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WaveNet: A Web-Based Metocean Data Access, Processing and Analysis Tool, Part 2 – WIS Database

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PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) describes coupling of the US Army Engineer Research and Development Center (ERDC) Wave Information System (WIS) database to Wavenet, the first module of MetOcnDat (Meteorological and Oceanographic Data or Metocean data) management and analysis system. Part 2 in the WaveNet technical note series provides a step-by-step procedure for users to access, process and analyze wave and wind data from the WIS database.

BACKGROUND: Wilson et al. (2012) provided a detailed description of WaveNet in the Part 1 companion CHETN and demonstrated the utility of WaveNet for National Data Buoy Center (NDBC) wave data. WaveNet is a web-based Graphical-User-Interface (GUI) data management tool that allows users to access, process and analyze wave and wind data from different metocean data sources. TideNet is the next addition to the MetOcnDat system that will provide access and similar functionality for water level and current data. Once the user identifies a data need for a time interval, WaveNet performs data processing on-the-fly to check the availability, quality and consistency of data. It allows users to extract data to download, analyze and prepare input files for numerical wave models, and provides tabular and graphical information for project planning and design reports. WaveNet addresses a basic need of the Corps coastal modeling and planning missions by acquiring metocean data and providing analysis methods to minimize the complexity and uncertainty involved in data processing. This CHETN provides a guide for users to access the WIS database using WaveNet and step-by-step instructions that demonstrate processing and analysis of WIS data for project planning, design and evaluation studies, as well as the generation of input files for numerical wave models.

For a given geographic region, WaveNet employs a Google Map® interface to query, select and display data from different sources. This flexible tool allows users to choose a preferred data source for viewing and to select a particular set of data parameters of interest. Selections are used to query the availability of data and then plot, analyze, and extract data for a specified date range (selected timeline). Post-processing analyses are used to produce tabular data and plots in a desired format, and write input files for numerical models. WaveNet allows users to download data files from a data source or access statistical wave parameters such as significant wave height, peak period and direction for a user-specified date range, and generate wave and wind roses for directional wave data. Types of WaveNet outputs include image files (*.png), portable document files (*.pdf), Matlab figures (*.fig), text files (*.csv or *.txt), and spectral input files (*.eng) for numerical models. Users can modify the figures to view data plots and change axes, labels or text for project reports and other publications as necessary. The *.eng file is an input file in the required format that can be used by the numerical wave models such as Coastal Modeling System Wave model (CMS-Wave) (Demirbilek and Rosati 2011; Lin et al. 2011a, b; Lin et al. 2008) and STeady WAVE model (STWAVE) (Massey et al. 2011).

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The following example illustrates the use of WaveNet with WIS data. This is done in a step-by-step manner and includes comments and instructions to guide users, where necessary.

EXAMPLE: WIS Data for Eastern Shore of Alabama Project. For this project, the following wave and wind data are needed: monthly mean values of significant wave height, peak or mean wave period and mean direction in tabular form; wave and wind roses for a year; and the *.eng file for 1 June through 1 October 2010 at a 6-hr interval. This example shows how to use WaveNet to access the WIS database, fetch the data from the source and provide data in the required format in files for project documents and use in a numerical wave model.

Step 1. Select the sub-region of interest. Click the following link on an ACE-IT machine to start the WaveNet server (*http://140.194.110.95/GoogleMap3/default/Datamap*). Use the mouse to click and zoom into the region of interest where data are desired (see Figure 1). The user can zoom into any part of the map displayed in Figure 1, including Alaska and Hawaii.

