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TOPAZ program and its subroutines are accepted and used by the recipient upon the expressed understanding that the developers make no warranties, expressed or implied, concerning the accuracy, completeness, reliability or suitability for any one purpose, and that the developers shall be under no liability or obligation to any person, institution, organization, or corporation by reason of any use made thereof. The subroutines in this program cannot be lifted, extracted or transferred out of TOPAZ for stand alone use with other programs or other purposes because variables transferred into subroutines must have been processed and assigned specific values by preceding subroutines that reflect program code and terrain specific particularities. Inappropriate use of a subroutine for other purposes than within this program may produce, at best, unexecutable code, or, at worst, inconsistent and erroneous results that go unrecognized. The developers of this program and its subroutines shall be acknowledged when the code, the model and/or the numerical solution techniques used herein are directly applied in conjunction with another code, or described and/or referred to in a publication or presentation.

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GENERAL INFORMATION

Latest Information

November 1999

TOPAZ Version 3.12 is now available. Changes from TOPAZ Version 3.11 include streamlining of selected portions of the code for faster execution with very large DEMs, and a modification to the Global Slope calculation for subcatchments to account for special channel/subcatchment configurations.

The Windows executable programs of TOPAZ Version 3.12 have been compiled with code optimization and should run faster than the previous Version 3.11, for most applications.
Note for TOPAZ applications to very large DEMs (<4,000,000 cells) with the windows executable TOPAZ code in directory Winexe. Due to compiler limitations in memory allocation/paging, the user must insure that adequate RAM memory is available for processing large DEMs. Program RASPRO is particularly sensitive to RAM memory limitations. If you encounter memory allocation problems (often listed as "access error"), you should try to run TOPAZ with the aggregation/resampling feature described in input file DNMCNT.INP. We are currently working to overcome this problem. A windows executable TOPAZ code with full virtual memory capabilities will be made available as soon as possible. Alternatively the user can compile the TOPAZ source code with their FORTRAN90/95 compiler.

September 1999

TOPAZ Version 3.11 is now available. Changes from TOPAZ Version 3.10 include a number of output format revisions to accommodate values associated with very large DEMs and/or very large cell sizes.

A draft User Manual for TOPAZ Version 3.1x is available on the TOPAZ Homepage. A final User Manual for TOPAZ Version 3.1x will be available in December 1999 for direct downloading from our FTP site.

July 1999

TOPAZ version 3.10 is now available in: (1) ASCII format (for user compilation with a FORTRAN90 compiler); and (2) executable format for application with Windows 95 and 98. Please check the "TOPAZ Distribution" section on how to obtain your copy of the code and manuals. A brief description of TOPAZ Version 3.10 is given in the "TOPAZ Versions" section. Please note that TOPAZ Version 3.10 supersedes TOPAZ version 3.00.

March 1999

TOPAZ version 3.10 is expected to be released around June 1999. This version will include calculations of representative area, slope and length values for the subcatchments within a watershed. In addition, minor code changes to accommodate a larger range of FORTRAN90 compilers are also implemented.

TOPAZ version 3.10 will supersede version 3.00.

TOPAZ
Purpose and Objectives

TOPAZ is an automated digital landscape analysis tool for topographic evaluation, drainage identification, watershed segmentation and subcatchment parameterization. While TOPAZ is designed primarily to assist with topographic evaluation and watershed parameterization in support of hydrologic modeling and analysis, it also has application to a variety of geomorphological, environmental and remote sensing investigations.

The overall objective of TOPAZ is to provide a comprehensive evaluation of landscape drainage characteristics while maintaining consistency between all derived data, the initial input data, and the physics underlying energy and water flux at the landscape surface. The analysis is based on the application of the deterministic eight-neighbor (D8) method to simulate flow across a land surface represented by a raster (grid) digital elevation model.

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TOPAZ
Significant Features

TOPAZ effectively handles drainage identification in the presence of depressions and flat areas in the input DEM by using an innovative combination of depression outlet breaching, depression-filling, and relief imposition. This feature is particularly effective when analyzing low relief landscapes with DEMs of limited resolution.

TOPAZ has the capability of generating spatially varying drainage densities and subcatchment areas. This is accomplished by varying the user-controlled parameters of Critical Source Area (CSA) and Minimum Source Channel Length (MSCL). This capability is useful to capture the effect of variable geology across the watershed on drainage density and subcatchment size.

TOPAZ identifies the topology of the channel network by assigning numbers to the channel links, junctions and subcatchment areas, and identifying the connectivity of the channel network. This includes the computation of the optimal sequence to perform cascade flow routing through the channel network. This feature provides fundamental information for hydraulic/hydrologic models that perform flow routing.

TOPAZ includes a comprehensive channel network analysis capability. This capability provides network and subcatchment statistics, as well as morphometric parameters of channel network composition. The channel network analysis is performed for both the generated raster network, as well as a network that has been corrected for biases associated with DEM resolution.

TOPAZ computes representative values for subcatchment properties that are distributed in nature and for which a single, absolute value does not exist. For example, representative travel distance for an irregular subcatchment must be approximated based on the various travel distances within the subcatchments. The capability of computing representative subcatchment properties is particularly useful for lumped-distributed hydrologic model applications.

TOPAZ generates raster output files of the drainage network, subcatchment areas and a variety of drainage-related topographic variables. These can be easily imported by most Geographic Information Systems (GIS) for display, registration to other data coverages and spatial analyses.

TOPAZ generates a series of tabular output files that provide the properties of individual channel links and subcatchments, as well as information on the overall channel network structure. These tables are for user analysis or input into traditional distributed hydrologic models.

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TOPAZ Input

- User provided input files for program DEDNM

  General input file DNMCNT.INP

  DEM input file DEDNM.INP

  Network generation input file NTGCOD.INP

- User provided input file for program RASPRO

  Raster reprocessing input file RASPRO.INP

- User provided input file for program RASFOR

  Raster reformatting option file RASFOR.INP

- User provided input file for program PARAM

  Subcatchment parameterization input file PARAM.INP

In addition to the input files that are provided by the users, each of the programs in TOPAZ requires input files that are generated internally. Topaz generates and reads these files automatically, without any action by the user.

Input files for program DEDNM

General input file DNMCNT.INP

File DNMCNT.INP is the input file which defines DEM raster characteristics, DEM processing options and corresponding parameters, as well as user output options. The following provides a more detailed list of the parameters in this input file.

*** General information

The information consists of a title for the current application which will be printed in tabular, evaluation and report files generated by TOPAZ.

*** DEM raster characteristics

The basic characteristics of the input DEM consist of: optional UTM coordinates if known; number of rows and columns of the input DEM; minimum and maximum elevation values of the input DEM; elevation values that identify indeterminate elevations; orientation of the DEM; and, approximate or estimated row and column number that defines the watershed outlet.

*** DEM processing options and parameters

Processing options include options for reduction of the input DEM by aggregation or resampling , the smoothing of the DEM, and, the breaching/depression filling option. In addition, Critical Source Area (CSA) and Minimum Source Channel Length (MSCL) parameter must be provided. A user option is also available to perform a detailed raster quality control/error checking.

*** User output options

The user output options define the desired tabular and report output files from TOPAZ.

User provided DEM input file DEDNM.INP

File DEDNM.INP is the file which contains the elevation data of the DEM. The unit of elevation is meters, and the precision with which the values are read is 1/10th of a meter or one decimeter. Any additional precision in the elevation input is rounded to the nearest decimeter. The minimum and maximum elevation values accepted by TOPAZ are 1.0 and 9999.0 meters, respectively. Sometimes not all elevation values in a DEM are relevant or known. In these cases a characteristic value that designates indeterminate elevation must be provided. This value can be any value outside the range of the minimum and maximum values given above. A recommended value for indeterminate elevation is 0 (zero) or -1.0. The format of the elevation data is one value per record, ordered column first, row second. Two displays of DEM elevation data are available: one is a 2-dimensional display of the elevations, and the other is a 3-dimensional perspective display of the elevations

Network generation input file NTGCOD.INP

File NTGCOD.INP is the file which contains the spatial distribution and value of the network generation codes. The spatial distribution of the codes reflects the spatial variability of geophysical landscape properties that are relevant for the generation of the drainage network and watershed segmentation to exhibit spatially variable characteristics. The user can select up to 5 code values. Each code value corresponds to a user defined Critical Source Area (CSA) and Minimum Source Channel Length (MSCL) value as given in input file DNMCNT.INP. The format in which the codes are provided is one value per record, ordered column first, row second, in exactly the same way as for input file DEDNM.INP.

The input file NTGCOD.INP is not needed if the user elected to use only one CSA and MSCL value for the entire DEM.

Input file for program RASPRO

Raster reprocessing input file RASPRO.INP

File RASPRO.INP contains raster reprocessing and user output options for program RASPRO. Options include reprocessing data for depression and flat area locations, reclassification into bands of equal elevations, calculation of local slope and aspect, and network and subcatchment display enhancements.

