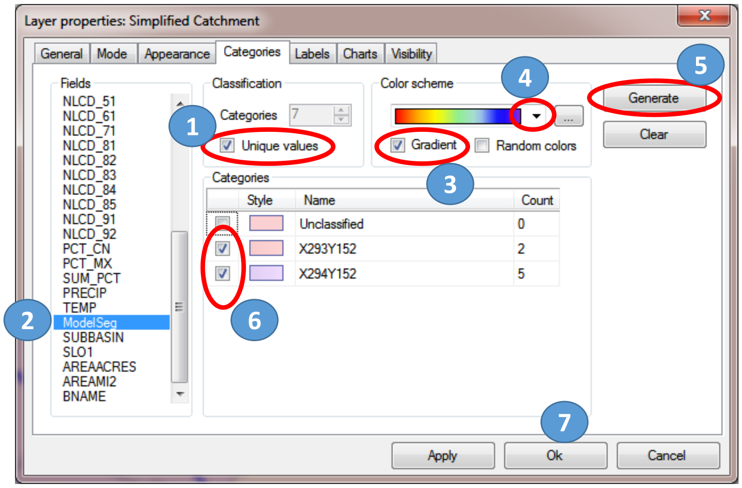
30. To see which subwatersheds (i.e., subbasins) are associated with which MET stations, double-click on “Simplified Catchment” (see blue arrow below):



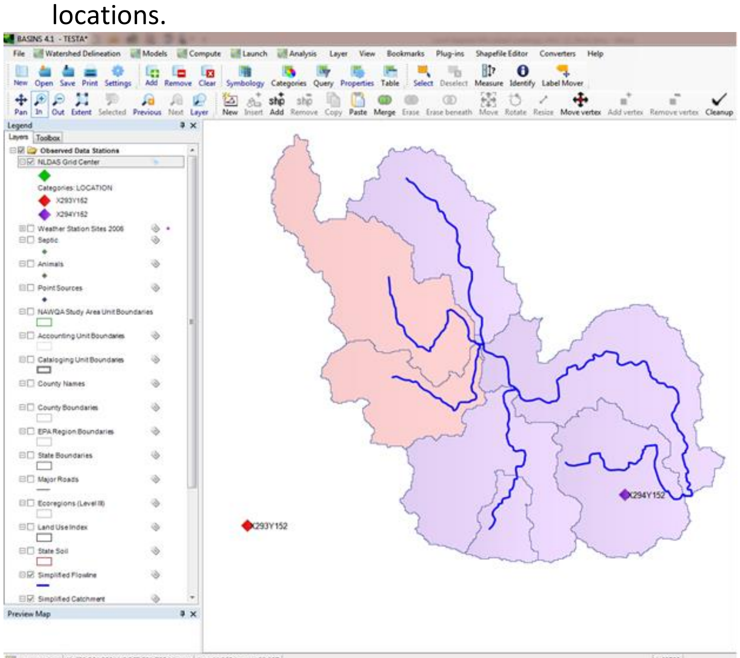
31. The following screen appears:



32. To color-code subwatersheds to match the color-coded MET stations, choose the “Categories” tab and
    1. check “Unique values”
    2. select “ModelSeg”
    3. check “Gradient”
    4. choose “Color scheme”
    5. click “Generate”
    6. check the boxes with non-zero counts
    7. choose “OK”



33. In the resulting image, see that the subwatersheds have been color-coded to the nearest NLDAS locations.



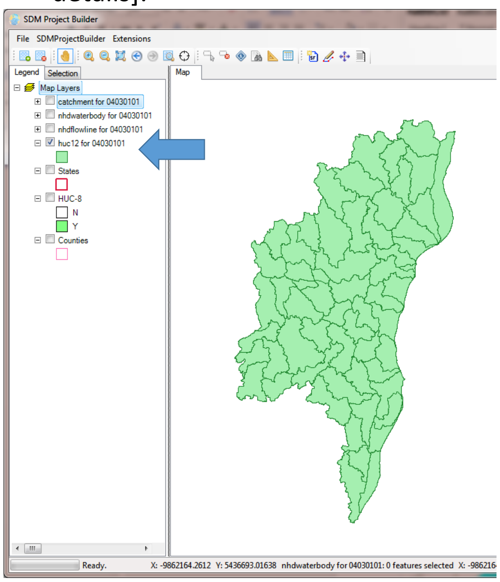
Appendix A illustrates how the HSPF UCI file captures and assigns the two NLDAS stations to the subwatersheds (Whelan et al., 2015c).