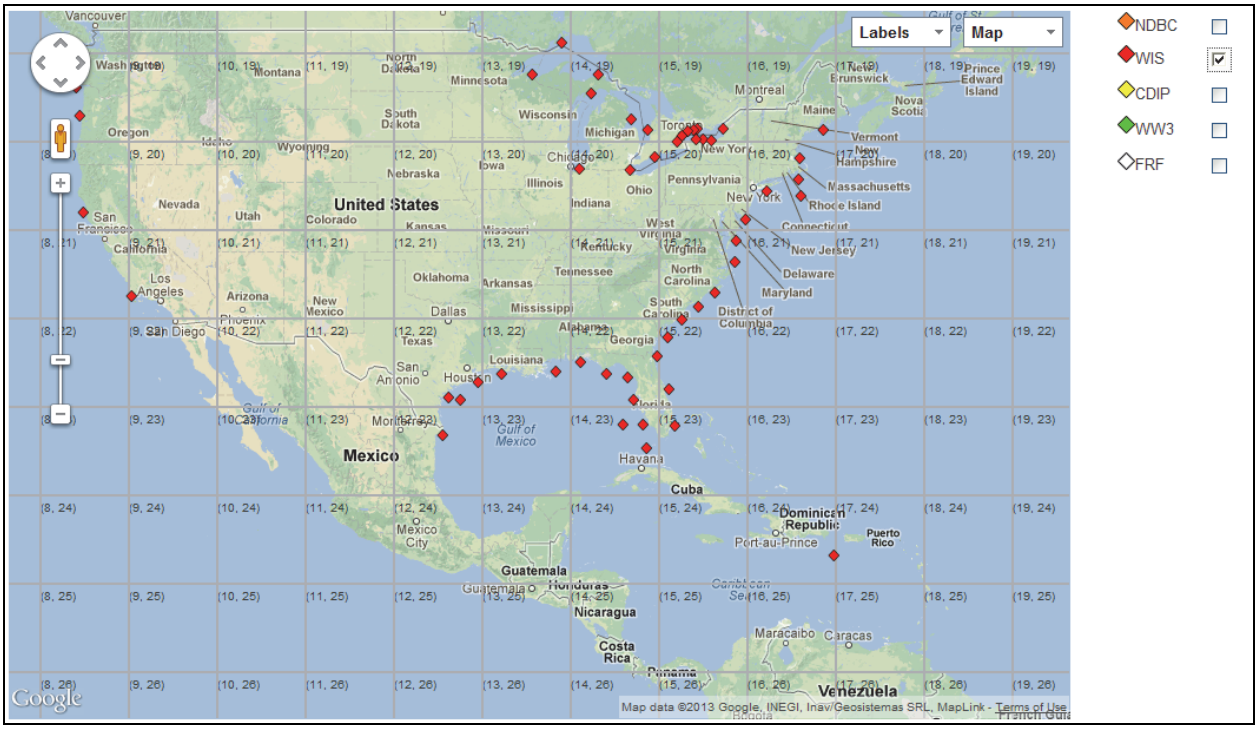


Figure 1. WaveNet main page for user to select the area of interest on a Google Map®.

Step 2. Select the data source and type of metocean data available from the WIS database. The list of available data sources is shown in the right side of Figures 1 and 2, and include the National Data Buoy Center (NDBC), Wave Information Study (WIS), Coastal Data Information Program (CDIP), Wave Watch III (WW3), and Field Research Facility (FRF). Select WIS as the data source. In this example, the area of interest is the Eastern Alabama Gulf Coast. Select this area of interest by using the map tools and zooming in to this region.

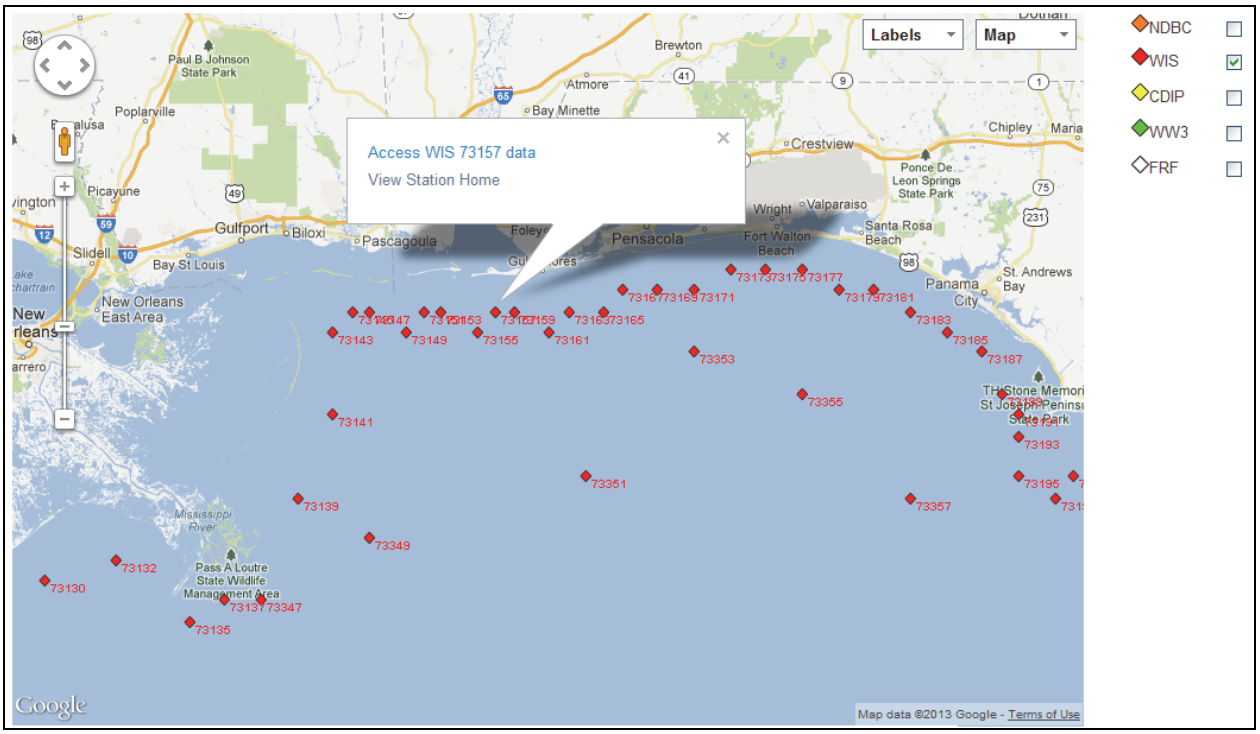


Figure 2. WIS stations offshore of Alabama and Mississippi, and portions of Florida and Louisiana.