Input file for program RASFOR

Raster reformatting option file RASFOR.INP

File RASFOR.INP contains user output options and format for raster files. User format choices include ARCINFO format, IDRISI version 4.0 format, ASCII 2-dimensional format and ASCII 1-dimensional format. Any or all of the raster files provided by TOPAZ can be selected for output.

Input file for program PARAM

Subcatchment parameterization input file PARAM.INP

File PARAM.INP contains user output options for subcatchment parameterization.

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TOPAZ Output

The output from TOPAZ consists of tree different types of files:

- Raster output files

  General description and types of raster files

  List of files and content description

- Tabular output files

  General description

  List of files and quantified variables

- Evaluation output files

  General description

  List of files and evaluated parameters

Raster output files

General description and types of raster files

Raster data are used to represent spatially varying watershed characteristics, such as topography, drainage boundaries and network configuration, and distributed land surface attributes. The raster data can be imported into a GIS for display, overlay analysis and/or further processing. Initially all raster output files are written as FORTRAN unformatted files (binary) and are given extension .out. Subsequently, these files may be reformatted by program RASFOR into one of four format options: ASCII 1-D, ASCII 2-D, IDRISI and ARCINFO.

- ASCII 1-D

  ASCII 1-D files are formatted (user readable) files that have one value per record. The order of the values are column first, row second. ASCII 1-D files have the extension .DAT.

- ASCII 2_D

  ASCII 2-D files are formatted (user readable) files that have multiple data entries per record. Each record contains the data of an entire row of the raster file. Thus, record 1 contains all the column values in the first row of the raster, record 2 the data of the second row, etc. ASCII 2-D files have the extension .DAT.

- IDRISI

  Files in IDRISI format can be directly imported into the commercial GIS package IDRISI. The files come in pairs: one image file (extension .IMG) and one corresponding documentation file (extension .DOC). The image and documentation files are fully compatible with IDRISI Version 4.0.

- ARCINFO

  Files in ARCINFO format can be directly imported into the commercial GIS package ARCINFO. ARCINFO files have the extension .ARC.

A list of raster output files, including content description is provided below.

List of files and content description

The following is a listing of raster files, including a short description of the content.

Output from program DEDNM:

- BOUND.OUT: Boundary of the watershed upstream of a user selected watershed outlet.
- FILDEP.OUT: DEM after removal of depressions and pits by a breaching-filling operation.
- FLOPAT.OUT: Beginning, ending and transition cells of drainage flow paths.
- FLOVEC.OUT: Drainage directions at each cell.
- INDTAR.OUT: Identification codes of cells in the DEM that are areas of defined/indeterminate elevation or adjacent to areas of indeterminate elevation.
- INELEV.OUT: Digital Elevation Model (DEM) of the landscape as provided by the user.
- NETFUL.OUT: Channel network for the entire DEM.
- NETW.OUT: Channel network within watershed boundary.
- NTGCOD.OUT: Identification of the areas corresponding to different channel network generation parameters to represent spatial variability of the channel network.
- RELIEF.OUT: DEM after removal of all depressions and after relief imposition on flat areas.
- SMOOTH.OUT: DEM after optional user selected smoothing.
- SUBWTA.OUT: Subcatchments identification (right, left, source and channel) corresponding to the generated channel network.
- UPAREA.OUT: Upstream drainage area.

Output from program RASPRO:

- DEPFLT.OUT: Location and extent of depressions and flat areas in the DEM.
- ELVCLA.OUT: Reclassified elevations into bands of equal elevation.
- ELDCHA.OUT: Elevation drop from each cell defined in the watershed to the next channel.
- ELDOUT.OUT: Elevation drop from each cell defined in the watershed to the watershed outlet.
- DISCHA.OUT: Distance from each cell in the watershed to the next channel.
- DISOUT.OUT: Distance from each cell in the watershed to the watershed outlet.
- FVASPEC.OUT: Aspect of the drainage direction (8 possible directions).
- FVSLOP.OUT: Slope of the outflowing drainage direction.
- HSLOPE.OUT: Average slope of the inflowing and outflowing drainage direction.
- NETWE.OUT: Widened channel network for enhanced display.
- SUBBDA.OUT: Boundaries of the subcatchments.
- SUBWTB.OUT: Aggregated subcatchments identification (right, left and source area combined) corresponding to the generated channel network.
- SUBBDB.OUT: Boundaries of aggregated subcatchments.
- TASPEC.OUT: Aspect of the terrain (from mathematically fitted surface).
- TSLOPE.OUT: Slope of the terrain (from mathematically fitted surface).

Tabular output files

General description

Tabular output files provide a tabular listing of channel and subcatchment attributes, such as channel length, channel slope, channel network junction information, subcatchment area and other related attributes. They contain data that is often needed in hydrologic applications and distributed models of land-surface processes. The following is a listing and description of attribute files produced by software TOPAZ.

List of files and quantified variables

Tabular output of program DEDNM:

- Netw.tab: Contains channel link information for the raster network.
  - Channel link index.
  - Index of upstream inflowing channel links.
  - Index of downstream channel link.
  - Channel link node code (source, junction or outlet).
  - Rearranged sequence of channel links for cascade type flow routing.
  - Strahler channel link order.
  - Coordinates of the beginning and ending point of a channel link.
  - Elevation of the beginning and ending point of a channel link.
  - Channel link length.
  - Channel link slope.
  - Upstream drainage area at the beginning and ending point of a channel link.
  - Direct drainage area into a channel link.

- Sbct.tab: Contains subcatchment information for the raster network.
  - Subcatchment index.
  - Strahler order of the channel link the subcatchment drains into.
  - Right, left, channel, and total area of the subcatchment.

- Catwin.tab: Window identification of the subcatchment areas defined in SBCT.TAB.
  - Node number corresponding to the subcatchment area window.
  - Minimum and maximum row/column value for the source, right, left, and channel subcatchment area.

Tabular output of program RASBIN:

- Netwb.tab: Contains channel link information for the binary network.
  - Node index.
  - Strahler channel link order..
  - Channel link node code (source, junction or outlet).
  - Execution sequence of channel links for cascade type flow routing.
  - Next node downstream index number.
  - Terrain elevation.
  - Channel link length.
  - Upstream and direct drainage area.
  - Channel link slope.

- Sbctb.tab: Contains subcatchment information for the binary network.
  - Subcatchment index.
  - Strahler order of the channel link the subcatchment drains into.
  - Right, left, and total area of the subcatchment.

Tabular output of program RASPRO:

- Elvcla.tab: Minimum and mean of user defined elevation reclassification.
  - Class number.
  - Beginning elevation value of each class.
  - Mean elevation value of each class.
  - Tabular output of program PARAM:

- Sbcta.tab: Contains subcatchment area information for the raster network.
  - Subcatchment index.
  - Strahler order of the channel link the subcatchment drains into.
  - Right, left, channel and total area of the subcatchment.
  - Right, left and total area of the subcatchment with channel cells integrated.

- Sbctl.tab: Contains subcatchment length information for the raster network.
  - Subcatchment index.
  - Strahler order of the channel link the subcatchment drains into.
  - Length to centroid from channel for source, right and left subcatchments.
  - Mean flow path length for source, right and left subcatchment areas.

- Sbcts.tab: Contains subcatchment slope information for the raster network.
  - Subcatchment index.
  - Strahler order of the channel link the subcatchment drains into.
  - Mean topographic slope of the source, right and left subcatchment area.
  - Mean flow path slope of the source, right and left subcatchment area.
  - Mean cell slope of the source, right and left subcatchment area.

Evaluation output files

General description

Evaluation output files contain statistics and derived data for channel and subcatchment properties. The files are formatted ASCII files for user review. Headings and units are given in the files. The following is a listing and short description of evaluation output files.

List of files and evaluated parameters

- Netwt.evl: Evaluation of the raster and binary channels and channel link data.
  - General network information
  - Number of channels and channel links.
  - Length of channels and channel links.
  - Elevation of channels and channel links.
  - Slope of channels and channel links.
  - Length weighted slope of channels and channel links.
  - Direct and total drainage areas.
  - Drainage density.
  - Channel link sinuosity.
  - Simplified drainage network composition.

- Sbctt.evl: Evaluation of the raster and binary subcatchment property data.
  - General information.
  - Subcatchment drainage areas.
  - Channel drainage areas.
  - Right drainage areas.
  - Left drainage areas.
  - Source drainage areas.

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Future Developments

- Distribution of an executable version of TOPAZ
  (Proposed December 1998; implemented July 1999)

  A number of users have requested an executable version of TOPAZ that does not require compilation. This will be implemented for WINDOWS 95/98 using the Salford FTN95 compiler.

  The expected target date for final implementation and release is July 1999.

- Calculation of the distribution of slope-aspect pairs within a subcatchment
  (Proposed October 1998)
  The terrain aspect within a subcatchment may have a range of values depending on the level of terrain dissection by channels within the subcatchment. A single aspect value for the entire subcatchment is representative because aspect values in opposite direction cancel one another. The distribution of the aspect within the subcatchment provides a better picture of the aspect values associated with the subcatchment. Therefore, it is planned to implement the calculations of the aspect distribution in eight directions, including the average slope associated with each aspect direction.