NLDAS AND NCDC MET DATA FOR POUR POINT

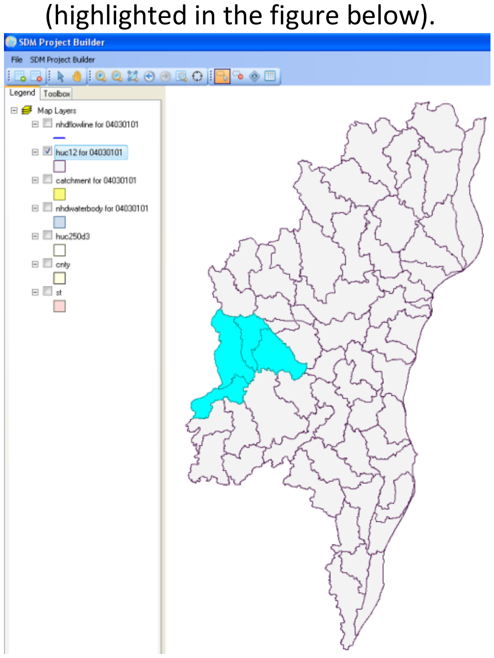
A similar procedure can be performed for a pour point (see Whelan et al., 2015d). This section also compares remote-sensing NLDAS stations to the monitoring NCDC station.

Viewing NLDAS and NCDC MET Stations for a Pour Point

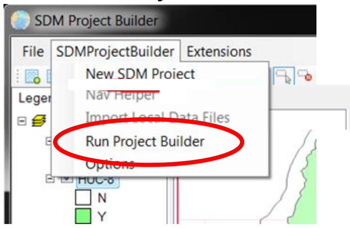
34. After repeating Steps 1 through 7 above, the HUC-8 corresponding to the Hydrologic Unit Code (HUC) Catalog Unit (CU) of 04030101 is defined as follows [see Whelan et al. (2015b) for more details]:



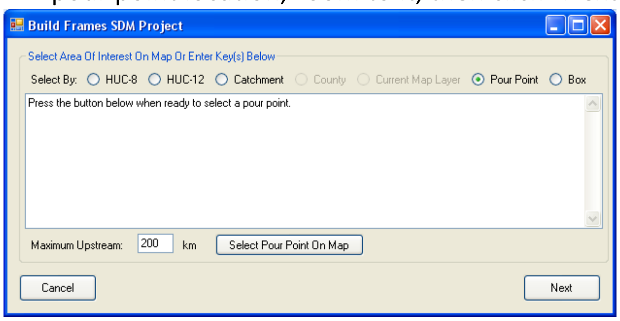
35. In this example, we assess only the four uppermost 12-digit HUCs in the Manitowoc watershed (highlighted in the figure below).



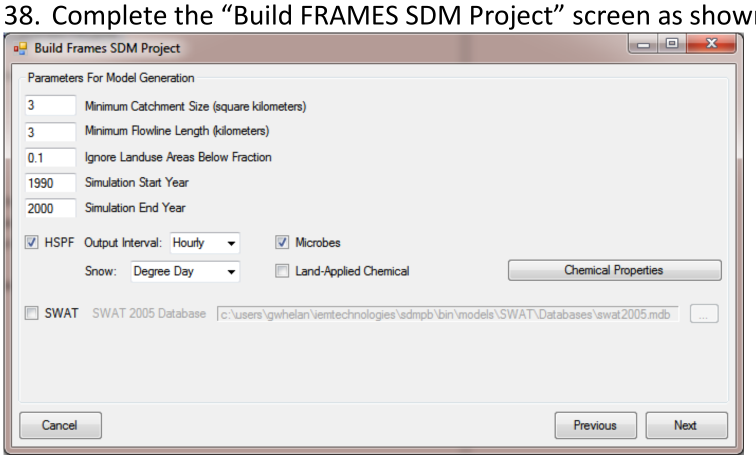
36. Follow procedures outlined in Whelan et al. (2015d) to identify the pour point corresponding to the subwatershed outlined in the figure above. From the Menu Bar, choose “SDMProjectBuilder”, then “Run Project Builder”.



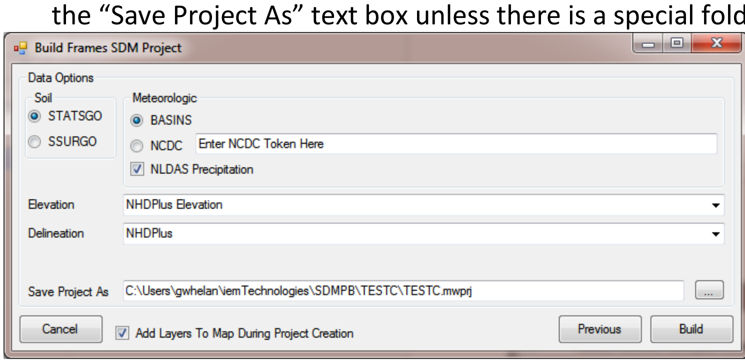
37. Use the choices identified below, choose “Select Pour Point On Map”, go to the map and choose the pour point location, zoom to it, then click “Next”.



