

Digital Elevation Models in Water Resources Engineering

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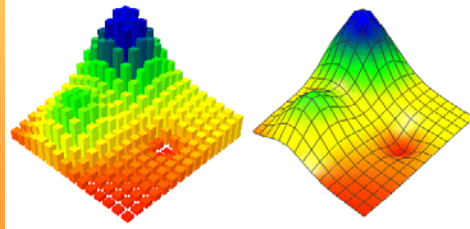
- Introduction to Digital Elevation Models (DEMs)
- Sources of DEM data bases
- Drainage pattern from DEM of Krishna basin

Digital Elevation Models



..... Any numeric or digital representation of the elevation of the land surface

Which One's the DEM?

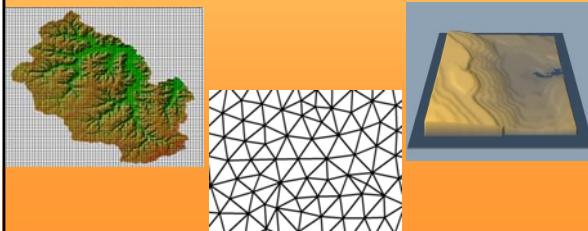


(a) Discrete Elevation Samples (b) Implicit (Linear) Continuous Surface

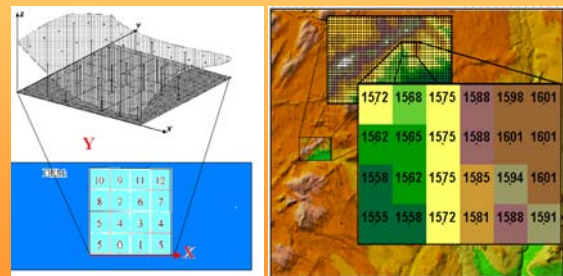
DEM - Types

Mainly three Types of DEM

- Grid (regular square grid)
- TIN (Triangular irregular networks)
- Contour

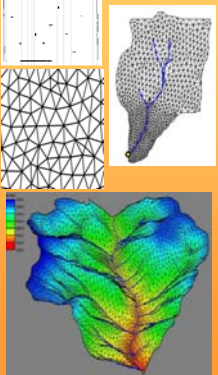


Grid DEM



A TIN (Triangulated Irregular Network)

- Depicts geographic surfaces as contiguous non-overlapping triangles.
- Topographic surface is represented by several triangles, with each triangle face having an approximate slope, aspect, and surface area.
- The vertices of each triangle match the elevation of the terrain exactly.
- The irregularity of the triangles comes from the scattered nature of the (x,y,z) points (the triangle vertices)
- Once a TIN is created, the elevation of any point on the triangle's continuous surface can be interpolated




Contour

- A line drawn on a map connecting points of equal height
- DEM from a topographic map
 - requires that the elevation contours on the topo map be converted to xyz data
 - The raster elevation contours must first be converted to vectors.
 - the vector contours must be "tagged" with their corresponding elevation values.
 - The tagged vector data is then transferred to a superimposed grid by an interpolation algorithm

Disadvantages

- Digitized contours have many vertices along contours, but no control between contours.
 - Over-sampling along contours and under-sampling between contours.
- If the contour interval of the source map is small, the surface model created from it is generally good. If the contour interval of the source map is large, the surface model created from it is generally poor, especially along drainages, ridge lines and in rocky topography.



DEM – in Hydrological Modeling

- Automated procedures are commonly used to derive
 - Slope/Aspect
 - Flow direction/ flow pathways
 - Flow accumulation
 - Streams/Catchment area / upstream contributing area for each grid cell
- Resolution of the data (scale) will have direct effects on analysis results at a range in scales

Slope

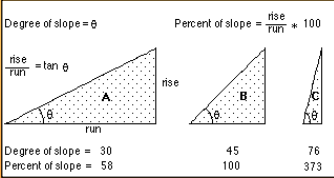
Identifies the max. rate of change in value from each cell to its neighbors.