  The expected target date for final implementation and release of calculations for slope-aspect distribution is September 1999.

- Calculation of representative subcatchment properties
  (Proposed in November 1997; implemented July 1999)
  Many subcatchment properties, such as slope and length, are distributed in nature which precludes the direct measurement of a single and unique. Since these properties vary through the subcatchment, they must be calculated based on a model that reduces the distributed values of the property into a representative value for the subcatchment. Alternative models to calculate representative subcatchment values for the area, slope and length are being considered for implementation into TOPAZ.

  The expected target date for final implementation and release of the calculations for representative subcatchment properties is May 1999.

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Relevant Publications:

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News Releases

- TOPAZ IS A TOPOGRAPHIC GEM
  Agricultural Research, April 1999, Vol. 47, No. 4

- UNIVERSITY OF SASKATCHEWAN GEOGRAPHER TEAMS WITH AMERICAN ENGINEER TO CREATE A TOPOGRAPHIC GEM
  University of Saskatchewan on Campus News, April 1999, Vol. 6, Number 15.

TOPAZ IS A TOPOGRAPHIC GEM

Agricultural Research, April 1999, Vol. 47, No. 4, ISSN 0002-161X

TOPAZ helps give farmers, engineers, scientists, and others a true lay of the land.

ARS hydraulic engineer Jurgen Garbrecht and Professor Lawrence Martz from Canada's University of Saskatchewan developed the software as part of an international research effort to apply digital landscape technology to drainage-and-runoff-related problems.

TOPAZ--short for topographic parameterization—is a computer-based evaluation tool that defines and analyzes land surface characteristics, watershed configurations, and drainage features. It has a range of analysis options and unique features that set it apart from commercial geographic information systems (GIS).

"TOPAZ has already gone global," says Garbrecht. "Researchers, engineers, and educators in Europe, the Middle East, and North America are using it."

ARS and USDA's Natural Resources Conservation Service are using the software to generate drainage path information needed for their water quality models. Canadian researchers are using it in their Global Energy and Water Cycle Experiment study of the Mackenzie River Basin—the second biggest river basin in North America—to better understand the role of cold regions in the global climate system.

Scientists from the International Water Management Institute are using TOPAZ for a modeling study of water-short basins in Turkey. And university staff are also using it as a teaching tool.

TOPAZ doesn’t produce graphic pictures on the computer monitor, but it creates data files from which pictures can be generated by a commercial GIS package. Garbrecht says this is an advantage, because it allows the user to select preferred or existing display software without being forced to buy another package. He says, "TOPAZ provides the data in a basic format that is readable by most GIS systems, allowing for more flexibility."

New capabilities are being developed and incorporated into the software to further broaden its application horizon. At this time, the scientists are working with the ARS Southwest Watershed Research Center in Tucson, Arizona, to add new features to TOPAZ for use by KINEROS, another ARS model that computes surface runoff and erosion.

- By Tara Weaver-Missick, ARS.

Copies of TOPAZ are available on request from Jurgen D. Garbrecht, USDA-ARS Grazinglands Research Laboratory, 7207 W. Cheyenne St., El Reno, OK 73036; phone (405)262-5291, fax (405)262-0133, e-mail jurgen.garbrecht@ars.usda.gov.

UNIVERSITY OF SASKATCHEWAN GEOGRAPHER TEAMS WITH AMERICAN ENGINEER TO CREATE A TOPOGRAPHIC GEM
University of Saskatchewan on Campus News, April 1999, Vol. 6, Number 15.

Idle boasting is by definition a hollow indulgence. But when an idle boast made eight years ago by a U of S (University of Saskatchewan) geography professor evolved into a computer program that's in use today around the world to study water runoff and soil erosion, one begins to marvel at the potential that lies drowsing in the word idle.

Professor Lawrence Marts had occasion during his sabbatical in 1991 to visit a research lab in Oklahoma, and there he met Jurgen Garbrecht, a hydraulic engineer with the U.S. Agriculture Research Service.

"Jurgen had spent two person-years on a project to measure stream lengths in a basin," Martz recalls. "As an idle boast, I told him that if I had an elevation model I could do that in five minutes. So he took a floppy disk with this model off his shelf, handed it to me and said, 'show me.'"

Martz chuckles at the recollection. "Well, I tried it, and it sort of worked and it sort of didn't. But we decided to collaborate on the package to make it of use worldwide."

Serendipitous encounter

That first encounter—Martz calls it "serendipitous"—marked the start of a team effort that in 1994 yielded the first version of a software called TOPAZ—short for topographic parameterization.

TOPAZ is a digital terrain-analysis tool that helps researchers analyze land surface characteristics, watershed configuration, and drainage features.

Martz and Garbrecht—the Canadian geographer and the American engineer—both wrote code for the program.

"I enjoy solving puzzles and writing code," Martz says. "Jurgen is good at refining. But I don't want to give the impression that I was the ideas man and he simply did the fine-tuning. It was in large part his intellectual input that made the program as rigorous and robust as it is.

"I think we complement each other nicely. It's been a tremendously fruitful collaboration."

Researchers, engineers, and educators in Europe, the Middle East, and North America are using TOPAZ today.

Canadian researchers are using the program in their Global Energy and Water Cycle Experiment study of the vast Mackenzie River basin to better understand the role of cold regions in the global climate system. Scientists in Turkey are using TOPAZ to develop irrigation systems in some of the drier areas of that country. Educators are using it as a teaching tool.

Martz says the program is designed to do two things.

First, using a digital elevation model, it determines stream channel locations and watersheds by breaking up a landscape into parts.

The digital elevation model is a grid of elevation values," he explains. "From that grid the valley bottoms and determine watersheds and drainage divides from where the water comes from."

Second, the program measures the characteristics and properties of stream networks in terms of their steepness, their orientation to the sun, and their size and shape.

Many practical applications

The practical applications are many. Since TOPAZ can be used to predict runoff and stream flow, it can suggest ways to protect against flood damage. It can predict water supply and assist in the operation of hydroelectric power stations. It can help with pollution management by locating sources of pollution and predicting where existing pollution might end up.

TOPAZ doesn't create graphic images on the computer monitor; it creates data files from which images can be generated with a GIS—a commercial geographic information systems package. This is an advantage, according to Garbrecht, because it allows the user to select preferred or existing display software rather than force the user to but another package.

"TOPAZ provides the data in a basic format that is readable by most GIS systems, allowing for more flexibility," he says.

Now in its third version, TOPAZ works with Windows 95/NT and can be downloaded for free from the U of S Web site. The URL is http://duke.usask.ca/~martzl/topaz/software.html.

Further revisions are forthcoming. Martz and Garbrecht hope eventually to link TOPAZ with hydrologic models and global climate models in order to help predict climate change.

- Bob Kohlmeier, University of Saskatchewan on Campus News.

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SOFTWARE

TOPAZ
Programs and Organization

TOPAZ consists of 6 programs that are interdependent. Not all programs need to be executed for a particular application. This section briefly describes each program and its functions, as well as the interdependence between the programs and their execution sequence.

Program DEDNM

Program DEDNM (Digital Elevation Drainage Network Model) performs the basic raster processing and produces fundamental raster data necessary for the operation of all other TOPAZ programs.

Program DEDNM performs the following specific functions:

- read and check the DEM input data;
- option to perform smoothing and/or aggregating of the DEM data;
- rectify depressions and flat surfaces in DEM;
- identify surface drainage;
- define the drainage network;
- identify watershed and subcatchment boundaries;
- assign indices to the channel links and subcatchments;
- define channel link length and topology;
- calculate subcatchment area.

Program RASPRO

Program RASPRO (RASter PROperties) derives additional spatial landscape information and parameters from the basic rasters produced by program DEDNM.

Program RASPRO derives the following additional raster information:

- location and extent of depressions and flat surfaces in the DEM;
- elevation reclassification into user specified classes;
- alternative evaluations of raster cell slope and aspect;
- enhancement of the visualization of channel network and drainage divides;
- subcatchment aggregation;
- distance from each cell to the next channel and to the watershed outlet;
- elevation drop from each cell to the next channel and to the watershed outlet.

Program RASFOR

Program RASFOR (RASter FORmatting) is a raster reformatting utility program. It reads the unformatted raster files produced by programs DEDNM and RASPRO, and reformats this raster data into either ASCII or GIS specific file formats.

Program RASFOR can convert raster files to the following formats:

- ASCII 1-Dimensional data string;
- ASCII 2-Dimensional array format;
- IDRISI GIS format;
- ARC/INFO GIS format.

Program RASBIN

Program RASBIN (RASter to BINary network) transforms a raster based drainage network definition into a binary (2 inflows per junction) drainage network definition.

Program RASBIN performs the following specific functions:

- decomposes complex junction nodes into simple junction nodes;
- assigns channel link and subcatchment indices to the binary network;
- computes the sequence for cascade-type flow routing through the binary network;
- define channel link length and topology for the binary network;
- calculate subcatchment area for the binary network.