38. Complete the “Build FRAMES SDM Project” screen as shown.



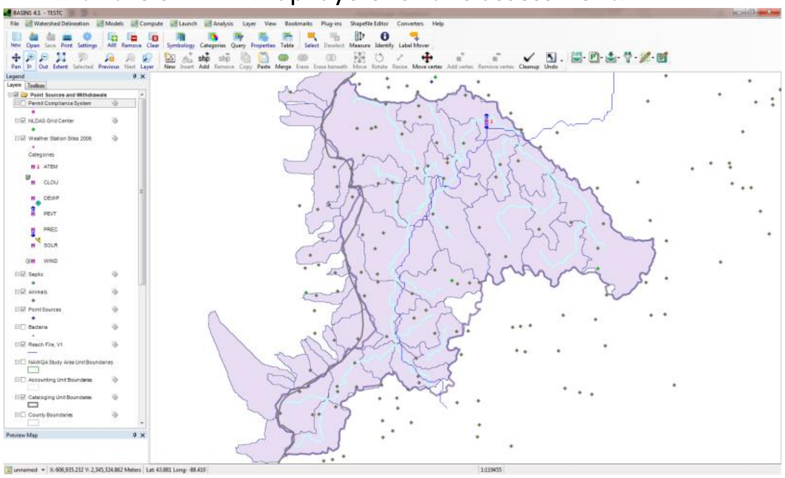
39. Click “Next” and the following screen appears. Change the screen to that below; make no changes to the “Save Project As” text box unless there is a special folder location.



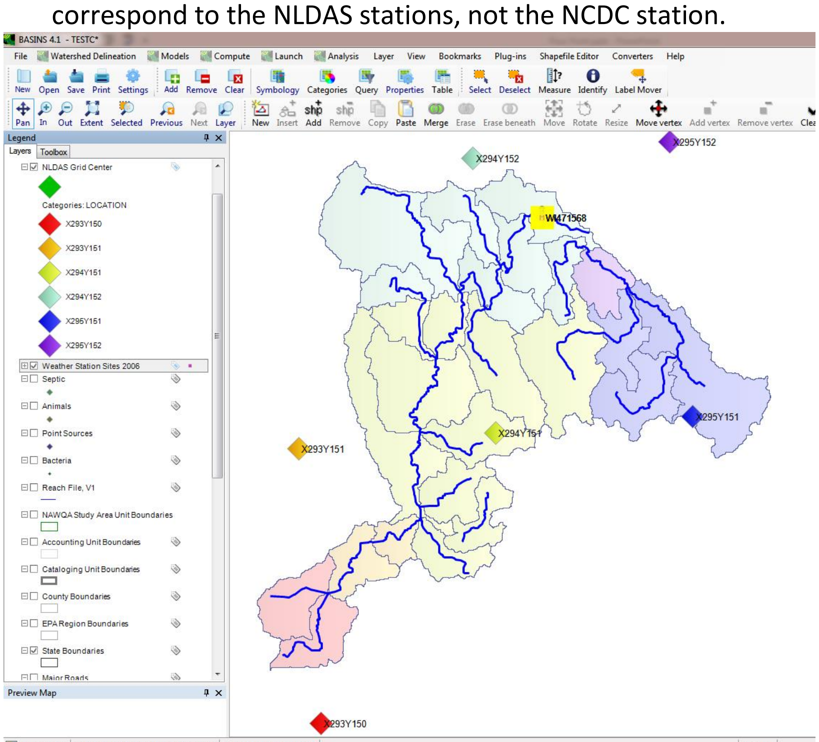
40. Now choose “Build” which takes approximately 25 minutes to complete for a pour point with four HUC-12s, depending on the computer.

41. Some computers may ask several times if the re-project map layer should match the map coordinate system; choose “Yes” each time.

42. When the SDMPB has finished running, choose “Open in BASINS”, and BASINS automatically opens with the SDMPB map layers for this assessment:



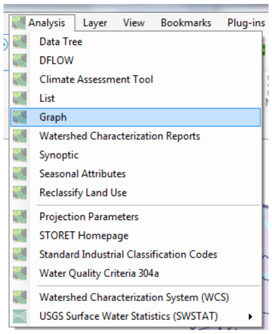
43. Following the same procedures outlined in previous sections, NLDAS and NCDC BASINS MET stations can be color-coded and mapped as shown below, where diamond symbols represent the NLDAS MET stations, and the yellow square (WI471568) represents the NCDC station. Color-coded areas correspond to the NLDAS stations, not the NCDC station.