Step 3. Select the WIS station in the area of interest. To access the station-specific data available from the WIS database, the user can select a WIS station from those displayed in Figure 2. For this example, select Station 73157. Click on the "View Station Home" link to access the station's page on the WIS webpage or the "Access Station 73157 Data" window option to access the station's data within WaveNet. The type of station-specific data available at WIS Station 73157 is shown in Figure 3. The user can click on any of these data types to view data or the plots and tables provided by the WIS data source (see Figure 3 for available information).

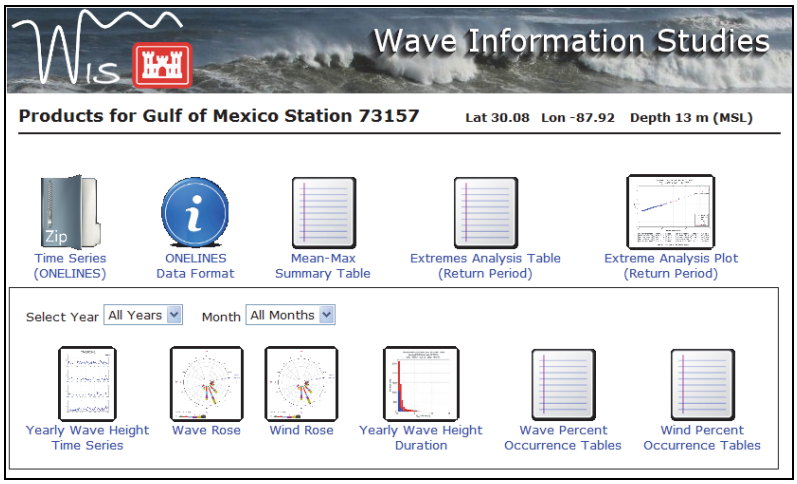


Figure 3. WIS station page for 73157 off the Eastern Shore of Alabama.

Step 4. Set the time range to determine availability of data for project needs. Users can access the data types at Station 73157 with WaveNet by specifying a time window of interest and clicking "Retrieve/Plot Data" located at the top section of Figure 4. This figure shows the process of selecting a time window. There is a "slider bar" at the bottom of Figure 4 for changing the start and end times, or users can manually type in the desired dates. To narrow the time window of interest to specific days or months, use the slider bar at the bottom of the plot or click on the display box. Two options are available to change dates; type in the Start and End date boxes, or use the calendar (Figure 4). Double click within the Start and End time boxes to get the calendar. The timeline plot will show data availability for wave height and wind speed including the data gaps. For a treatment of the data gaps, consult the methods discussed in CHETN-IV-83 (Wilson et al. 2012).