Program NSSTAT

Program NSSTAT (Network and Subcatchment STATistics) computes the statistics of the channel link and subcatchment properties for both the raster and binary channel network.

Program NSSTAT performs the following mean and standard deviation calculations for the entire network and for each Strahler channel order:

- number of channel links;
- length of channels and channel links;
- elevation of channels and channel links;
- slope of channels and channel links;
- direct and total drainage areas;
- drainage density;
- channel link sinuosity;
- network composition;
- subcatchment drainage areas;
- channel, right, left and source drainage areas.

Program PARAM

Program PARAM (PARAMeterization) computes representative subcatchment properties and parameters from the rasters produced by programs DEDNM and RASPRO.

Program PARAM performs the following calculations for each subcatchment in the watershed:

- length to the center of moment;
- mean flow path length;
- drainage area;
- topographic based slope alternative;
- flow path based slope alternative;
- cell path based slope alternative.

TOPAZ Organization

The TOPAZ programs are interdependent in as far as the output of one program is used as input into other programs. The exception is program DEDNM which accepts only user provided data and does not depend on input from any other program. Because of program interdependence, the sequence in which the programs are executed is important for proper TOPAZ operation.

- Program DEDNM is always evaluated first followed by any of the three programs RASBIN, RASPRO or RASFOR.
- If the user chooses to exercise program RASPRO, then program RASFOR should be executed after program RASPRO.
- Program NSSTAT can only be used when program RASBIN has been executed.
- Program PARAM execution depends on output of data from both programs DEDNM and RASPRO cannot be executed until both program have run.

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TOPAZ Versions

TOPAZ Version 3.12 and TOPAZ Version 1.22 are available for distribution.

TOPAZ Version 3.12

- Release date: November 1999.
- Same as TOPAZ Version 3.11 (see below) but with: a) a streamlined code for the treatment of flat areas that should result in faster execution times with very large DEMs; b) a modification to the Global Slope calculation for subcatchments to account for special channel/subcatchment configurations; and, c) an increased output format in the header of ARC/INFO output files.

TOPAZ Version 3.11(Superseded by Version 3.12)

- Release date: September 1999.
- Same as TOPAZ Version 3.10 (see below) but with revisions that address problems in output formats associated with very large DEMs.

TOPAZ Version 3.10 (Superseded by Version 3.11)

- Release date: July 1999.
- This TOPAZ Version 3.10 is written in the FORTRAN 90 software language.
- Array size definition in FORTRAN90 is dynamic and is automatically assigned by the program. No user intervention is required.
- Representative area, slope and length values for the subcatchments within a watershed are calculated.
- Selected algorithms have been streamlined and are faster.
- Code is available in ASCII format for user compilation and executable format for Windows 95/98.

- The TOPAZ programs that are included in TOPAZ Version 3.10 are DEDNM, RASPRO, RASFOR, RASBIN, NSSTAT and PARAM (For explanation see TOPAZ programs and organization).
- Overview and installation are manuals available. The user manual will be released in August-September 1999. Until that time, the user manual of TOPAZ Version 1.22 is provided as a guide for TOPAZ Version 3.10.

TOPAZ Version 1.22

- Release date: October 1997.
- This TOPAZ Version 1.22 is the final version that was written in the FORTRAN 77 software language.
- Array size definition in FOTRAN77 is static and must be explicitly defined in the code before program compilation. When large array sizes are desired the user may have to manually edit the code to increase the value of the array size parameter.
- The source code must be compiled by the user with a suitable FORTRAN77 compiler.
- The TOPAZ programs that are included in this TOPAZ version 1.22 are DEDNM, RASPRO, RASFOR, RASBIN and NSSTAT (For explanation see TOPAZ programs and organization).
- Overview, installation and user manuals are available.

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Software Availability

The source code of software TOPAZ and manuals are available free of charge upon written request. The request should include:

- your name
- mailing address
- phone with country code
- fax with country code
- e-mail
- we would appreciate a brief description of your intended application of TOPAZ

Send request to:

Dr. Jurgen Garbrecht
USDA-ARS Grazinglands Research Laboratory
7207 West Cheyenne St.
El Reno, Oklahoma 73036
Fax: (405) 262-0133
E-Mail: jurgen.garbrecht@ars.usda.gov

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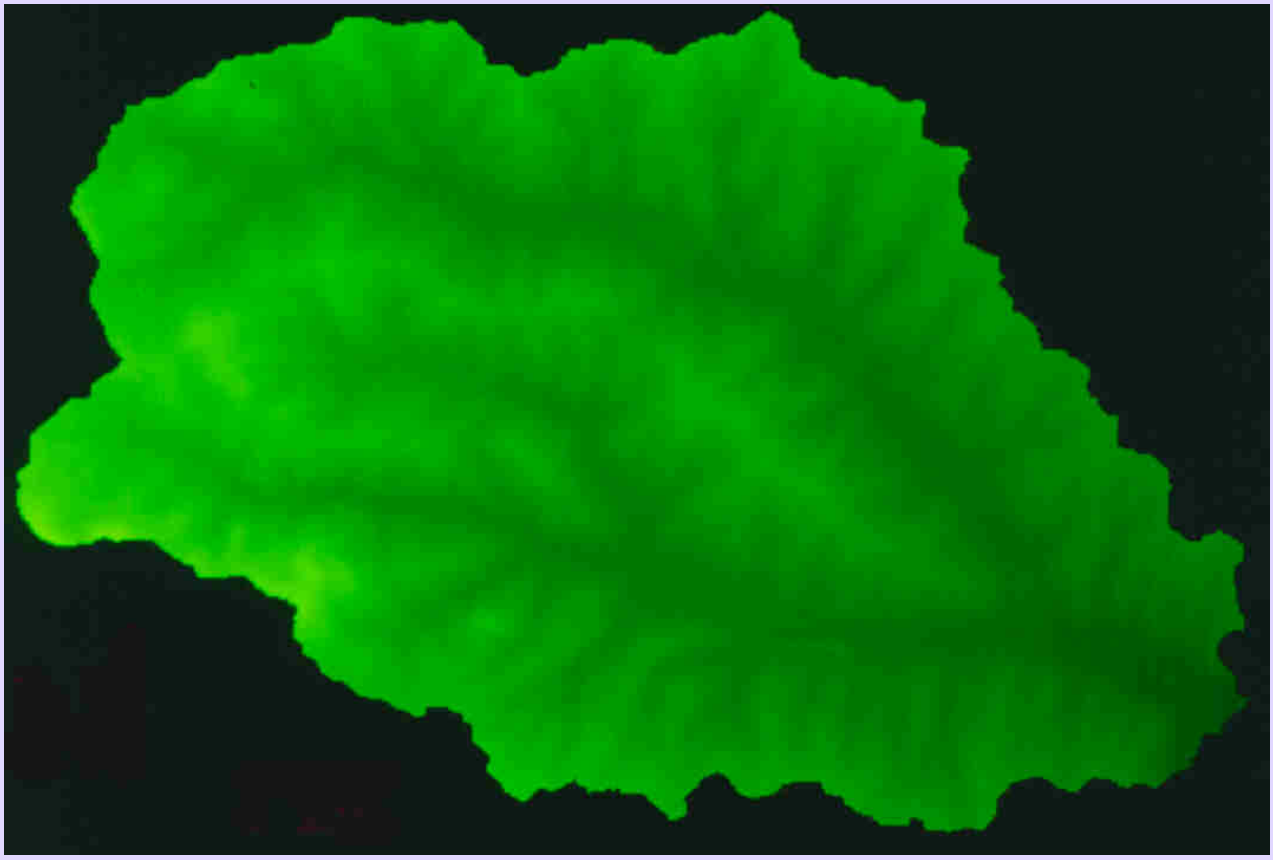
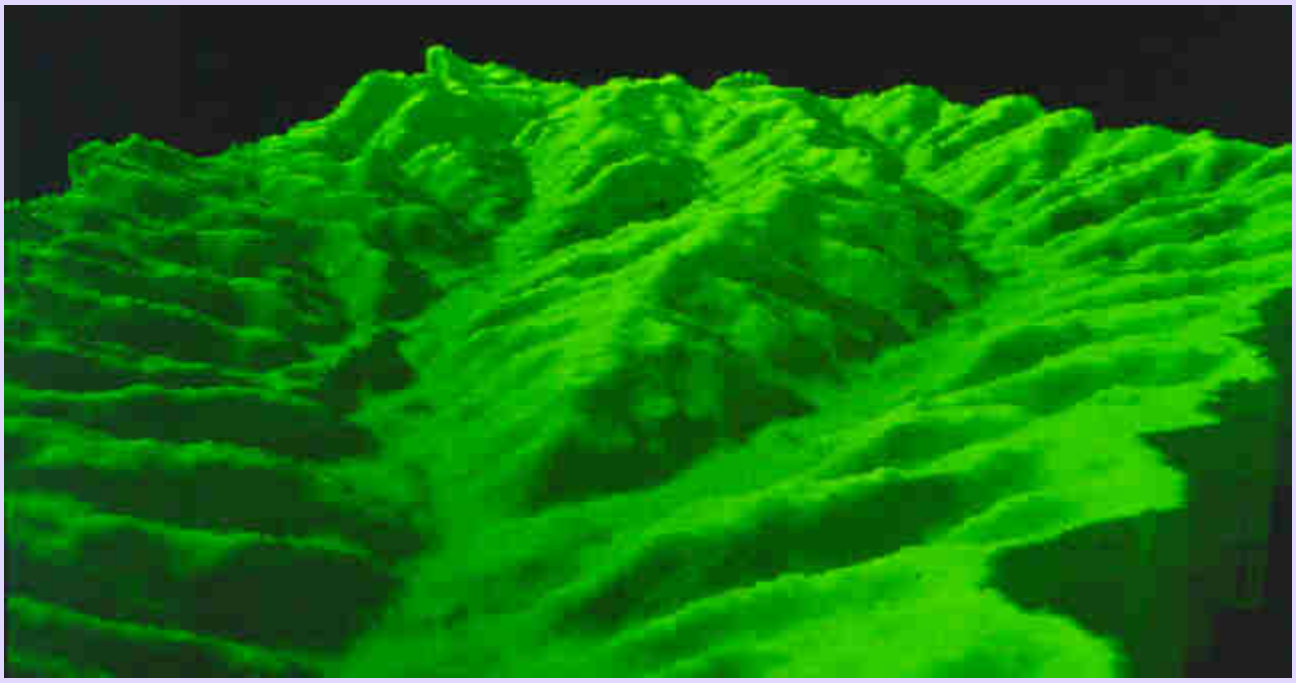
IMAGES

