HIGHEST ASTRONOMICAL TIDE (HAT)

The elevation of the highest predicted astronomical tide expected to occur at a specific time station over the National Tidal Datum Epoch (NTDE) (NOAA; http://tidesandcurrents.noaa.gov/datum_options.html). In the United States the NTDE is a 19 year time interval ranging currently from 1983 to 2001 and is updated about every 20 years.

MAPPING METHODS

The five tidal datum survey sites in Pacific County are located in Willapa Bay. Of those five sites, three have predictions for HAT. Those tidal datum stations are located at Nahcotta, South Bend, and Toke Point (Table 1).

Table 1. HAT predictions from Pacific County tidal datum survey sites.

<table>
<thead>
<tr>
<th>Location</th>
<th>HAT prediction (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nahcotta</td>
<td>13.49</td>
</tr>
<tr>
<td>South Bend</td>
<td>15.96</td>
</tr>
<tr>
<td>Toke Point</td>
<td>16.8</td>
</tr>
</tbody>
</table>

The study area (coastal and estuarine areas of Pacific County) were divided into three subregions, and the three HAT values were assigned to the full subregion where they reside. The spatial extent of HAT was calculated from 1m LiDAR-derived DEM. Steps in Esri ArcGIS 2.0 included:

1. Dividing the DEM into the three subregions using the Split tool.

2. Reclassifying the data into two categories where value 1 included cell values less than the respective HAT for the subregion, and value 2 included cell values greater than the HAT.

3. Using the Fill tool to fill in "sink" locations (cells that are below the HAT level but are disconnected from the rising marine water by land areas above the HAT.)

4. Using the Mosaic tool to combine the three outputs back into a single dataset for the study area.

5. Using the Spatial Calculator to select only the HAT area (value==1).

6. Using the Euclidian Distance tool to calculate distance from the HAT (using the original DEM as a Mask to limit the extent of necessary distance).
7. Using the Reclassify tool to create categories of distance from the HAT, where HAT area = 0 and distance categories in feet were converted from meters to give distances categories of 0’, 50’, 100’, 150’, and 200’. (Distances over 200’ were converted to NoData.)

8. Raster output from step 7 converted to polygons (choosing to simplify the output polygons rather than maintaining the raster cell outlines for the sake of processing and output file size. The difference is minimal.

VIEWING HAT MAPS

Link to view maps online: http://tnc.maps.arcgis.com/apps/webappviewer/index.html?id=b5cd0dd9975045fda354415b41f6fc81

Note:
There are two layers in this map: the HAT line for Nahcotta area and the 50-foot interval setbacks for the whole county. These can be turned off/on with the Layers button in the upper left of the map.

POSSIBLE QUESTIONS AND CONCERNS

Why can’t we calculate error?

HAT (Highest Astronomical Tide) is modeled by NOAA and provided as a number representing feet above sea level at a single location (i.e. Nahcotta). TNC applied this single value to all areas along the bay-side of Long Beach peninsula to create a “HAT line.” The calculated error at any location along this HAT line is unknown without ground-surveyed data at multiple points distributed along that shoreline. However, from visual comparison of the HAT line to aerial imagery of the shoreline, the HAT line appears to do a good job of depicting the interface of inland vegetation with estuarine vegetation, which seems to be a good proxy for HAT in relatively undisturbed, naturally vegetated places.

Other potential sources of error include:

- “bathtub” model approach of evenly applying the HAT value to a broad area without considering hydrodynamic factors such as slope and horizontal distances that water could possibly travel as well as the horizontal angle (direction) at which the tidal water hits land features. (See next question for more about this.)
- In GIS, the HAT value and inland setback distances were applied to all areas along the shore including manmade structures like piers. These structures inhibit the ability of the analysis to provide a true HAT line at those locations and should be considered anomalous.
- Very small errors from vertical (centimeters) and horizontal (meters) resolution of the elevation data (LiDAR).
What are the inland blobs (mainly at towns) that seem strange?

These are locations where there is a continuous path from the bay water to the HAT elevation. In some cases, typically in towns like Nahcotta and Oysterville where a flat road ends at a ramp into the bay water and is below the HAT elevation, the road acts theoretically as a continuous path for water(tide) to travel inland before finally reaching elevation above HAT. In all likelihood, the resultant inland blobs would not be reachable during a HAT event because of hydrodynamics (e.g. tide forces not strong enough to push enough water inland along a flat narrow road). Also, direction of the tide would likely not be directly up the ramp/road but instead be angled from the northeast, thus causing the tidal force to dissipate near the road/water interface.

What can County do to fix that?

A team should decide where those roads should be “cut” in GIS to separate those inland blobs and delineate a likely HAT. For example, the HAT analysis created a blob intruding inland here (just north of Nahcotta) which should probably be excluded. To do this, the County’s GIS staff need to edit the data by cutting the blob off somewhere in the yellow circle where a road is linking the water to inland. These determinations need to be made a on a case by case basis.

Should island anomalies (like trees) be deleted?

Probably. TNC has made an attempt to delete the small “islands” where the HAT analysis resulted in locations (such as trees near shorelines) that show up as HAT lines. This was a simple filter to delete islands smaller than 5000 sq m(?).
General Recommendations:

TNC recommends that the HAT data/maps we are providing to Pacific County not be used for assigning site-specific rules and should not be included as an official regulatory map (like FEMA Floodplains Hazard Areas) or distributed as such. Rather, these data and maps should be used only as reference for developing the County’s rules around HAT setbacks by better understanding general trends and increasing awareness of potential tide-related problems. Any discrepancies and conflicts should be resolved with on-ground surveys. **TNC does not take responsibility for any errors or conflicts that may arise from using these data or maps used for any purpose.**