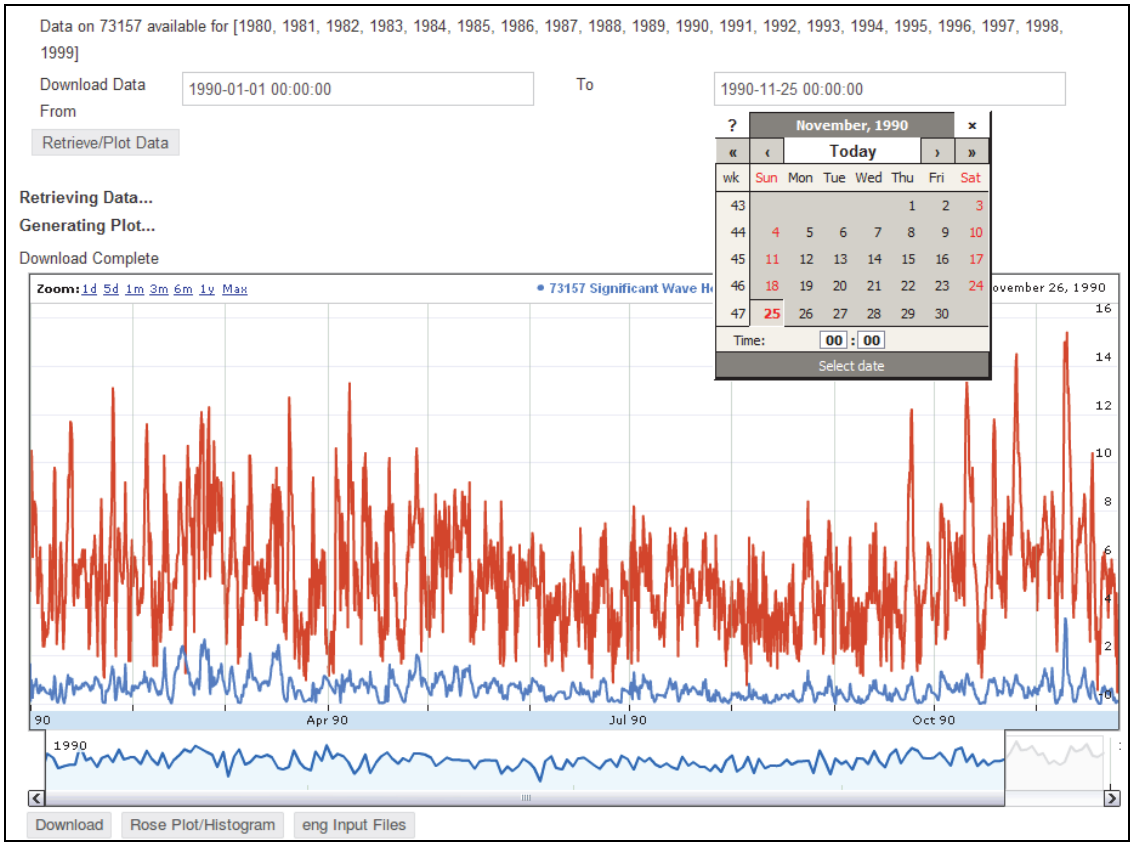


Figure 4. The user can set the time window by using a calendar.

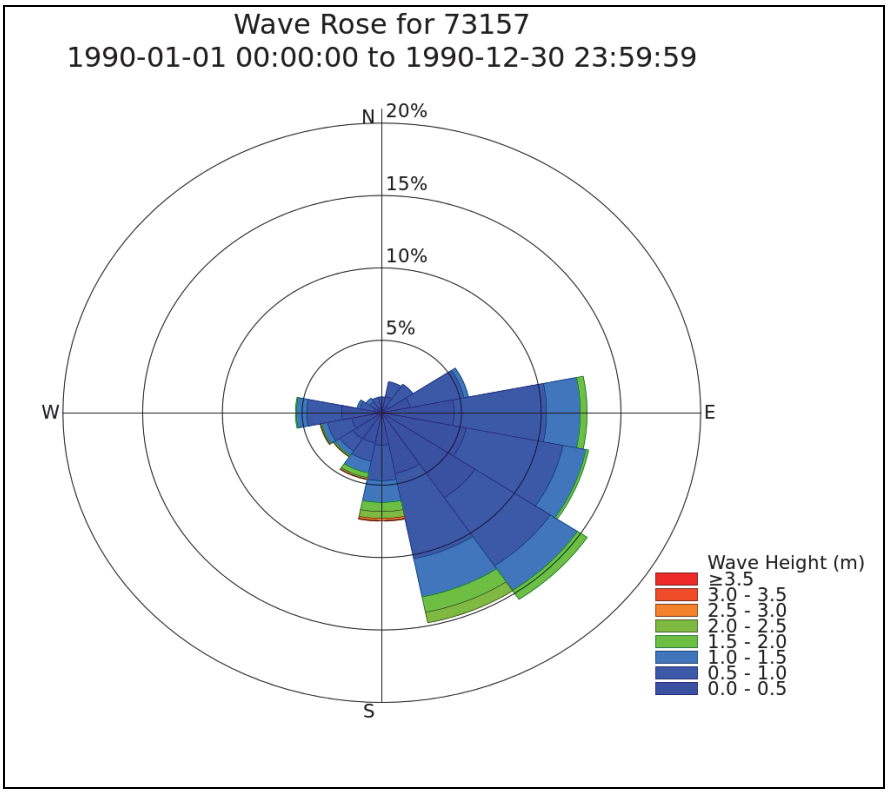
To preview or download the selected station data, users may plot wind or wave data parameters either using the WIS website data management tools or WaveNet's tools. In Figure 4, time series of the significant wave height (blue) and wind speed (red) at WIS Station 73157 are displayed for a user-specified time period (1 Jan 1990 through 31 Dec 1990). This display uses the WaveNet tools, while WIS and other data sources may have their own data management tools, which users could also use to handle and perform data operations prior to downloading and processing data in the WaveNet. Although users have these data access options, WaveNet provides a unified platform to perform these functions in a consistent manner to avoid potential errors and has additional custom analysis tools that may not be available from the data sources.

Step 5. Download data for project needs. To perform additional analyses of data on the user's desktop machine, it is necessary for the users to download data from the WIS data source for the date range chosen. This is done by clicking on "Download" to save data in a *.csv" file as shown in Table 1. The comma-separated values (*.csv) is an ASCII spreadsheet in text format. Table 1 displays the partially tabulated *.csv data saved by WaveNet. These ASCII data can be used with the Matlab, Fortran, Excel or other software or commercial plotting packages, if desired.

Table 1. Tabulated data downloaded to local machine for WIS Station 73157.