An output slope grid can be calculated as percent slope or degree of slope.


Degree of slope = θ

Percent of slope = $\frac{\text{rise}}{\text{run}} \times 100$

$\text{rise} = \tan \theta$



Degree of slope = 30	45	76
Percent of slope = 58	100	373

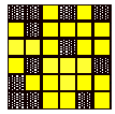


Aspect(slope direction) - Identifies the down-slope direction of the maximum rate of change in value from each cell to its neighbors.

The values of the output grid will be the compass direction of the aspect. (Sharpnack & Akin, 1969)

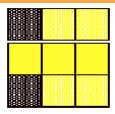
DEM grid size impact on slope

- As a DEM's cell size is increased, local slope estimates decrease (Jensen 1991; Zhang and Montgomery 1994).
 - As a cell increases in size it represents a larger area, hence the averaging of elevations of large areas will result in a smoother, less steep, surface (Wolock and Price 1994).
 - This in turn has an impact on processes such as soil erosion since erosion is directly related to slope.




grid size increases →

slope decreases

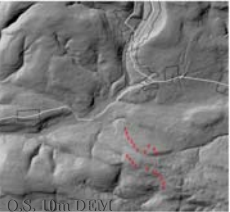


DEM grid size impact on Information Details

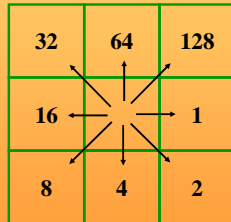


Grid size decreases →

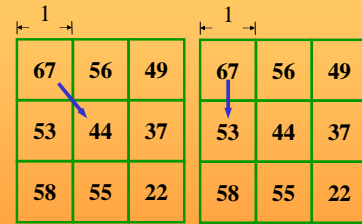
Information extraction increases



Eight Direction Pour Point Model

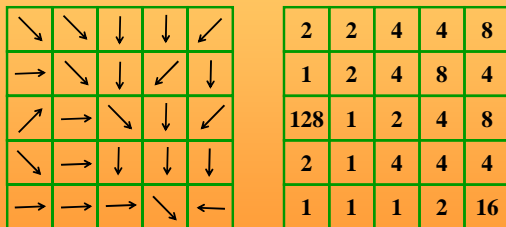


Direction of Steepest Descent

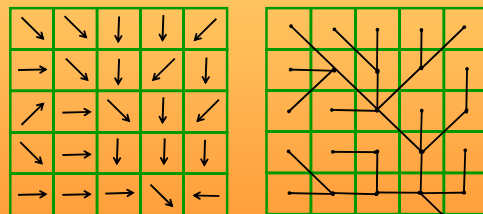


Slope: $\frac{67 - 44}{\sqrt{2}} = 16.26$ $\frac{67 - 53}{1} = 14$

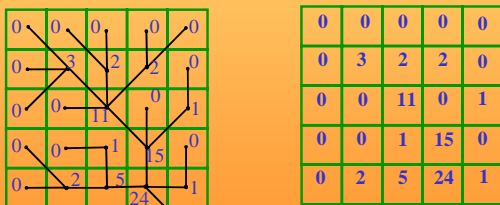
Flow Direction Grid



Grid Network

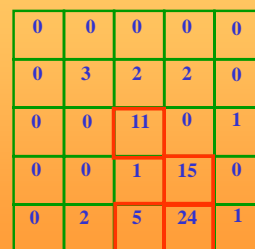


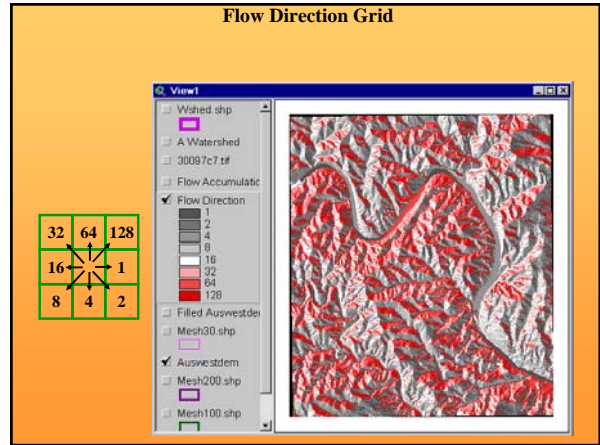
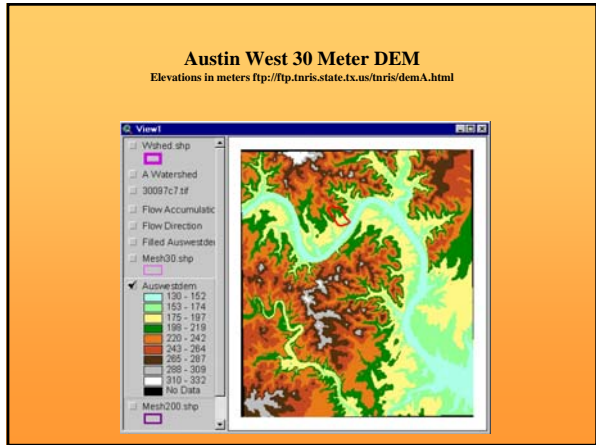
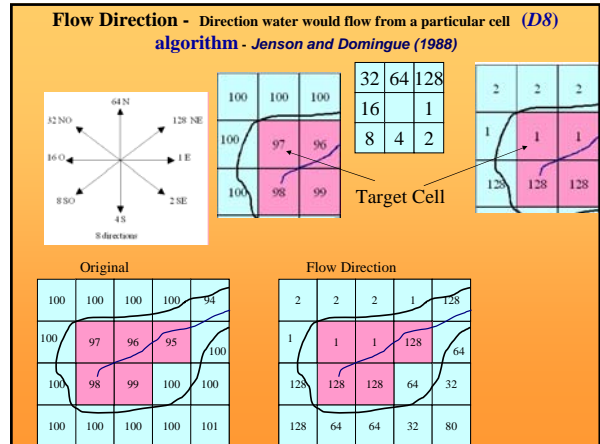
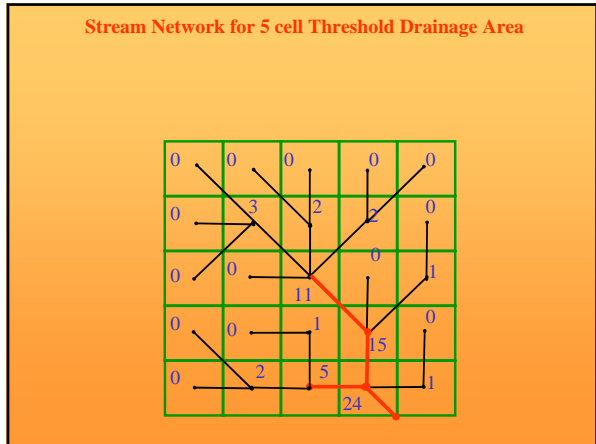
Flow Accumulation Grid



[Link to Grid calculator](#)