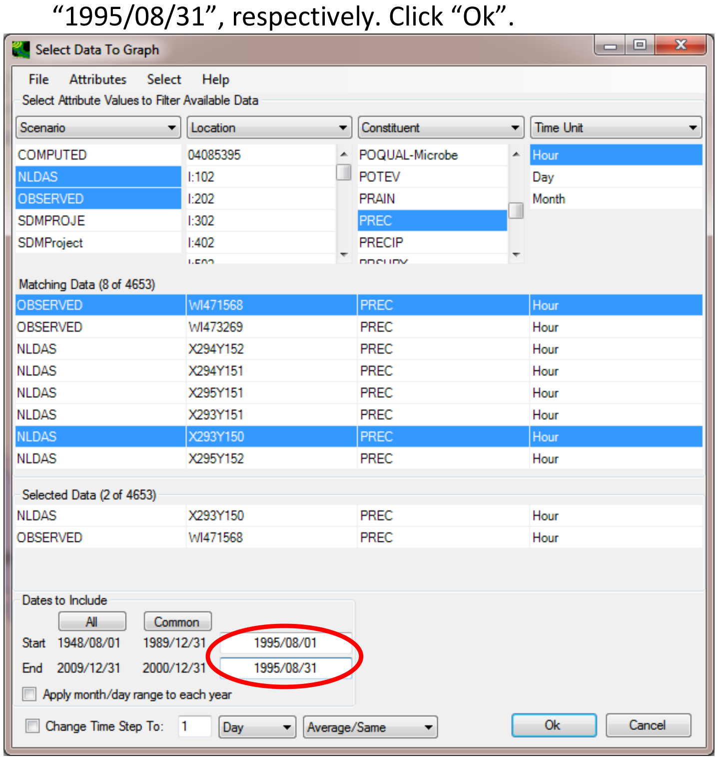
Comparing NLDAS and NCDC MET Stations for a Pour Point

Using the case developed under Whelan et al. (2015d), NLDAS and NCDC MET station results are compared to demonstrate temporal differences between stations at different locations. To demonstrate differences between NLDAS remote-sensing and NCDC monitoring results, NLDAS station X293Y150 and NCDC station WI471568 are compared. NLDAS stations X293Y150 and X293Y152 are also compared since they represent southern- and northern-most stations in the watershed.

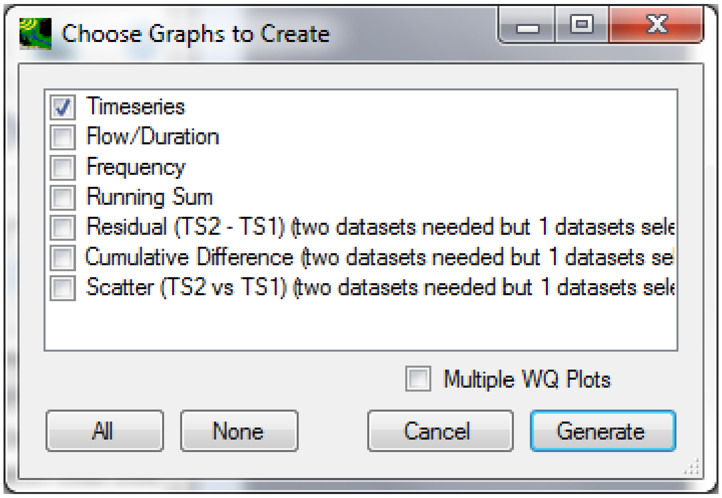
44. To compare NLDAS station X293Y150 and NCDC station WI471568, choose "Analysis" from the BASINS menu bar, then "Graph".



