GISC9312 – GIS Applications

Deliverable D2

Raster Based Analysis of Terrain Surfaces

Due Date: Friday, **May 9, 2014**; Close of Business; both Sections to submit hardcopy to Ian D. Smith.

Grade Value: 30% of Final Grade

Background:

Raster representations of surfaces are often used to undertake comparative analyses such as cut/fill or terrain loss/accretion. This assignment serves as an opportunity for the analysis of a surface that will experience topographic change; a solid waste landfill.

The landfill in question has a maximum allowable elevation profile, dictated by the Ontario Ministry of the Environment, which is known as the 'final contours'. Your client, the Municipality that operates the landfill, has hired your firm to determine the remaining volume of waste that may be placed in the landfill to reach this final contours surface.

Purpose:

To undertake an advanced three-dimensional analysis using raster based techniques.

Deliverables:

Within a 'Technical Memorandum' style to:

Ian D. Smith, Director of Landfill Operations,
Town of Gumby Municipal Offices
2269 Niagara Rd.
Gumby, Ontario
Canada
L0S E1O

you will provide the following:

- A Technical Memorandum (hardcopy) that has the following components:
    - Introduction (statement of challenge/need, background)
    - Methodology description (for a client that understands terrain in a landfill management sense, but not GIS),
    - Mappings/Graphics of:
        - Existing landfill surface,

- Maximum allowed landfill surface,
- Remaining depth of landfill in a $1m^2$ grid (differential).

- Discussion of Findings,
- Conclusions and recommendations,
- Bibliography.

The Tech Memo must not exceed 10 pages (not including graphics).

Procedure:

1. Your client has provided you with the following layers of data:

   - GPS existing.shp – 8,525 3D points collected over 2 days by your surveys staff using a DGPS (Trimble 5700), elevations are contained in the CORR_ELEV (corrected elevation) field.
   - MOE final contours.shp – Final allowed landfill contours, under MOE certificate of approval.
   - landfill footprint.shp – The area of the landfill that is licensed by the MOE. All calculations are to occur within this boundary (hint: soft line clip polygon).

   N.B., all dimensions are in metres; X and Y coordinates are arbitrary, based not on Northing/Easting but upon the datum set by previous consultants, Dewey, Rippem & Howe Consultants; your GPS observations were corrected to the arbitrary coordinates by your 'astute' field staff; all Z values are metres above mean sea level.

   Explore these data using ArcCatalog. Create a Map file (mxd) that includes the three layers above.

2. Create two TIN surfaces as follows:

   - Existing landfill surface, clipped to the landfill footprint,
   - Final approved landfill surface, clipped to the landfill footprint.

3. Using ArcGIS' 3D Analyst Extension, convert both TIN surfaces into rasters that have a grid size of $1m^2$, with the Z value being the elevation for each cell.

4. Using the Raster Calculator feature of the Spatial Analyst Extension for ArcGIS, subtract the existing raster from the final contours raster. This new raster (called Calculation by default) should be saved as a layer so that it is not lost. Reclassify the calculation (differential) raster so that the Z intervals are a constant 1 metre. Also, change the raster symbology so that the raster cells that are less than zero (above the allowable final elevation – convince yourself of this) are coded varying shades of red. Colour the cells that are zero or greater shades of blue. Finally, using ArcScene, drape the calculated, red/blue symbolized raster over the existing TIN as a powerful means for demonstrating the areas of the landfill that the client will have to cut back and the areas that allow for further landfilling.

5. Using the Surface Analysis component of either the 3D Analyst Extension or the Spatial Analyst Extension (available in both extensions), determine the amount of cut/fill between the existing landfill surface and the final allowed landfill surface. How much more waste can the municipality place in this landfill before it reaches capacity (hint – check the attribute table for this created layer)?

6. The Director of Landfill Operations supplies you with the following information regarding waste generation in the Town of Gumby to allow you to answer the question posed in #5, above:

   - The number of households serviced by the landfill is 10,200 and has remained at that level for the past twelve years. There is no major development proposed at the present time, so we can assume that the landfill will continue to service 10,200 households for the near future.

- Statistics Canada reports that the mean occupancy rate is 2.5 persons per household and has been so for the 2001 and 2011 census efforts.
- A very rigorous and successful recycling and compostable waste diversion program has had a marked effect upon the amount of waste that is actually sent to the Gumby Landfill by the residents of the Town of Gumby in the past fourteen years. Table One, below, details the waste generation rate for landfilling over this period:

Table One – Actual Waste Landfilled per Capita

Year	*Waste Generation Rate (To Landfill) Tonnes/Capita/Year*
1999	0.65
2000	0.60
2001	0.49
2002	0.44
2003	0.40
2004	0.35
2005	0.33
2006	0.31
2007	0.31
2008	0.30
2009	0.31
2010	0.30
2011	0.30
2012	0.31

- The landfill operations staff report that they are now able to compact the waste at the landfill very effectively with their new 'sheepsfoot roller'. They are consistently attaining final compaction rates of 0.6 tonnes per m^3.