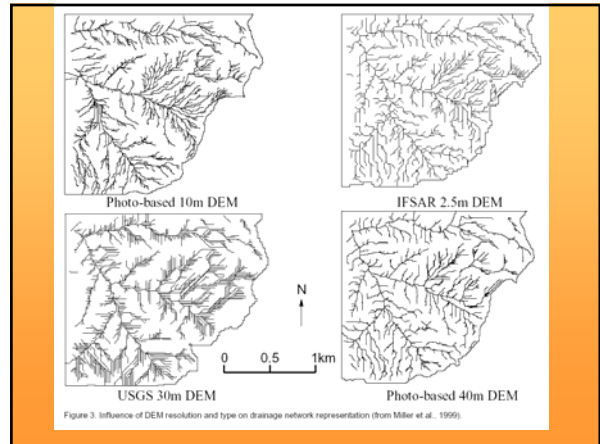
Flow Accumulation > 5 Cell Threshold

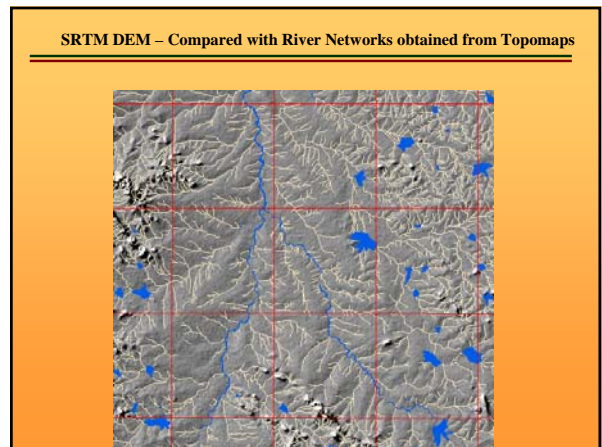
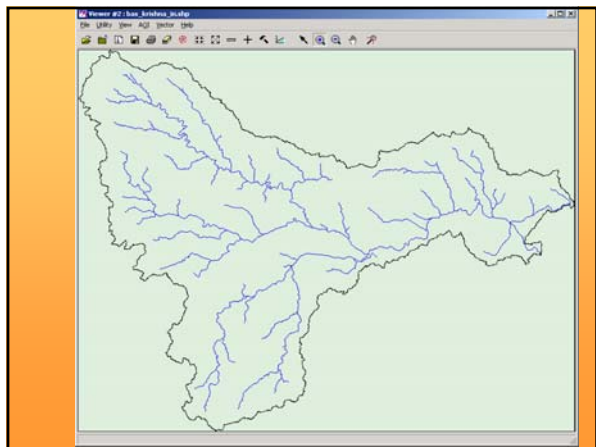
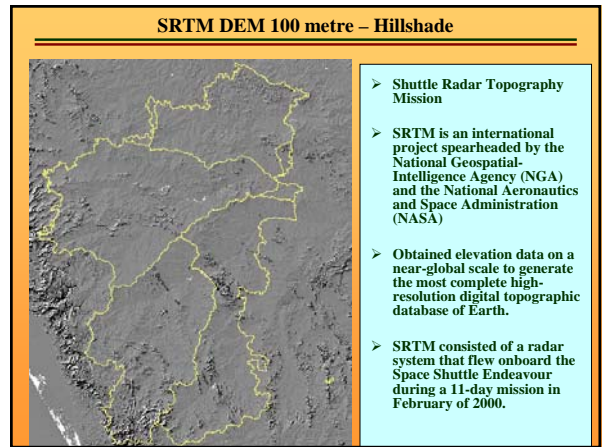
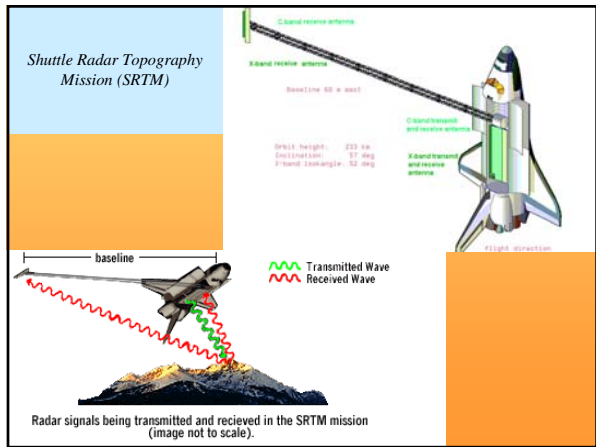
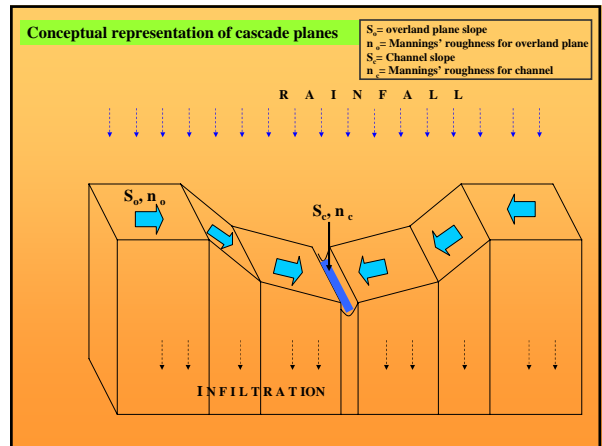
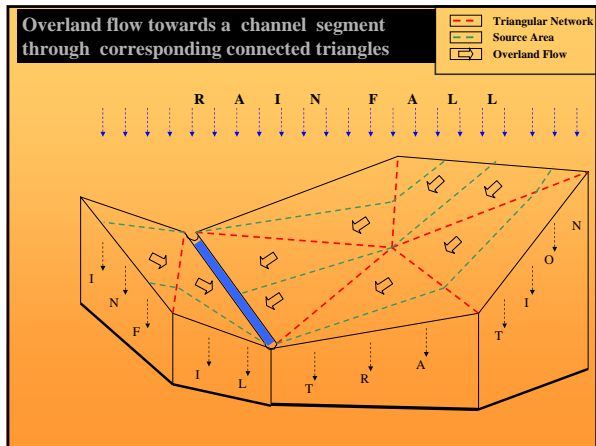




