Cell Coverage Estimate

The ability to conduct even rudimentary cell phone analysis is becoming crucial in SAR response as cellphone can often times can provide critical information on the location of the missing Subject. While a detailed description of all types of analysis of cellphone related data is beyond the scope of this document, some explanation is necessary in order to understand the utilization of the Cell Coverage Estimate tool within the IGT4SAR template.

Geolocation through cellphone related data is possible by various means and can result in varying degrees of accuracy. However even a gross estimate of the location of the cellphone (and subsequently the subject) can aid in reducing the size of the search area. The Cell Coverage tool within IGT4SAR allows a user to better visualize the potential cellphone coverage for an area and provide an estimate of the geolocation of a specific cellphone based on cell antenna/tower utilization information.

The Cell Coverage Estimate within the "Planning" section of the SAR_Toolbox10b Toolbox permits the user to elect plotting the potential "Cell Sector" of a given antenna/tower and /or estimate the actual service area of a particular antenna/tower. This analysis can be performed on multiple antenna/tower pairs in the vicinity of the search area to provide critical information to assist in reducing the size of the search area. The tool offers the user several options for entering data related to the cell antenna/tower and performing the subsequent analysis.
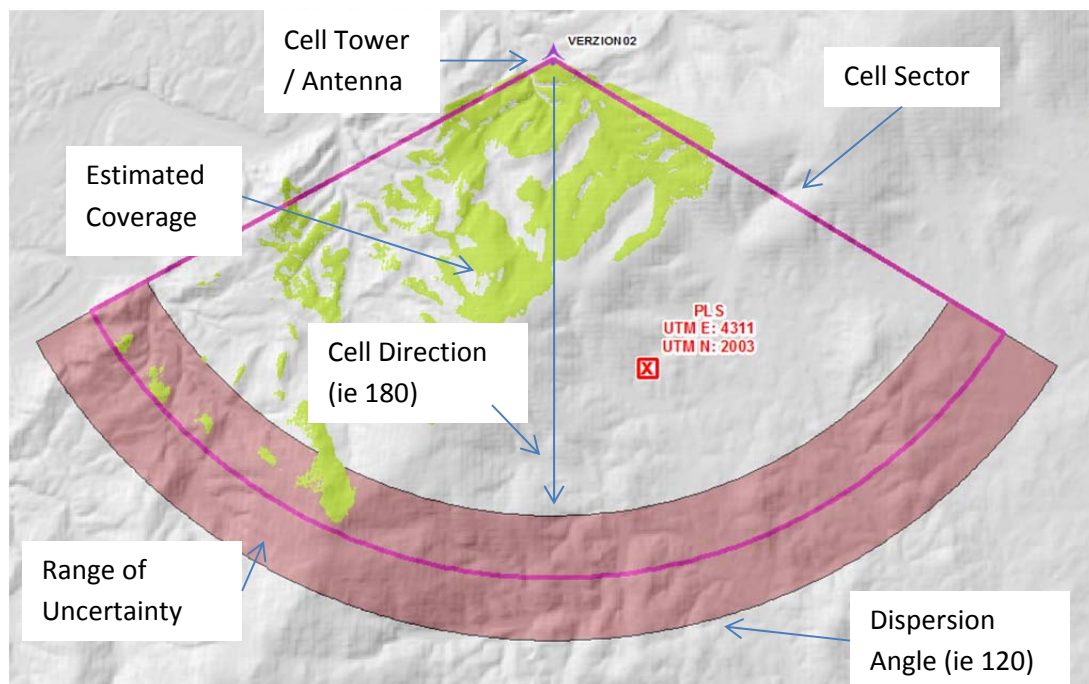