Digital Elevation Model



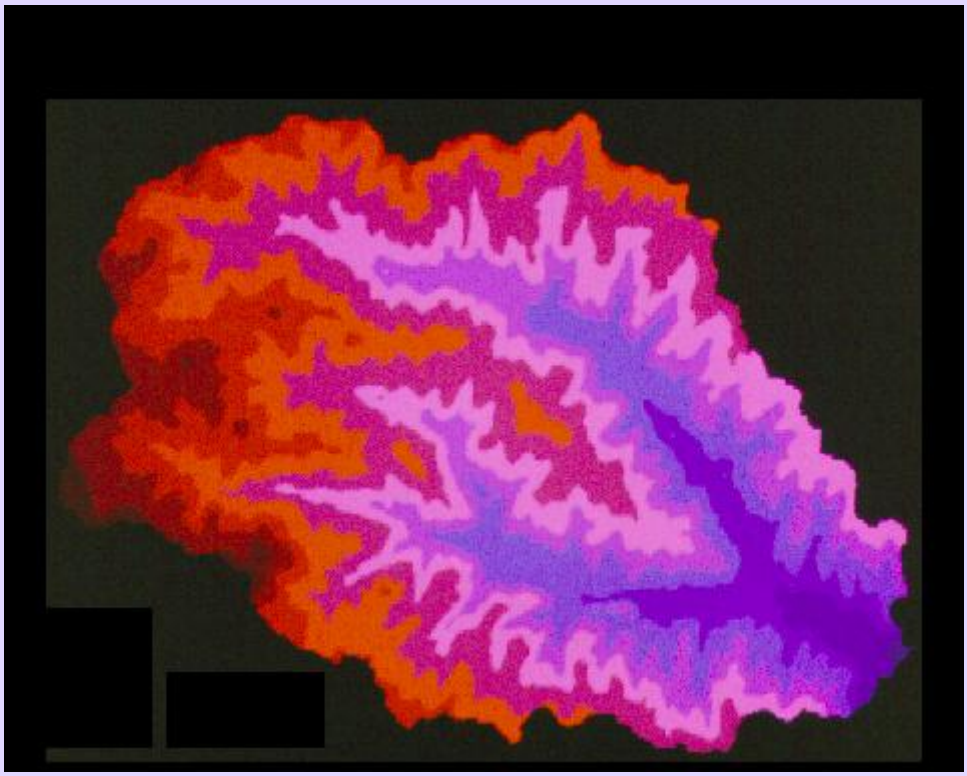
This image displays elevations of a Digital Elevation Model (DEM) within a given watershed boundaries. Dark green colors represent lower elevations and light green colors higher elevations. The image is generated from a standard USGS 30 meter DEM. DEMs are a basic input to TOPAZ. The image was created from information produced by TOPAZ.

3-D Image of Topography



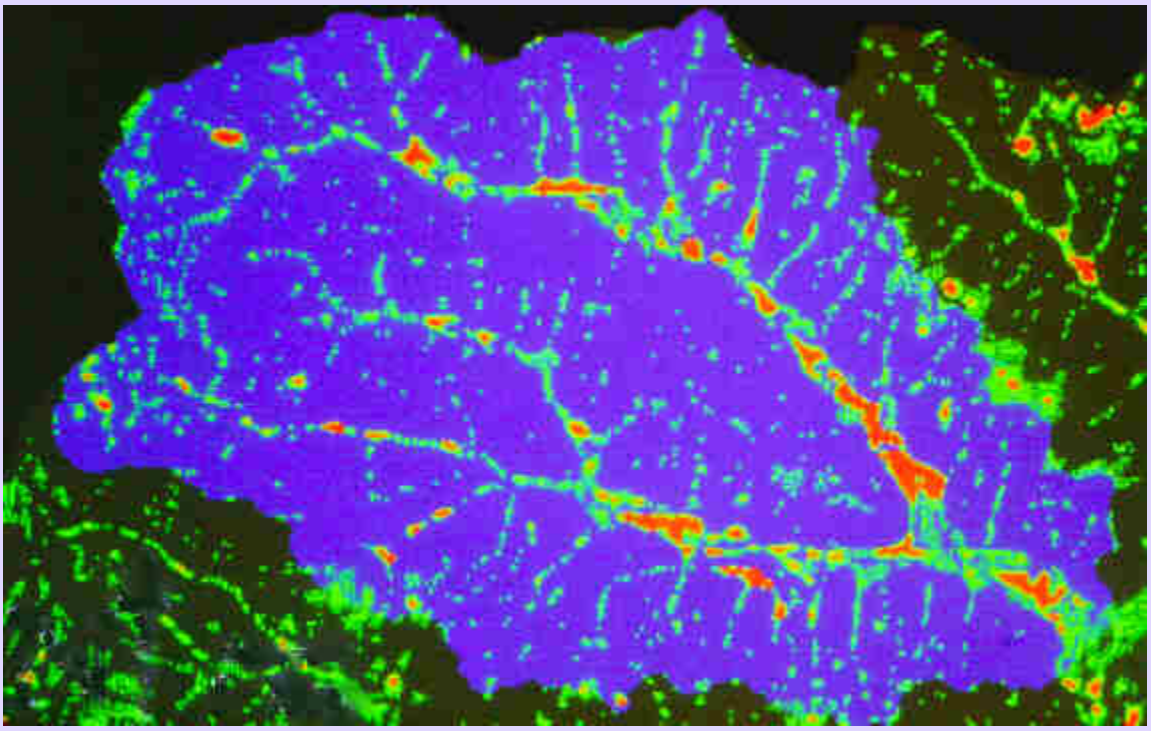
This is a 3 dimensional representation of the Digital Elevation Model of a watershed. The image was created from information produced by TOPAZ.