	A	B	C	D	E
1	date	windSpeed	windDir	waveHeight	waveDir
2		m/s	deg	m	deg
3	1/1/1990 0:00	4.7	294	1.66	180
4	1/1/1990 3:00	8.4	315	0.15	315
5	1/1/1990 6:00	9.6	324	0.88	315
6	1/1/1990 9:00	10.5	340	1	321
7	1/1/1990 12:00	10.1	350	0.84	337
8	1/1/1990 15:00	8.4	355	0.71	354
9	1/1/1990 18:00	6.1	9	0.28	9
10	1/1/1990 21:00	6.9	30	0.59	31
11	1/2/1990 0:00	7.6	25	0.74	33
12	1/2/1990 3:00	7.9	40	0.76	46
13	1/2/1990 6:00	8.4	50	0.8	57
14	1/2/1990 9:00	8	55	0.79	65
15	1/2/1990 12:00	8.3	60	0.82	72
16	1/2/1990 15:00	8.1	70	0.9	81
17	1/2/1990 18:00	7.7	80	1.06	85
18	1/2/1990 21:00	7.1	80	1.03	84
19	1/3/1990 0:00	5.8	80	0.77	88
20	1/3/1990 3:00	4.8	80	0.64	95
21	1/3/1990 6:00	4.2	80	0.55	101
22	1/3/1990 9:00	4.2	75	0.46	105
23	1/3/1990 12:00	4.7	70	0.47	101
24	1/3/1990 15:00	4.9	75	0.46	94
25	1/3/1990 18:00	5.4	84	0.54	87
26	1/3/1990 21:00	6	90	0.67	91
27	1/4/1990 0:00	6.5	104	0.81	101
28	1/4/1990 3:00	5.5	119	0.61	115

Step 6. Wave, wind roses, and histograms. These processing tools are available in WaveNet. As noted in Step 5, if the data source does not provide rose plots or histograms, users can generate such plots for wave or wind for the segment of downloaded data by clicking on "Rose Plot/Histogram" below the timeline plot (as shown in Figure 4). Rose plots can be generated for directional wave and wind data (shown in Figure 5 and 6, respectively). The percent occurrence is depicted by radial circles, and 1-m wave height and 4-m/s wind speed bands are color coded in the radial direction. In both plots, the direction bins from which waves approach the shore are also shown. Figures 5 and 6 show the wave and wind histograms which illustrate the statistical distribution of wave height and wind speed.



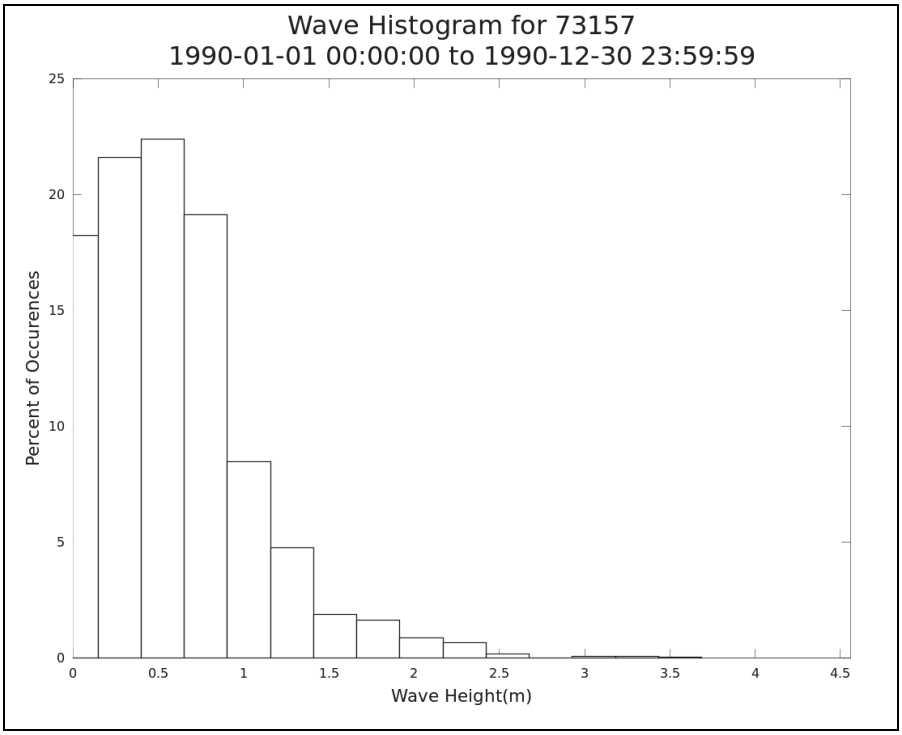
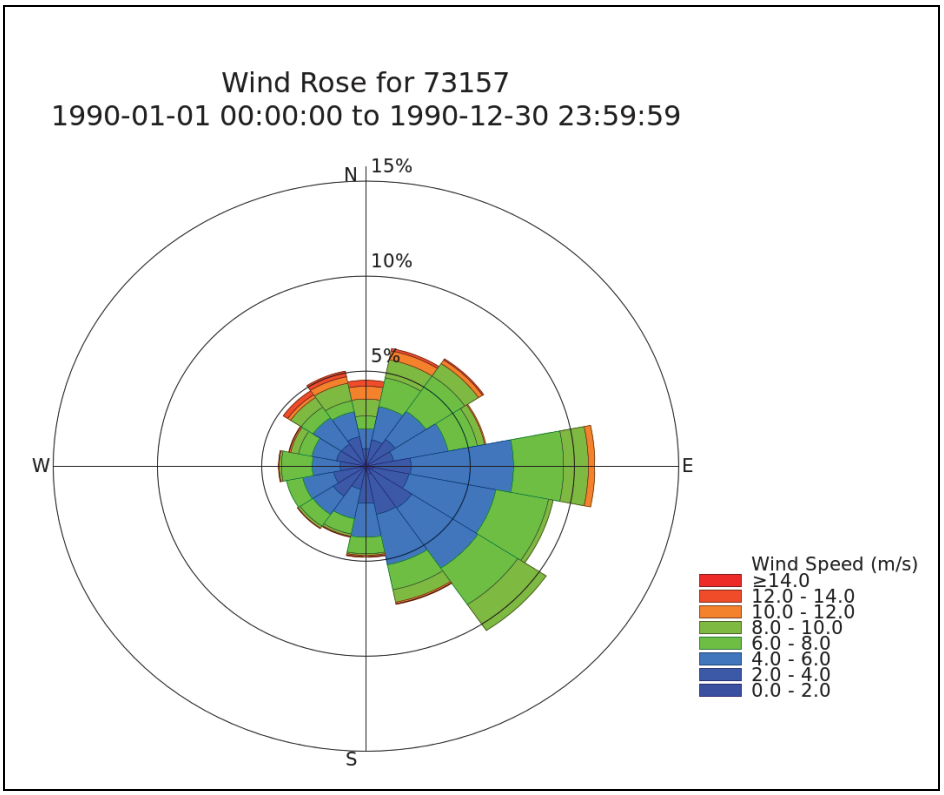