Figure 1: Cell Coverage definitions

The "CellTowers" feature (14 Base_Data_Group) within the IGT4SAR template was intended as a destination for cell tower related data. If using the CellTowers data layer to estimate Cellular Service Coverage for an area the minimum data fields required is: DESCRIPTION (a name with no special

characters), ANTENNA HEIGHT, SECTOR DIRECTION, DISPERSION ANGLE and RANGE MAX. A description of each of these fields is shown in Figure 1 as illustrated by the Cell Sector.
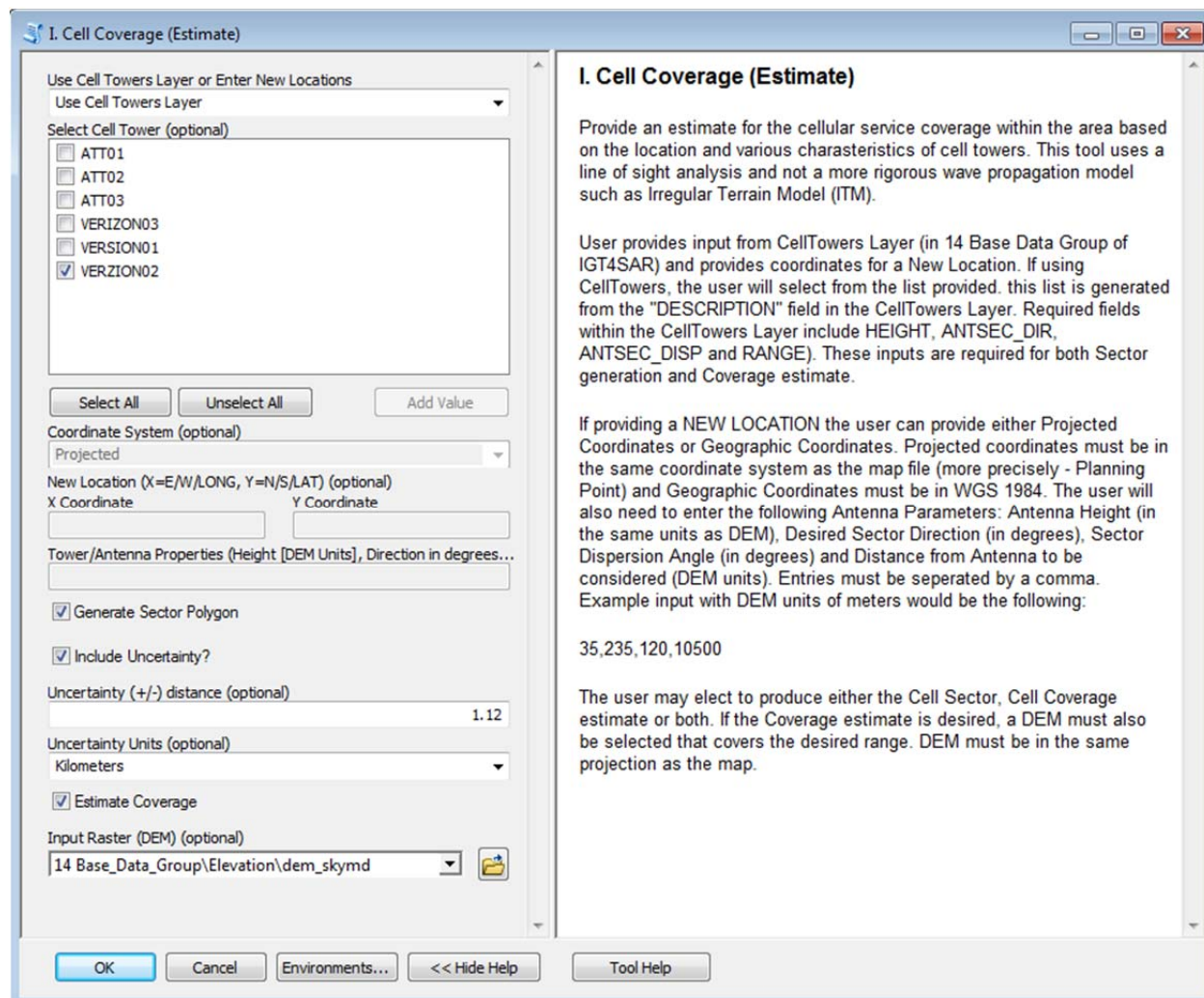