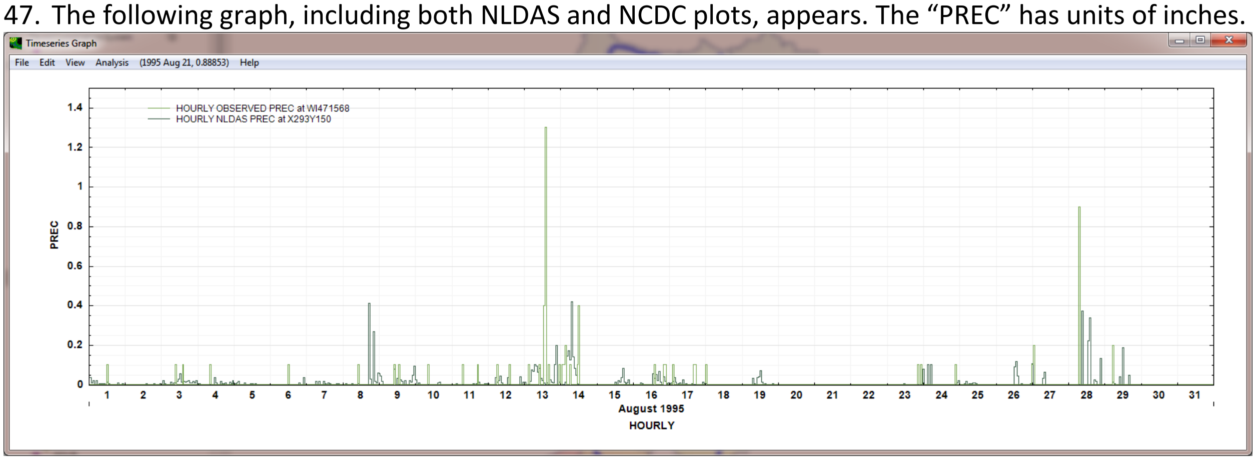
45. See Whelan et al. (2015c) for guidance on selecting data to graph. Under "Scenario", select "NLDAS" and "OBSERVED". Under "Constituent", choose "PREC". Under the "Matching Data" section, a list of stations will appear. Choose "OBSERVED" for "WI471568" and "NLDAS" for "X293Y150". The results below should appear under "Selected Data". Because it will be nearly impossible to compare results from more than 10 years of records, change the start and end dates to cover only the month of August 1995; under "Dates to Include", change the "Start" and "End" dates to "1995/08/01" and "1995/08/31", respectively. Click "Ok".



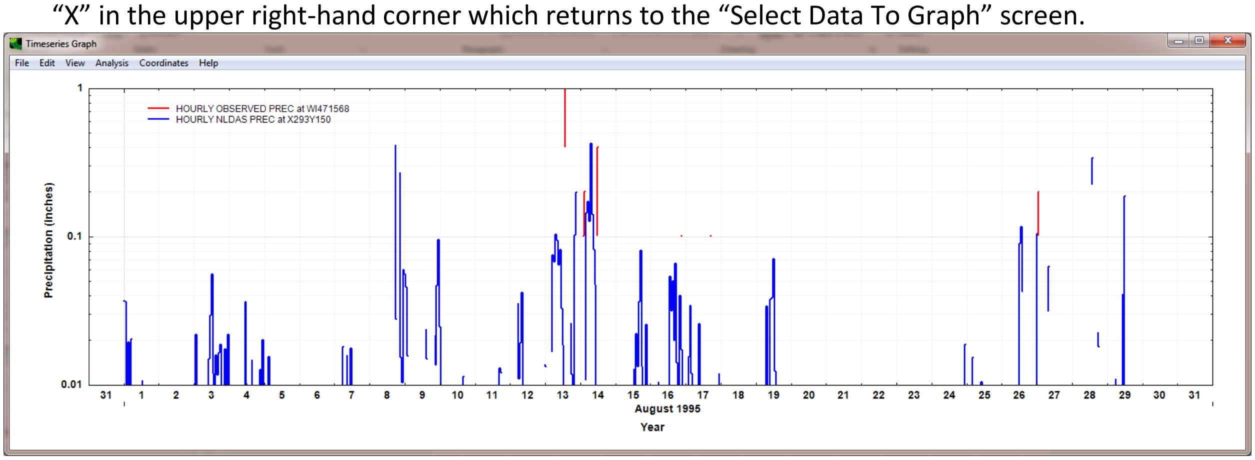
46. Choose “Timeseries” and “Generate”.



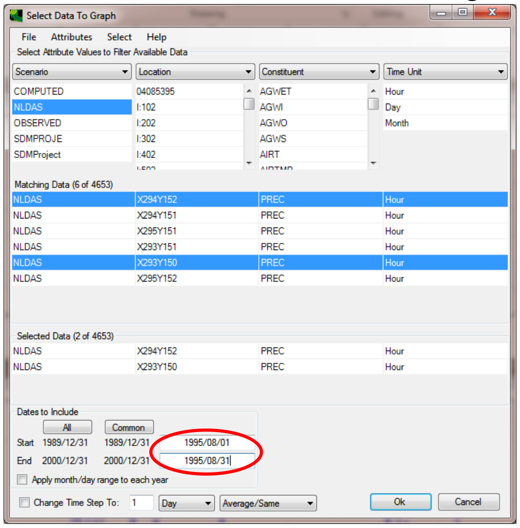
47. The following graph, including both NLDAS and NCDC plots, appears. The “PREC” has units of inches.