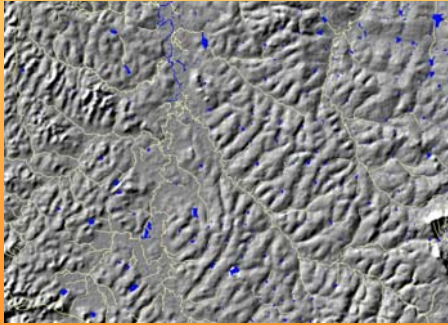
DEM grid size impact on stream channels

- In the study a range of DEMs was used to generate stream channels for a rangeland watershed using a GIS flow direction algorithm (Miller et al. (1999)).
 - Figure illustrates the influence of DEM resolution and model type on stream network generation.
 - Note that variability in complexity and number of smaller channels exists among the maps, yet the underlying structure remains constant.
- Syed (1999) used the same suite of DEMs to parameterize a distributed hydrologic model and found that the choice of DEM significantly altered the results at smaller scales.

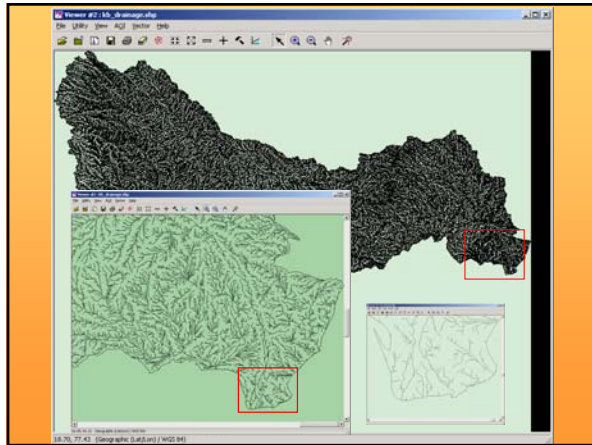
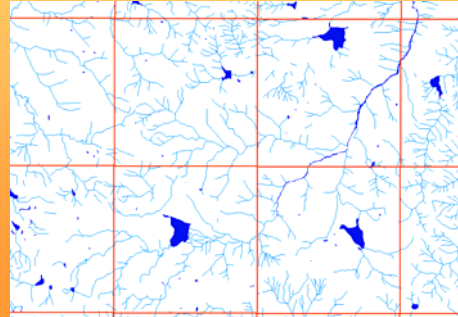




SRTM DEM – Compared with River Networks obtained from Topomaps



Drainage map from SOI topomaps 1: 50,000 scale



Thank you