Figure 5. Rose plot and histogram for waves at WIS Station 73157.



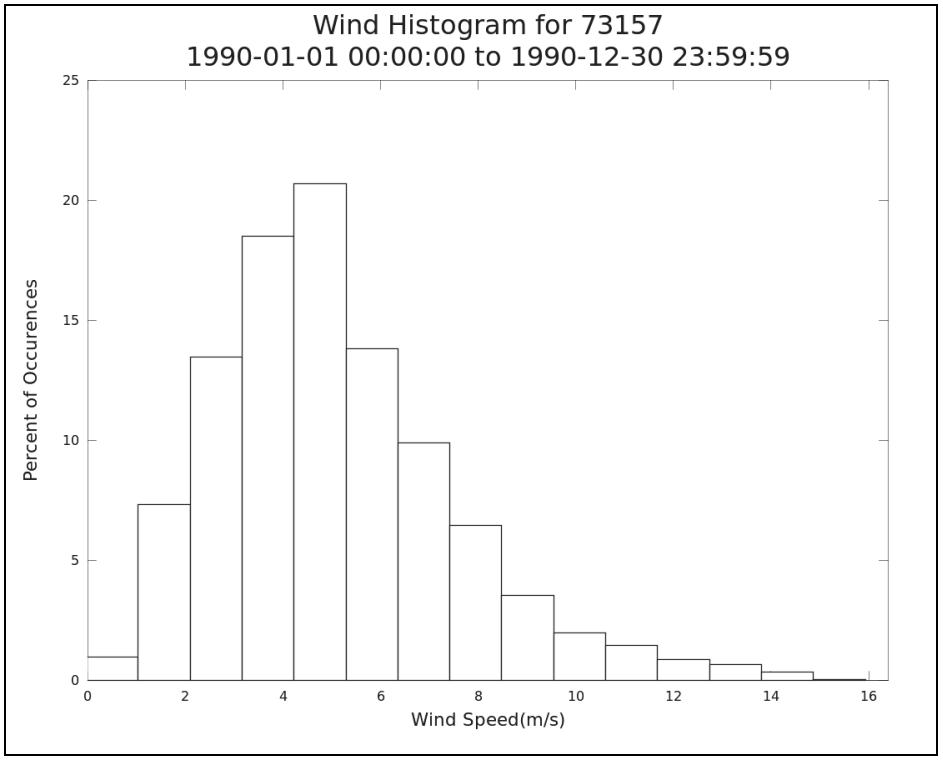


Figure 6. Rose plot and histogram for wind at WIS Station 73157.