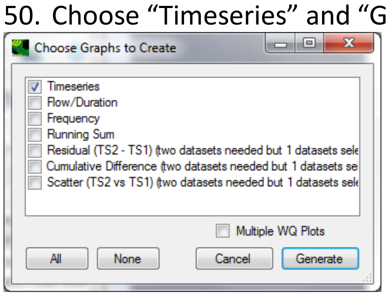
48. Using the editor described in Whelan et al. (2015c), the graph can be modified for a better view of the results. The hourly NCDC observed data are the red curve, and the hourly NLDAS data are the blue curve. The NLDAS station does not necessarily record the precipitation that hits the ground, but Kim et al. (2014) noted anomalies in monitoring stations in the Manitowoc basin. Exit by clicking the “X” in the upper right-hand corner which returns to the “Select Data To Graph” screen.



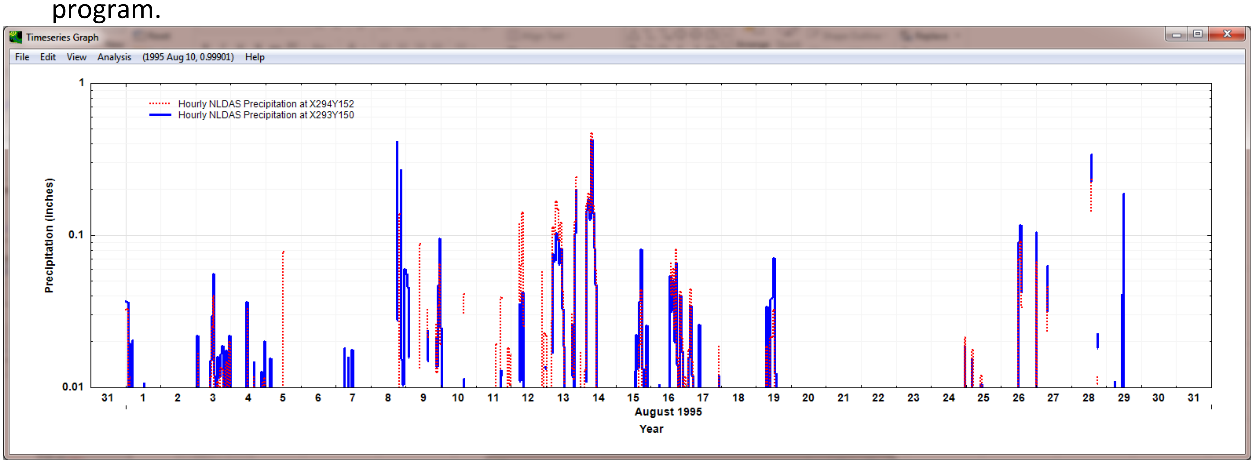
49. To compare NLDAS stations X293Y150 and X293Y152, make the following selections, ensuring that the start and end dates refer to August 1995. Click “OK”.



50. Choose “Timeseries” and “Generate”.

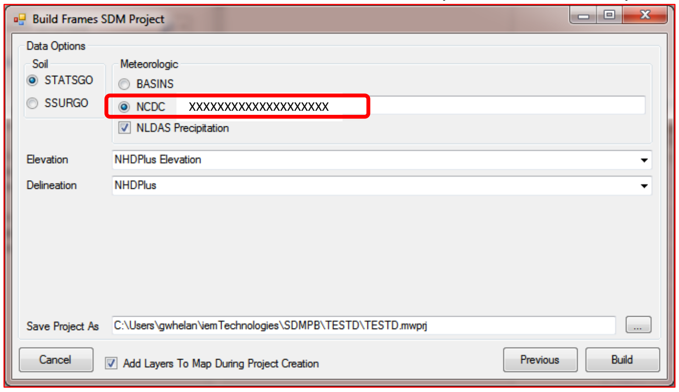


51. The NLDAS precipitation plots appear. The “PREC” has units of inches. Using the editor described in Whelan et al. (2015c), the graph can be modified to better view results. Hourly results associated with the southern station X293Y150 are in blue and hourly results associated with the northern station X293Y152 are in red. Although this is a relatively small watershed, localized effects on precipitation are evident and become more pronounced within the larger Manitowoc River watershed (not shown). Exit by clicking the “X” in the upper right-hand corner. Now exit the program.



