

APPENDIX G-4

DRAINAGES DERIVED BY ADWR ANALYSIS

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ADWR depicts drainages (streams) with small and large runoff areas on several maps presented in the HSR. These drainages are also used for some hydrologic analysis. Most of the data needed to define drainage networks by runoff area was acquired and processed during the watershed analysis described in Appendix C of ADWR's report on streamflow characteristics on the Hopi Indian Reservation (ADWR, 2008). ADWR created drainage lines with runoff areas of 1 km², 0.1 km², and 0.01 km².

Digital elevation models (DEMs) (USGS 2004) were joined using the Mosaic Wizard in ERDAS Imagine software prior to analyses (ERDAS 2006). The mosaic DEM was smoothed with 3 iterations of a low-pass filter, and then clipped to a smaller area (~13,100 mi²) encompassing watershed boundaries in the vicinity of the Reservation.

Terrain Preprocessing operations in ArcHydro software were applied to DEMs to identify surface drainage patterns and generate intermediate datasets used in subsequent calculations (Maidment 2002). Preprocessing operations consisted of:

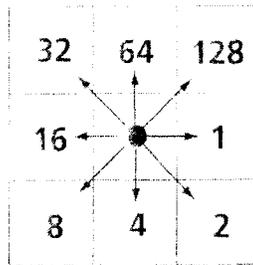
- Fill Sinks (Fill Threshold = 10 ft)

If a cell is surrounded by higher elevation cells, this function modifies the elevation value so that when a drainage analysis is run, water is not trapped in cell. A threshold of 10 feet was selected so that only those cells whose elevation is lower than that threshold would be filled.

- Flow Direction

This function computes a flow direction for each cell in the grid by finding the steepest descent from each cell. Values are either 1(E),2(SE),4(S),8(SW),16(W),32(NW),64(N) or 128 (NW). This number scheme is derived from the computer's binary series (**Figure 1**).

Figure 1. Flow Direction Grid Values



- Flow Accumulation

This function calculates the number of cells upstream of each cell and exports a new raster file with this number in each cell.

- Stream Definition

This function assigns a value of “1” to any cells in the flow accumulation grid with a value greater than a given stream threshold. The threshold is the number of cells or area used to form (“initiate”) a stream segment. All other cells contain no data. Smaller thresholds result in a denser drainage network.

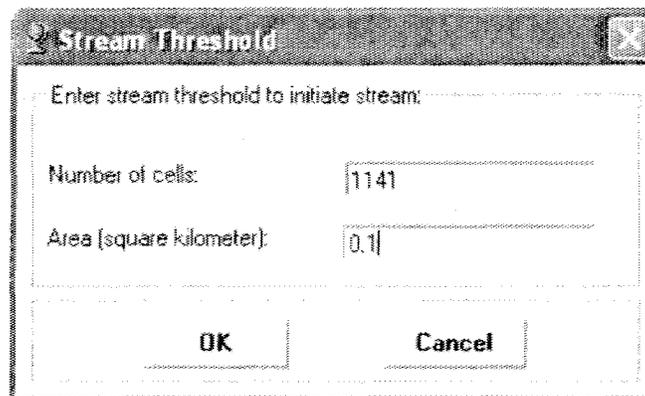
ADWR consulted with two experts that developed and use the ArcHydro tools on recommended thresholds to use for stream definition. They generally recommend, as defined by the proposed default value when the tool is run, 1% of the maximum flow accumulation from the flow accumulation grid. They also recommend limiting the number of individual stream and drainage segments to 200, but that is just a practical matter if one plans to proceed to use the drainage network to define watersheds (Djokic, 2008 and Ye, 2008). Although watersheds were defined for the Hopi streamflow characteristics analysis, it was done using stream segments defined with a much larger threshold (10 mi²).

According to the ArcHydro book (Maidment, 2002), typical stream thresholds used with the National Elevation Dataset (NED) is 5,000 cells or 4.5km² area if the cells are 30 meters. ADWR used the 10-meter pixel size DEM mosaic with the goal of identifying micro drainages on the Reservation that may carry surface water to agricultural fields.

ADWR chose stream thresholds of 1km^2 , 0.1km^2 , and 0.01km^2 based on the local topography; the number, size and location of claimed agricultural fields; the computing limits of the software; and, in order to show enough difference between different runoff areas (orders of magnitude).

Within ArcHydro, one defines stream thresholds either by the number of contributing cells or the runoff area. ADWR chose the desired runoff area. The number of contributing cells changes as this area is adjusted (**Figure 2**).

Figure 2. Stream Threshold



- Stream Segmentation

This function creates a grid of stream segments with a unique identifier. All the grid cells between two junctions are assigned the same grid code specific to that segment. The resulting raster is called the stream link. This is a necessary step for converting the raster data to linear vector data.

- Drainage Line Processing

This function converts the stream link raster into a drainage line feature class.

These operations produced linear datasets that show three sets of drainage patterns within the vicinity of the Hopi Reservation. These derived drainages represent three stream orders with contributing drainage areas of 1 km^2 , 0.1 km^2 , and 0.01 km^2 .

REFERENCES

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- Maidment, D.R., 2002. Arc Hydro: GIS for Water Resources. ESRI Press, Redlands, California. 203 p.
- United States Geological Survey, 2004. 10-meter lattices. Processed and Published by the Arizona State Land Department. Metadata Link: <http://www.land.state.az.us/alris/metadata/dem10m.htm>
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