Reclassified Elevations



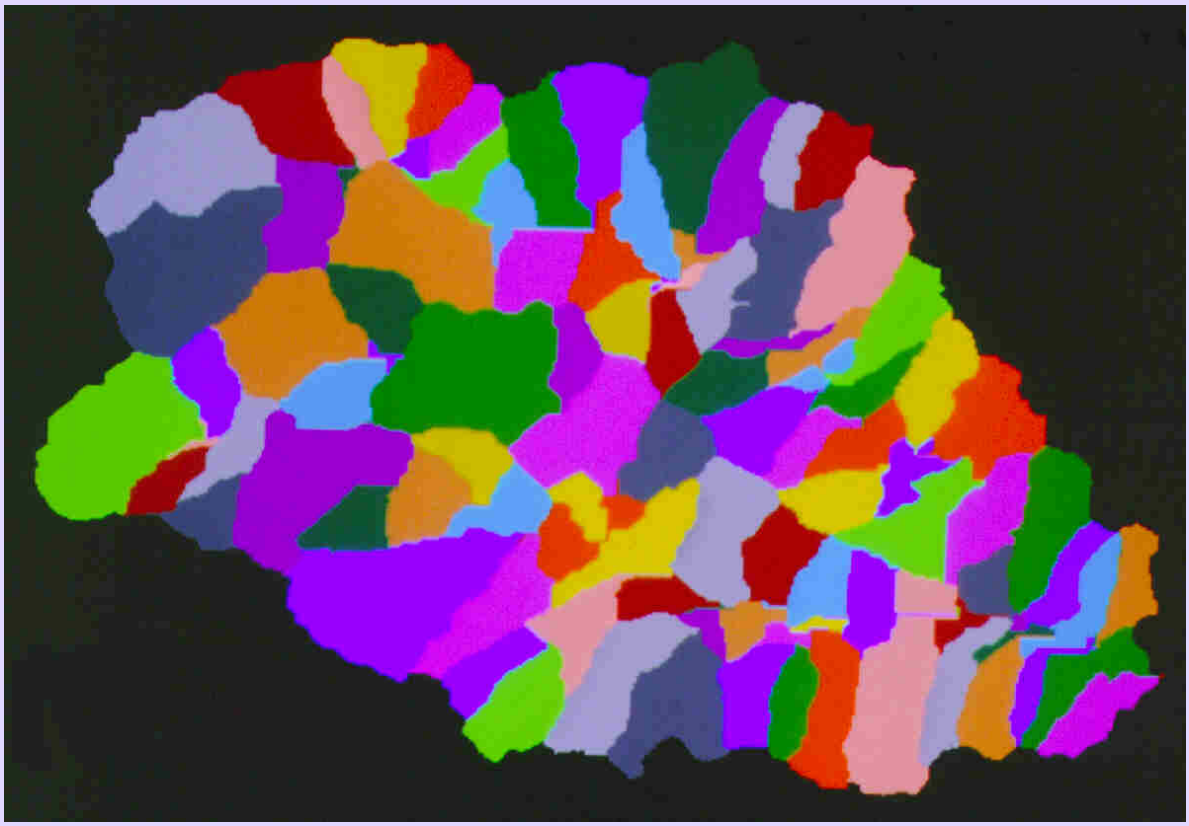
This image displays areas of elevations that fall within a user-specified range of elevation values. Blue colors represent lower and red colors higher elevations. The user can select any number of elevation classes to produce images that meet the needs of specific applications. The image is based on information produced by TOPAZ.

Filled Depressions and Flat Areas



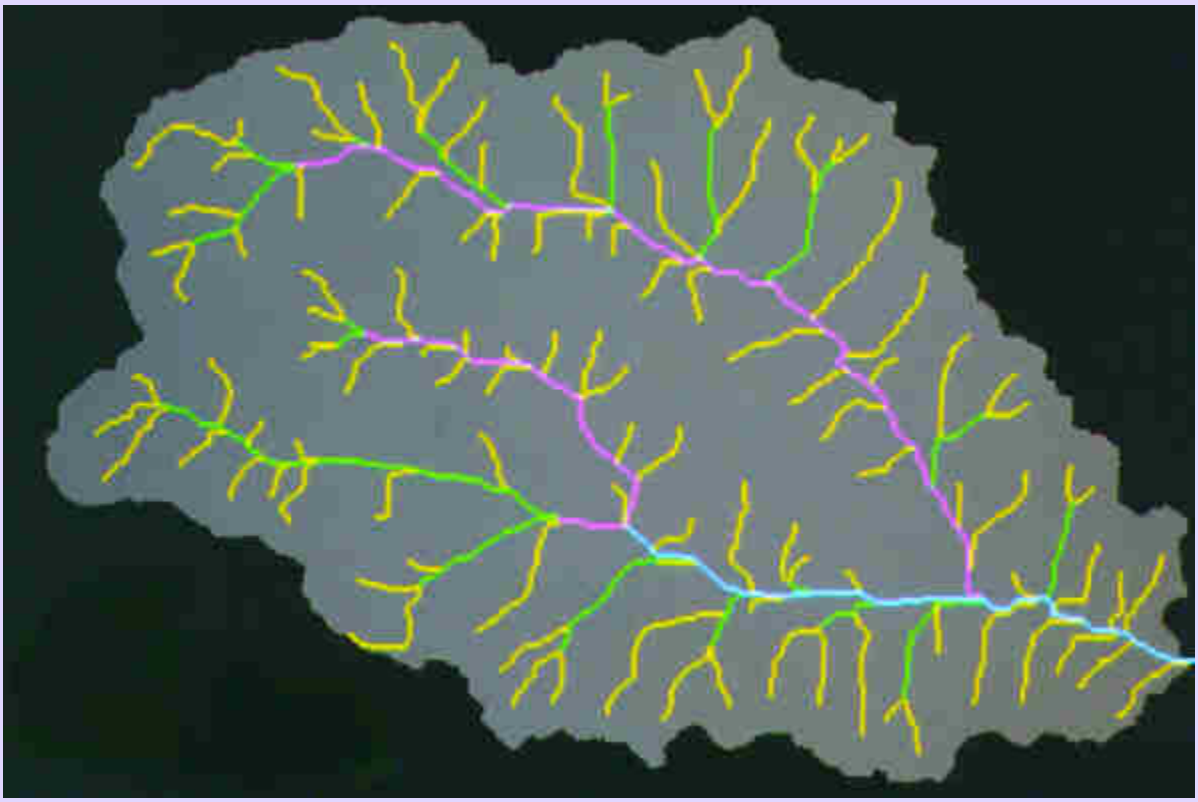
This image identifies areas in the DEM that correspond to depressions (red) or to flat areas (green). The blue color defines the watershed. The image was created from information produced by TOPAZ.

Subcatchment Areas



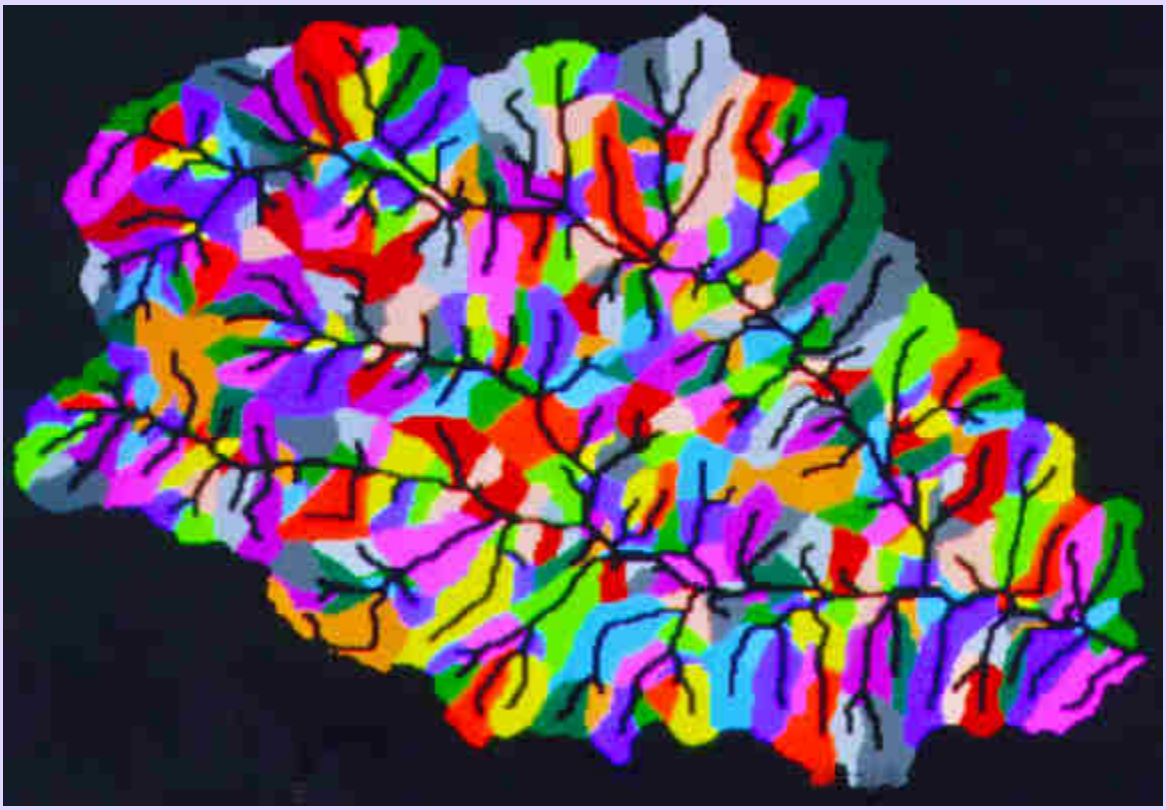
This image displays subcatchment areas. Each subcatchment area drains into a channel link. The image was created from information produced by TOPAZ.