Step 7. Desktop data analyses. After the segments of data have been accessed from the WIS database and reviewed and downloaded to the user's local machine using WaveNet, users can then perform certain data analyses. For example, the CMS-Wave and STWAVE models require an *.eng file for directional wave input. If directional wave data (1-D or 2-D wave spectra and associated Fourier coefficients used to generate wave spectra) are available from the data source sites, users can download these files to their local machine and perform post-processing analyses for their project needs. If Fourier coefficients are not provided by the data sources, the user may perform these operations using WaveNet. Click on "eng Input Files" located below the timeline plot in Figure 7. At the bottom of Figure 7, *.eng files are listed according to the timeline selected by the user. Table 2 displays the partial content of a *.eng file for illustration. See Lin et al. (2011a, 2008) and Demirbilek and Rosati (2011) for additional information about *.eng files.

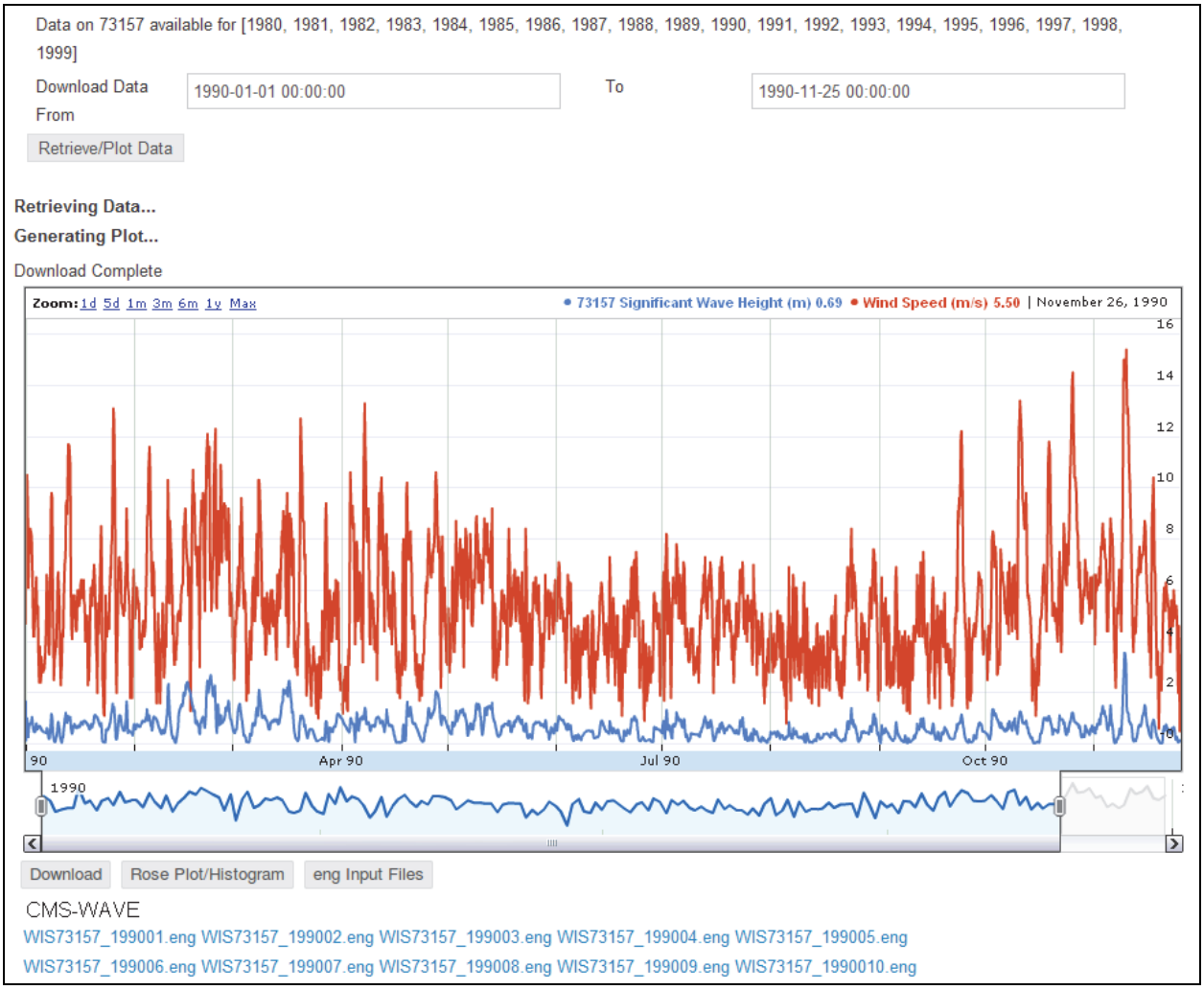


Figure 7. List of *.eng input files generated by WaveNet for WIS Station 73157.