Figure 2: Cell Coverage Tool dialog box

Figure 2 shows the dialog box that is presented to the user upon selection of the Cell Coverage tool. The first parameter titled "Use Cell Towers Layer or Enter New Locations" allows the user to select between the two choices as defined by the title. If the user elects to use the "CellTowers" Layer (part of IGT4SAR) the user will then be required to select the desired towers from the "Select Cell Tower" parameter. The absence of a list of cell towers which indicate that either the "CellTowers" Layer is not present in the Table of Contents or the layer is empty. In either case the user should elect to use the "Enter New Locations" option listed in the first parameter. Using the "CellTowers" option greys (makes unselectable) several of the parameters of the Cell Coverage tool including: Coordinate System, New Location- X and Y, and Tower/Antenna Properties.

Even if cell towers are listed in the "Select Cell Tower" parameter, the user must desire to enter a new location not currently in the listed in the "CellTowers" Layer (Figure 3). At this point, the user can either

edit the CellTowers Layer placing the tower at the appropriate location and entering the tower information, or use the "New Location" option of the Cell Coverage Tool. If the "New Location" option is selected, any towers listed in the "Select Cell Tower parameter will be greyed and become unselectable. The user will than need to specify if the coordinate system projection for the coordinates to be entered for the new location. Either Projected or Geographic coordinates may be entered. Geographic coordinates can be entered as Latitude and Longitude, while Projected coordinates are entered in the units of the projection (for example UTM: X=Easting, Y=Northing). If using Projected coordinates, the coordinates must be in the same projection as the data frame and only the X and Y values are entered and not for example the UTM zone. Using the "New Location" option, the user will be required to enter

Figure 3: Cell Coverage Tool using the New Location option.

the Tower Properties for the new location. These properties include the height of the antenna above ground level reported in the same units as the Digital Elevation Model (DEM), the Direction in degrees of the desired sector, the Sector Range or Dispersion Angle in degrees and the Antenna Range also reported in the DEM units. The DEM is only relevant if the actual coverage is to estimated using the "Estimate Coverage" option. If only a Generated Sector Polygon is selected than the units need to be in those of the coordinate system (for Projected Coordinate Systems only). These values need to be entered in the space provided each separated by a comma. Upon executing the coverage tool a default name will be given to the new Tower/Antenna.

Next the user may elect to generate the Cell Sector (Generate Sector Polygon) and / or Estimate Coverage. As noted, the Cell Sector will generate a "pie slice" representing the estimated theoretical range of coverage for the desired antenna based on the Antenna Properties provided in either the dialog box (Tower / Antenna Properties) or in the CellTowers Layer.

The "Estimate Coverage" provides computational estimate of the actual cell coverage based on the terrain assuming the cell phone is held at slightly above ground level (2 meters). The coverage estimate is performed using the Viewshed analysis tool within ArcGIS and requires a Digital Elevation Model (DEM). If the user elects not to perform the "Estimate Coverage" the "Input Raster (DEM) will be greyed and thus unselectable. Otherwise, the user will need to select the appropriate DEM in the same coordinate system as the data frame that covers the distance from the tower/antenna in the direction and distance specified either in the Tower / Antenna Properties on the CellTowers Layer.
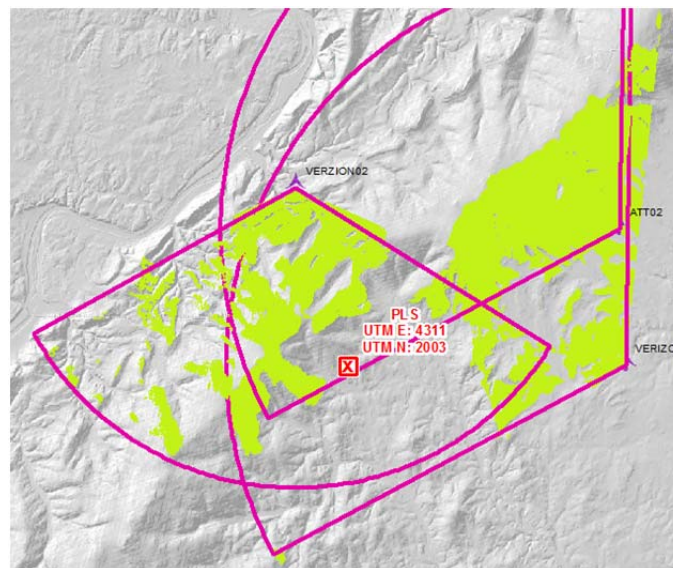