Generated Drainage Network



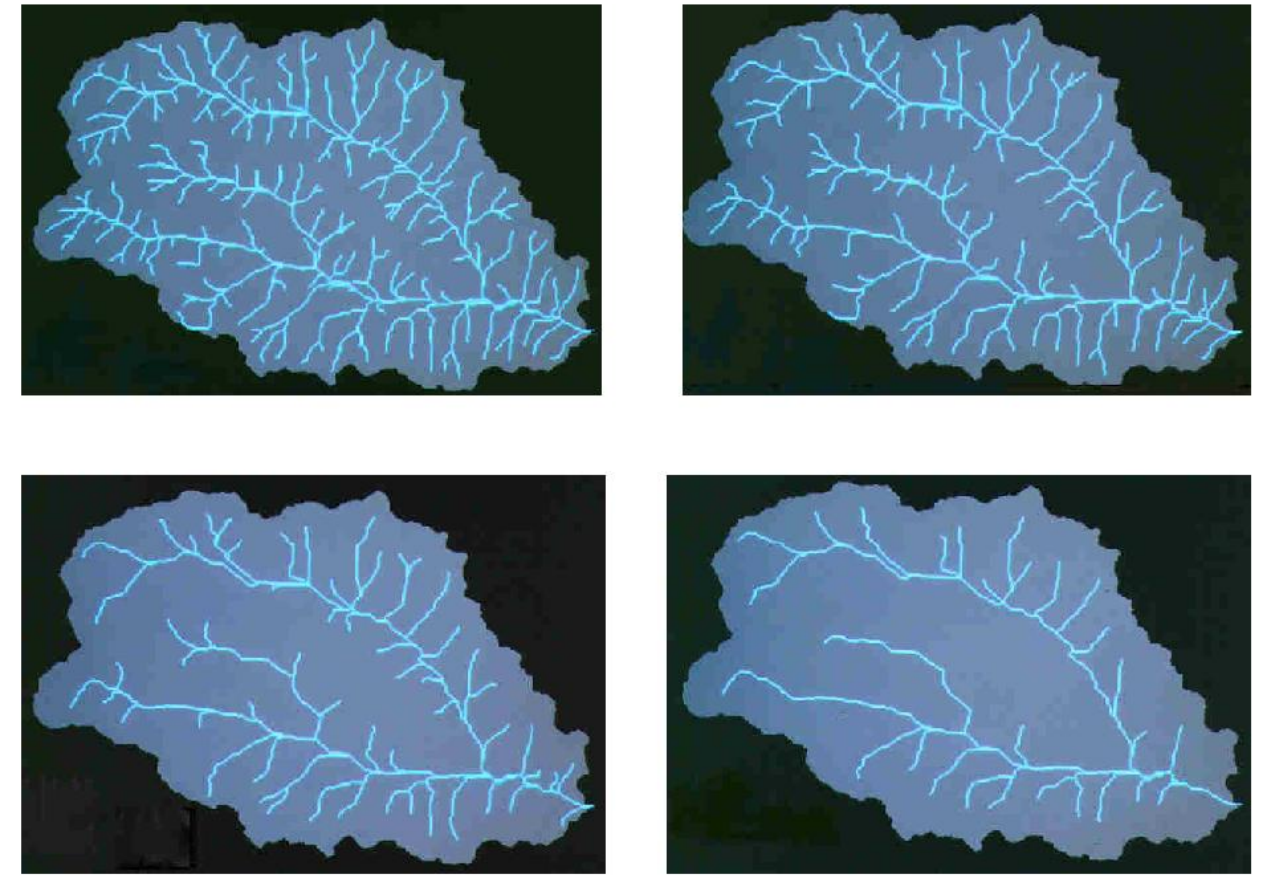
This is a display of the generated channel network within a watershed area. The different colors in the channel network represent the different Strahler orders of each channel link. The image was created from information produced by TOPAZ.

Enhanced Network and Catchment Areas



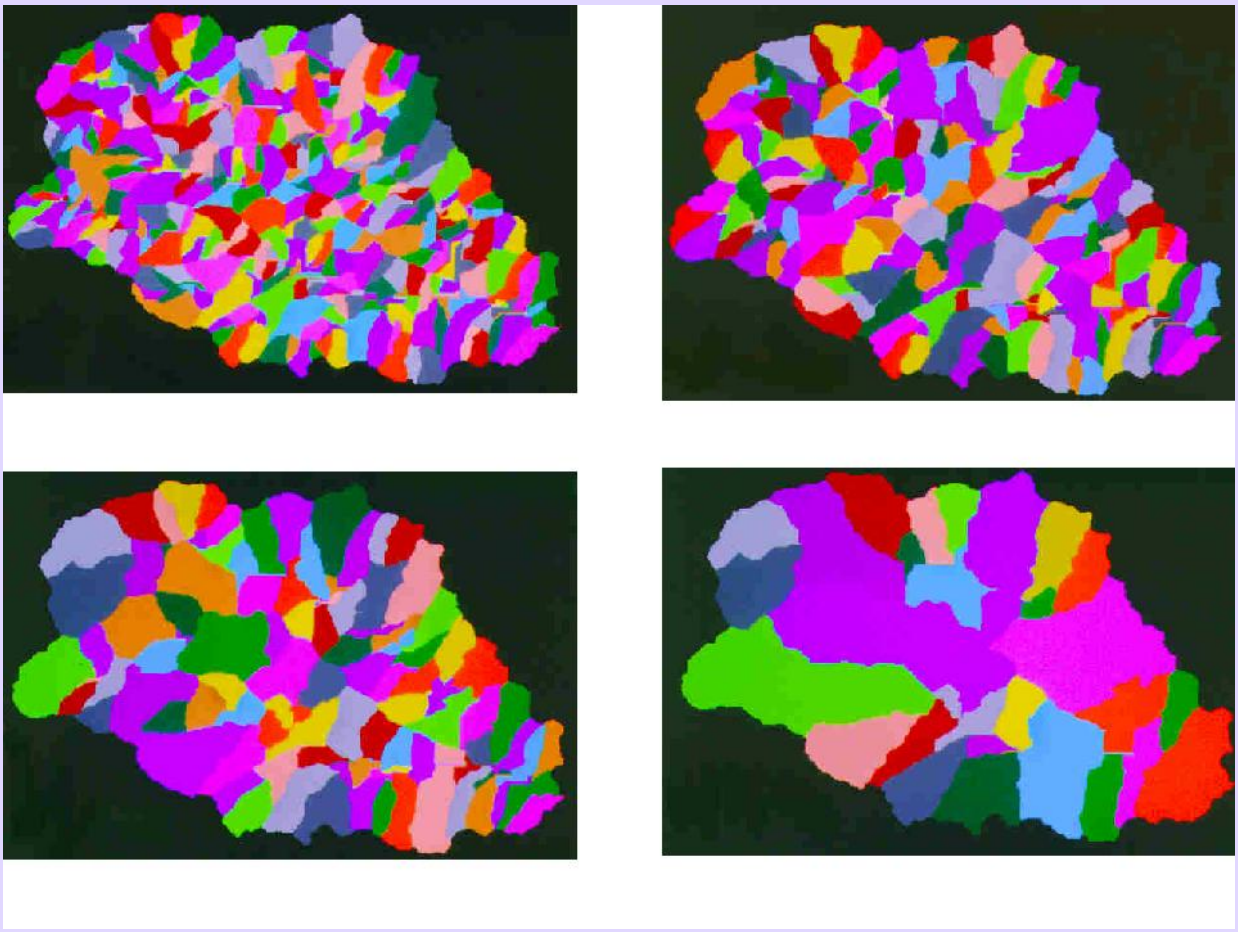
This image displays the enhanced network and catchment areas. The channel network has been enhanced (widened) for better visualization. The source, right and left subcatchment areas have been aggregated into one catchment area for each channel link. The image was created from information produced by TOPAZ.

Critical Source Area and Drainage Density



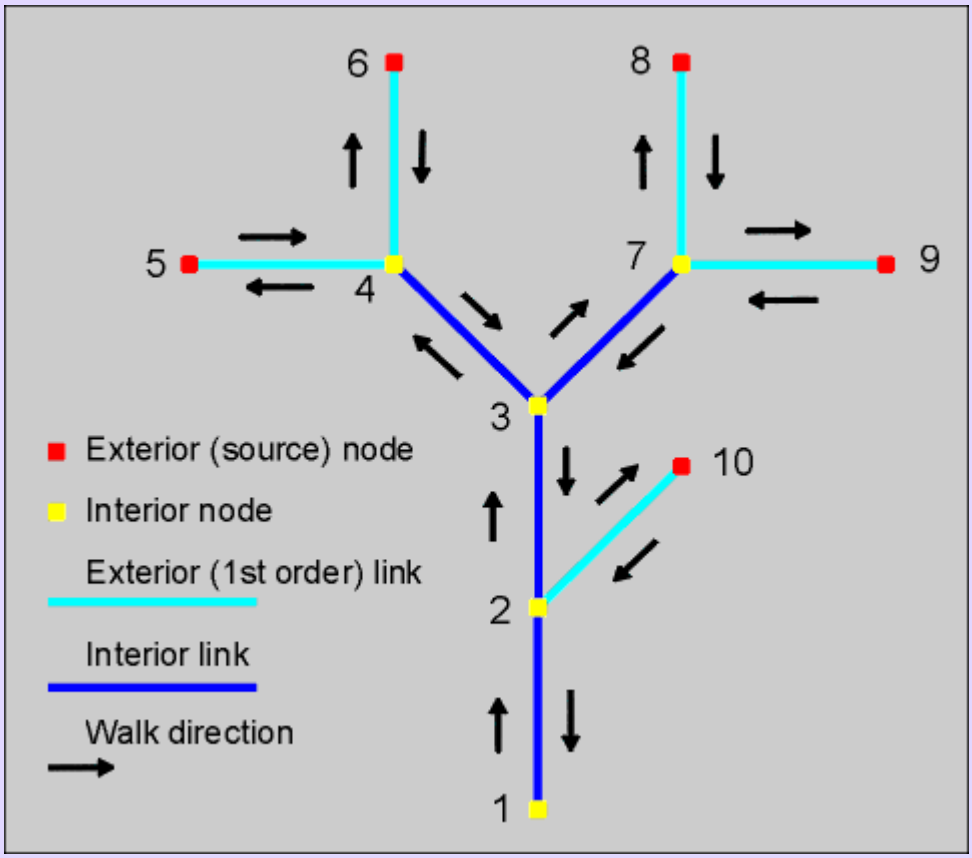
This image illustrates the difference in the drainage density of the generated network by changing the value of the Critical Source Area (CSA) from a smaller to a larger area value. The CSA parameter represents the threshold drainage area below which as channel is assumed to form. The image was created from information produced by TOPAZ.