POST-2009 NCDC MET DATA

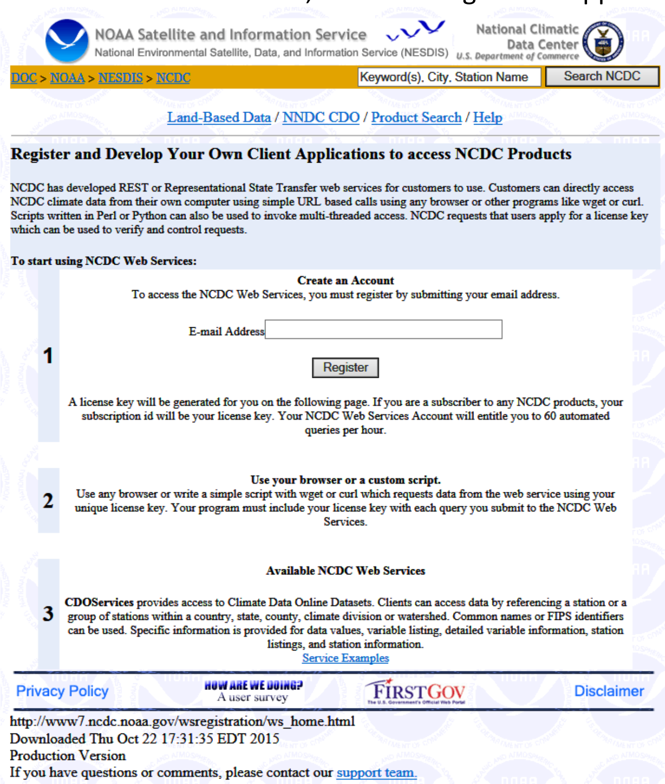
Pre-2009 NCDC data and additional MET information are cached with the BASINS install, so direct access to the NCDC web site is unnecessary. For times post-2008, direct access to the NCDC web site to obtain MET data. The NCDC data are not as complete as the cached, pre-2009 BASINS data, so even if pre-2009 NCDC data are directly requested from the NCDC site, the results may not exactly match those based on BASINS. The SDMProjectBuilder allows direct access to the NCDC web site if the user has registered with NCDC and obtained an access token (i.e., ID number), as illustrated below:



Once obtained, the same token is good every time and additional tokens are not needed to access the site again. The link to obtain a token is

http://www7.ncdc.noaa.gov/wsregistration/ws_home.html

When the site is accessed, the following screen appears:



NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)
National Climatic Data Center
U.S. Department of Commerce

DOC > NOAA > NESDIS > NCDC

Keyword(s), City, Station Name | Search NCDC

Land-Based Data / NNDC CDO / Product Search / Help

Register and Develop Your Own Client Applications to access NCDC Products

NCDC has developed REST or Representational State Transfer web services for customers to use. Customers can directly access NCDC climate data from their own computer using simple URL based calls using any browser or other programs like wget or curl. Scripts written in Perl or Python can also be used to invoke multi-threaded access. NCDC requests that users apply for a license key which can be used to verify and control requests.

To start using NCDC Web Services:

1 **Create an Account**
To access the NCDC Web Services, you must register by submitting your email address.

E-mail Address

Register

A license key will be generated for you on the following page. If you are a subscriber to any NCDC products, your subscription id will be your license key. Your NCDC Web Services Account will entitle you to 60 automated queries per hour.

2 **Use your browser or a custom script.**
Use any browser or write a simple script with wget or curl which requests data from the web service using your unique license key. Your program must include your license key with each query you submit to the NCDC Web Services.

3 **Available NCDC Web Services**

CDOServices provides access to Climate Data Online Datasets. Clients can access data by referencing a station or a group of stations within a country, state, county, climate division or watershed. Common names or FIPS identifiers can be used. Specific information is provided for data values, variable listing, detailed variable information, station listings, and station information.
Service Examples

Privacy Policy | HOW ARE WE DOING? A user survey | FIRSTGOV | Disclaimer

http://www7.ncdc.noaa.gov/wsregistration/ws_home.html
Downloaded Thu Oct 22 17:31:35 EDT 2015
Production Version
If you have questions or comments, please contact our support team.

After the token is received, the following screen capture illustrates its use which is automatically handled by the SDMProjectBuilder:

DISCLAIMER

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication.

REFERENCES

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Whelan, G., K. Kim, K. Wolfe, R. Parmar, M. Galvin, M. Molina, R. Zepp, P. Duda, M. Gray. 2015d. Quantitative Microbial Risk Assessment Tutorial: Pour Point Analysis of Land-applied Microbial Loadings and Comparison of Simulated and Gaging Station Results. EPA/600/B-15/290. U.S. Environmental Protection Agency, Athens, GA.