Figure 4: Estimate of Cell Service near the IPP

The output from all the analysis is saved in the SAR_Default.gdb (or default workspace) and the results are placed in the "13 Incident Analysis" group layer where they can easily be moved into the Cellphone Coverage subgroup. Figure 4 displays the results from evaluating the coverage for multiple antenna towers in the vicinity of the search area indicating that no coverage is expected to be available at or near the PLS (verified to be correct).

Note that the Coverage Estimate is merely an estimate based on a very simple model. A more robust analysis using an Irregular Terrain or more sophisticated model would be required for a more accurate assessment of the actual service coverage available in the area.

Range of Uncertainty

Often the cell provider will specify a range of Uncertainty if a distance is estimated from the cell. This value is often reported as "+/- X distance". The user can include a visual representation of the Uncertainty Band by electing to include values for the Uncertainty analysis. The user will need to select the checkbox for the Uncertainty estimate and will need to provide distance and units. The distance is given as a numerical value and the units are selected as either Kilometers or Miles. A plot similar to the one shown below will be provided resulting in an additional polygon feature being created. Note – if the user has ArcGIS Desktop Advanced, the edges of the Uncertainty Zone will be "FLAT" or straight. However, in the user is using the Basic or Standard license the Uncertainty Zone will have "Rounded" edges.
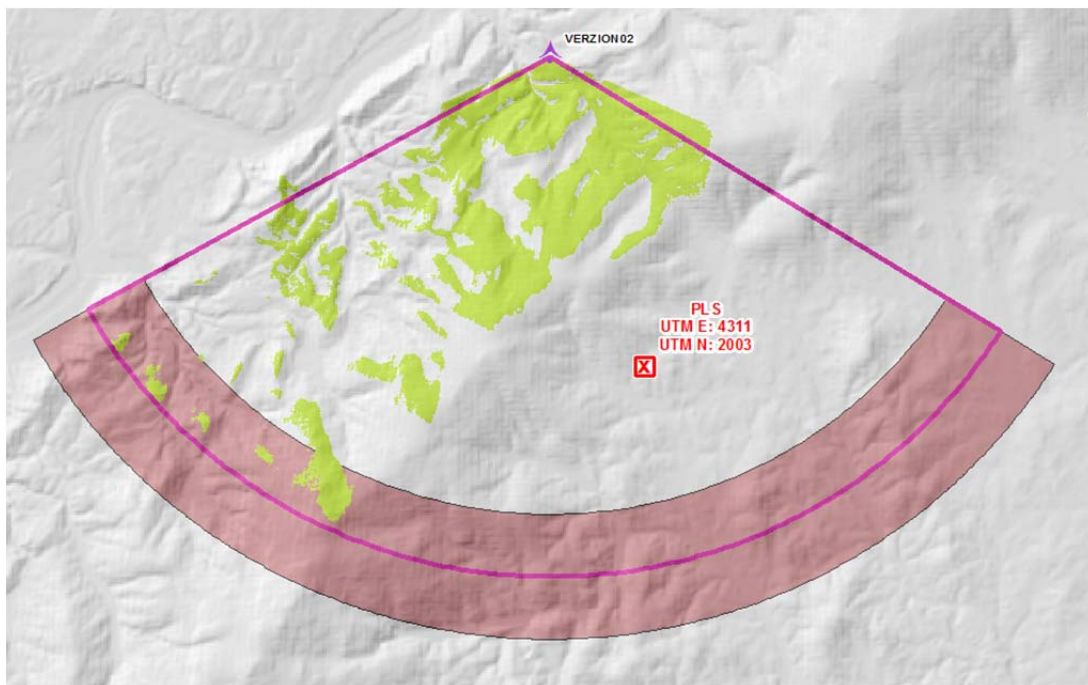

Figure 5: Uncertainty Zone