Calculating Ventura River Estuary Volume

The LiDAR (Light Detection and Ranging) data from NOAA was used for bathymetry because it was deemed to be more accurate and precise. This is due to the fact that it is at a higher resolution than the DEM (Digital Elevation Model) data. Also, the LiDAR method is able to penetrate through the water to the estuary floor. The decision to use LiDAR data represented a consensus among staff from SCCWRP, CSUN, and the Regional Board.

The LiDAR data provides a value that represents height above "Mean Lower Low Water" (MLLW) in meters. This value was used to determine the volume. MLLW is defined by NOAA as follows:

> A tidal datum. The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum Epoch. (NOS CO-OPS 1 2000)

The CSUN calculations were based on the assumption that estuarine wetland areas are represented by values above 0 (the MLLW) but below the "Mean Higher High Water" (MHHW). The MHHW value used was 2.32m. This number came from Martha Sutula at SCCWRP and is based on research consulting with botanists and referencing tide charts from NOAA. This was used as a representative value for the entire coast of California. More research would be needed to find a value specific to this watershed area. MHHW is defined by NOAA as follows:

> A tidal datum. The average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum Epoch. (NOS CO-OPS 1 2000)

After a few iterations and consultation with Patricia Pendleton of CSUN, Regional Board GIS staff were able to duplicate the procedures used in determining the estuary volume. Once that was accomplished staff were able to match the CSUN results and validate the process.

Before performing the final calculations Regional Board staff, in consultation with Martha Sutula of SCCWRP, decided to adjust the height of water in the estuary. As previously mentioned, the height of 2.32 meters was a representative height for all of coastal California and not specific to the Ventura River Estuary. In order to determine a number more accurate to local conditions the DEM data was used to estimate the height of the berm. DEM was preferred because the data are at a larger scale and average out the high and low points of the berm. The resulting berm height was determined to be 2.5 meters. Regional Board staff—again in consultation with Martha Sutula—then assumed that a typical Southern California coastal lagoon, when full, is 20 cm below the tip of the berm. The height of the water in the estuary was therefore estimated at 20 cm below the height of the berm which is equal to 2.3 meters. This was the number used in the final calculations.

By its very nature LiDAR data is prone to having gaps (due to sun angle, reflections, etc.). Also, the data did not extend to the full extent of our watershed. Regional Board GIS staff were able to use ArcGIS to fill in the gaps and extend the data to cover our entire watershed. This is explained in the following procedures:

Procedures:

1. Validated the process by calculating the volume for the polygons used by Patricia Pendleton at CSUN to ensure that Regional Board results matched theirs
2. Started the process again using the wetlands polygons created as described in "Creating our Wetlands Polygons"
3. Overlaid these polygons on top of the Ventura County LiDAR data (Figure 1)
4. Trimmed LiDAR data to Regional Board wetlands polygons using "Spatial Analyst Tools/Extraction/Extract by Mask" (Figure 2)
5. Filled in gaps and extrapolated the LIDAR data to the extent of the wetlands polygons using "Spatial Analyst Tools/Map Algebra/Raster Calculator" with the argument: "Con(IsNull(Raster), FocalStatistics(Raster, NbrCircle(11, "CELL"), "MEAN"), Raster)" (Figure 3)
6. Trimmed the result from Step 4 using the same procedure as in Step 3 (Figure 4)
7. For graphic purposes excluded the areas where the value exceeded the MHHW value of 2.3 (Figure 5)
8. Calculated volume of watershed using "3D Analyst Tools/Functional Surface/Surface Volume" with Reference Plane = BELOW, Plane Height = 2.3, and Z Factor = 1

RESULTS:

Area_2D = 52,602 m^2
Volume = 58,877 m^3

Note that in the following figures the blue colors are not consistent. This is a function of a smaller range of values being represented by the same color ramp. There was not a change in any of the original values. For example the original LiDAR layer values in Figure 1 (which included the entire coast of California) ranged from -1.21 to 102.966. The values in Figure 2 (including only our watershed) ranged from 0.116 to 22.0477. Therefore in Figure 1 the darkest blue represents 102.966 and in Figure 2 (and 3 and 4) the darkest blue represents 22.0477. In Figure 5 the darkest blue represents 2.3.

Figure 1: Our Wetlands Polygons over LiDAR data

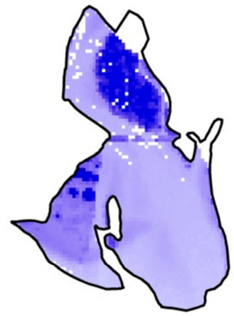

Figure 2: LiDAR Data Trimmed to our Wetlands Polygons

Figure 3: Trimmed LiDAR Data Extrapolated to Fill in Gaps and Reach Full Extent of Wetlands Polygons

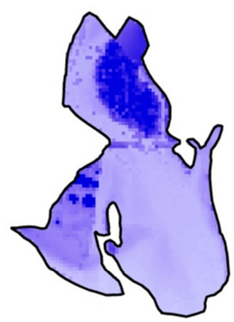

Figure 4: Extrapolated LiDAR Data Trimmed to Wetlands Polygons

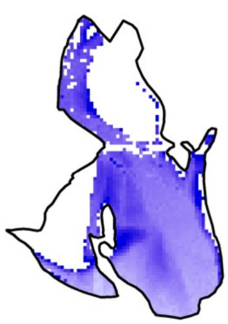

Figure 5: Area Used in Volume Calculation
Based on 20 cm below berm or 2.3 meters

Creating our Wetlands Polygons

1. Start with SCCRWP wetlands polygons
2. Compared to NAIP imagery, found that the layer matched the 2005 version
3. Compared to NWI data to verify extent of estuarine wetlands
4. Deleted the Riverine polygon
5. Redrew the SCCRWP unattributed polygon to align edges
6. Cut the 3 northernmost polygons to fit narrative descriptions from State of the Watershed Report