APPENDIX A
NLDAS Stations Recorded in the HSPF UCI File
(Whelan et al., 2015c)

Looking at the UCI, we see two sets of pervious and impervious land types (PERLND and IMPLND, respectively), which correspond to the two NLDAS locations in use.

```
RUN

GLOBAL
  UCI Created by WinHSPF for 040301010406
  START       1990/01/01 00:00  END    2000/12/31 24:00
  RUN INTERP OUTPT LEVELS    1    0
  RESUME     0 RUN     1                         UNITS    1
END GLOBAL

FILES
<FILE>  <UN#>***<----FILE NAME--------------------------------
------>
MESSU       24   040301010406.ech
            91   040301010406.out
WDM1        25   040301010406.wdm
WDM2        26   met.wdm
BINO        92   040301010406.hbn
END FILES

OPN SEQUENCE
    INGRP                 INDELT 01:00
      PERLND      101
      PERLND      102
      PERLND      103
      PERLND      104
      PERLND      105          1
      PERLND      106
      PERLND      107
      PERLND      108
      IMPLND      102
      PERLND      201
      PERLND      202
      PERLND      204
      PERLND      206          2
      PERLND      207
      PERLND      208
      PERLND      205
      IMPLND      202
      RCHRES        5
      RCHRES        1
      RCHRES        4
      RCHRES        6
      RCHRES        3
      RCHRES        2
      RCHRES        7
    END INGRP
END OPN SEQUENCE
```

The external sources (EXT SOURCES) block assigns MET data to each subwatershed (subbasin). Since we only pull precipitation data from NLDAS, the other met constituents are from a BASINS station with the full suite of meteorological data (Green Bay).

```
EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name>   x <Name> x tem strg<-factor->strg <Name>   x   x        <Name> x x ***
*** Met Seg X294Y152
WDM2     21 PREC      ENGLZERO             SAME PERLND 101 108 EXTNL  PREC
WDM2      6 PEVT      ENGL                 SAME PERLND 101 108 EXTNL  PETINP
WDM2      3 ATEM      ENGL                 SAME PERLND 101 108 EXTNL  GATMP
WDM2     14 WIND      ENGL                 SAME PERLND 101 108 EXTNL  WINMOV
WDM2     15 SOLR      ENGL                 SAME PERLND 101 108 EXTNL  SOLRAD
WDM2     17 DEWP      ENGL                 SAME PERLND 101 108 EXTNL  DTMPG
WDM2     18 CLOU      ENGL                 SAME PERLND 101 108 EXTNL  CLOUD
*** Met Seg X293Y152
WDM2     31 PREC      ENGLZERO             SAME PERLND 201 208 EXTNL  PREC
WDM2      6 PEVT      ENGL                 SAME PERLND 201 208 EXTNL  PETINP
WDM2      3 ATEM      ENGL                 SAME PERLND 201 208 EXTNL  GATMP
WDM2     14 WIND      ENGL                 SAME PERLND 201 208 EXTNL  WINMOV
WDM2     15 SOLR      ENGL                 SAME PERLND 201 208 EXTNL  SOLRAD
WDM2     17 DEWP      ENGL                 SAME PERLND 201 208 EXTNL  DTMPG
WDM2     18 CLOU      ENGL                 SAME PERLND 201 208 EXTNL  CLOUD
*** Met Seg X294Y152
WDM2     21 PREC      ENGLZERO             SAME IMPLND 102     EXTNL  PREC
WDM2      6 PEVT      ENGL                 SAME IMPLND 102     EXTNL  PETINP
WDM2      3 ATEM      ENGL                 SAME IMPLND 102     EXTNL  GATMP
WDM2     14 WIND      ENGL                 SAME IMPLND 102     EXTNL  WINMOV
WDM2     15 SOLR      ENGL                 SAME IMPLND 102     EXTNL  SOLRAD
WDM2     17 DEWP      ENGL                 SAME IMPLND 102     EXTNL  DTMPG
WDM2     18 CLOU      ENGL                 SAME IMPLND 102     EXTNL  CLOUD
*** Met Seg X293Y152
WDM2     31 PREC      ENGLZERO             SAME IMPLND 202     EXTNL  PREC
WDM2      6 PEVT      ENGL                 SAME IMPLND 202     EXTNL  PETINP
WDM2      3 ATEM      ENGL                 SAME IMPLND 202     EXTNL  GATMP
WDM2     14 WIND      ENGL                 SAME IMPLND 202     EXTNL  WINMOV
WDM2     15 SOLR      ENGL                 SAME IMPLND 202     EXTNL  SOLRAD
WDM2     17 DEWP      ENGL                 SAME IMPLND 202     EXTNL  DTMPG
WDM2     18 CLOU      ENGL                 SAME IMPLND 202     EXTNL  CLOUD
```