Table 2. Partial content of an *.eng wave input file generated by WaveNet.

```
30 35
0.04000 0.05000 0.06000 0.07000 0.08000 0.09000 0.10000 0.11000 0.12000 0.13000
0.14000 0.15000 0.16000 0.17000 0.18000 0.19000 0.20000 0.21000 0.22000 0.23000
0.24000 0.25000 0.26000 0.27000 0.28000 0.29000 0.30000 0.31000 0.32000 0.33000
9040821     9.1       -42.    0.30000    0.00
   0.00032    0.00033    0.00034    0.00034    0.00034    0.00033    0.00032
   0.00030    0.00029    0.00026    0.00024    0.00021    0.00018    0.00015
   0.00013    0.00010    0.00007    0.00005    0.00003    0.00001    0.00000
   0.00001    0.00005    0.00010    0.00017    0.00025    0.00033    0.00043
   0.00052    0.00062    0.00071    0.00081    0.00089    0.00097    0.00103
   0.00108    0.00112    0.00114    0.00115    0.00114    0.00112    0.00108
   0.00103    0.00097    0.00089    0.00081    0.00071    0.00062    0.00052
   0.00043    0.00033    0.00025    0.00017    0.00010    0.00005    0.00001
   0.00005    0.00017    0.00034    0.00056    0.00082    0.00111    0.00142
   0.00174    0.00206    0.00238    0.00268    0.00296    0.00322    0.00343
   0.00360    0.00373    0.00381    0.00384    0.00381    0.00373    0.00360
   0.00343    0.00322    0.00296    0.00268    0.00238    0.00206    0.00174
   0.00142    0.00111    0.00082    0.00056    0.00034    0.00017    0.00005
   0.00005    0.00017    0.00035    0.00057    0.00084    0.00113    0.00144
   0.00177    0.00210    0.00242    0.00273    0.00302    0.00328    0.00350
   0.00367    0.00380    0.00388    0.00391    0.00388    0.00380    0.00367
   0.00350    0.00328    0.00302    0.00273    0.00242    0.00210    0.00177
   0.00144    0.00113    0.00084    0.00057    0.00035    0.00017    0.00005
   0.00009    0.00031    0.00063    0.00103    0.00151    0.00204    0.00261
   0.00320    0.00380    0.00439    0.00495    0.00546    0.00593    0.00632
   0.00664    0.00688    0.00702    0.00707    0.00702    0.00688    0.00664
   0.00632    0.00593    0.00546    0.00495    0.00439    0.00380    0.00320
   0.00261    0.00204    0.00151    0.00103    0.00063    0.00031    0.00009
   0.00007    0.00025    0.00052    0.00086    0.00125    0.00169    0.00216
   0.00265    0.00315    0.00363    0.00409    0.00452    0.00491    0.00524
   0.00550    0.00570    0.00581    0.00585    0.00581    0.00570    0.00550
   0.00524    0.00491    0.00452    0.00409    0.00363    0.00315    0.00265
   0.00216    0.00169    0.00125    0.00086    0.00052    0.00025    0.00007
   0.00007    0.00026    0.00053    0.00087    0.00127    0.00171    0.00219
   0.00268    0.00318    0.00367    0.00414    0.00458    0.00497    0.00530
   0.00557    0.00576    0.00588    0.00592    0.00588    0.00576    0.00557
   0.00530    0.00497    0.00458    0.00414    0.00367    0.00318    0.00268
```

CONCLUSIONS: This CHETN describes the application of WaveNet to the WIS database. An example is provided with a step-by-step procedure that demonstrates how to use WaveNet to access wind and wave data from the WIS data source website. Steps illustrate how to extract and analyze WIS data for use in coastal navigation and storm damage reduction projects. This is a user-guide for engineers and planners to obtain wave and wind data for project planning, design and evaluation study reports, and develop input files required for numerical wave models. WIS data vary in content, complexity and accuracy of information. It was shown in CHETN-IV-83 (Wilson et al. 2012) how WaveNet tools allow users to identify data gaps, fill in missing data, and provide users a number of options for handling data gaps. Presently the options include interpolation between the endpoints of a gap in the wind and wave data time series, fetching missing data from the nearest WIS Station, and other analysis capabilities. The goal is to enhance the capabilities of WaveNet to help Districts obtain project-specific data from the WIS or other data sources. User feedback is welcome for expanding and improving the capabilities of WaveNet to better serve the USACE community.

POINTS OF CONTACT: This CHETN was prepared by the Coastal Inlets Research Program (CIRP) Waves work unit. The POC for technical inquiries is Dr. Zeki Demirbilek (*Zeki.Demirbilek@usace.army.mil*). For information about CIRP, please contact the CIRP Program

Manager, Dr. Julie Dean Rosati (*Julie.D.Rosati@usace.army*.mil; tel: 202-761-1850). This technical note should be referenced as follows:

> Demirbilek, Z., L. Lin, D. Wilson, and J. Rosati. 2013. *WaveNet: A web-based metocean data access, processing and analysis tool, part 2 -- WIS database*. ERDC/CHL CHETN-IV-92. Vicksburg, MS: US Army Engineer Research and Development Center. An electronic copy of this CHETN is available from *http://chl.erdc.usace.army.mil/chetn*.

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