Variable Resolution Subcatchment Areas



This image illustrates the difference in generated subcatchment resolution as a result of different values of the Critical Source Area (CSA). The CSA parameter represents the threshold drainage area below which as channel is assumed to form. Small CSA values produce small subcatchment areas, and large values produce large subcatchment areas. The image was created from information produced by TOPAZ.

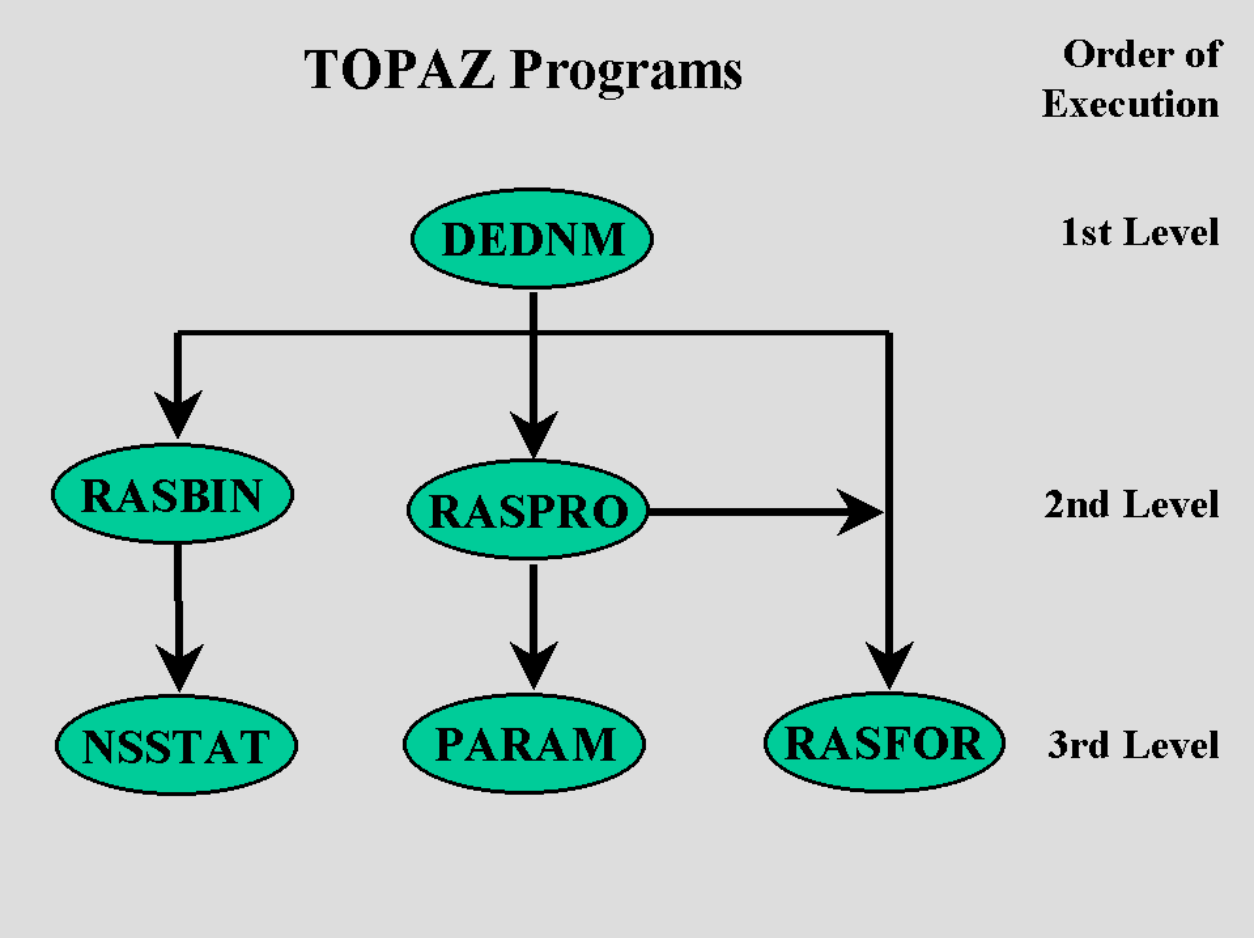
TOPAZ Node Numbering System



Node Number Assignment

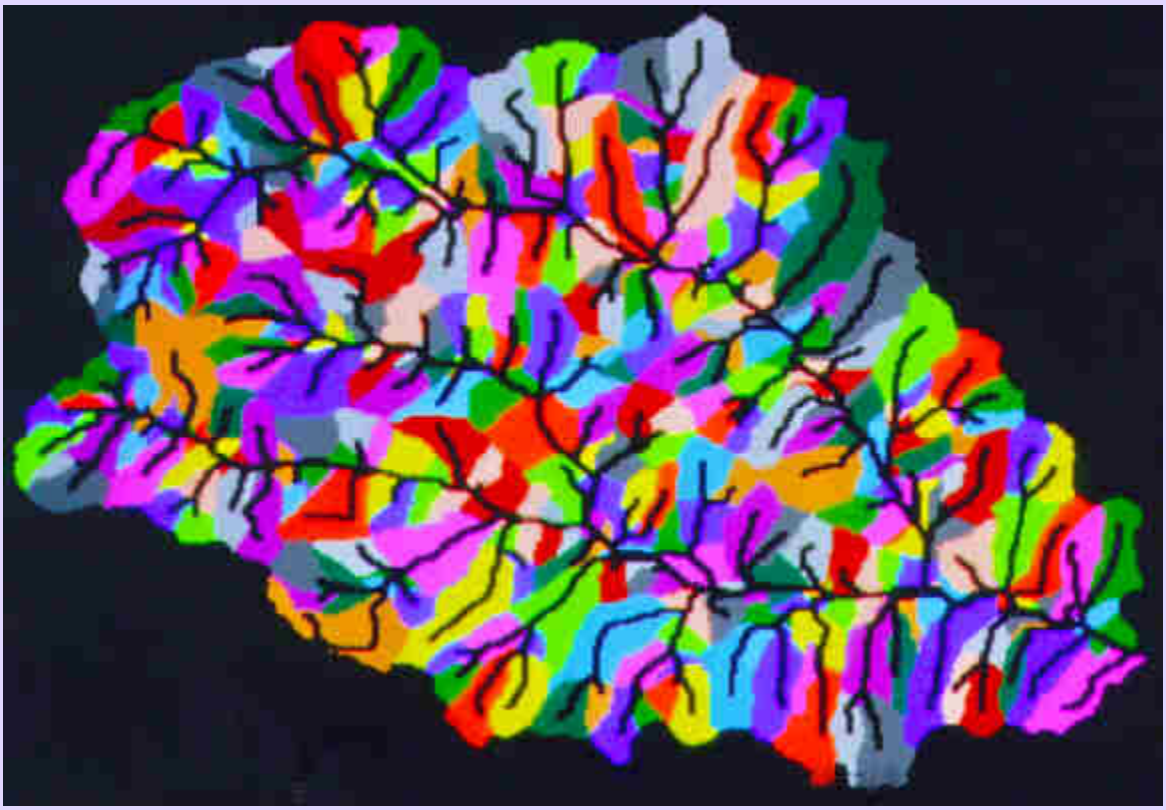
- walk through network in direction indicated by arrows
- assign node number in sequence first time each node encountered

Program Interdependence



The TOPAZ programs are interdependent because output of one program is used as input to another. This interdependence requires that the programs be executed in a pre-specified sequence. Level one programs are executed first. Level two programs require input from level one programs and can only be executed after level one programs have been executed. Level three programs are executed last. Program RASFOR is an exception. It does not necessarily require the input from program RASPRO. If the user needs raster data that has been produced by program RASPRO, then the latter program has to be executed before program RASFOR. Otherwise program RASFOR will process only the raster data produced by program DEDNM.

Enhanced Drainage Network



This is a display of the enhanced generated channel network within a watershed area overlaying aggregated subcatchment area. The network has been enhanced for display by a general widening applied to the entire network. The subcatcment areas have been aggregated from source, left and right areas into a single subcatchment area. The image was created from information produced by TOPAZ.

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