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ABSTRACT

This Open-File Report, which is one of three components of the compact disc, contains several geographic data sets of interest to water-resource managers of eastern Nevada. These data were used to develop a method for estimating the magnitude and distribution of ground-water evapotranspiration by phreatophyte shrubs, grasses, and associated bare soil in the Great Basin as a function of plant cover, based on Landsat-data-derived vegetation indexes. The data sets are divided geographically into 16 contiguous hydrographic areas (valleys) of eastern Nevada. Data include: phreatophyte and hydrographic-area boundaries, digital elevation models, and shaded relief of the elevation models. Other sets are derived from Landsat Thematic Mapper satellite data including three vegetation indexes and a color-infrared composite. The vegetation indexes for 1985 and 1989 are normalized-difference, weighted-difference, and modified soil-adjusted. Final data sets show the computed annual ground-water evapotranspiration in phreatophytic zones for 1985 and 1989.

The compact disc also includes data documentation, summary tables, photographs, a precipitation data set, and two journal articles related to the estimation of ground-water evapotranspiration. The ability to browse the contents of the disc with an

internet browser and the software to do limited geographic operations on the data sets also are incorporated in the disc.

INTRODUCTION

This Open-File Report, which is one of three components of the read-only memory compact disc (CD-ROM), contains a compilation of several geographic data sets of interest to water-resource managers of eastern Nevada. (The other two disc components are U.S. Geological Survey Professional Paper 1628 and Fact Sheet 073-00.) Evapotranspiration from phreatophyte shrubs and grasses and evaporation from associated bare soil are the principal mechanisms of ground-water discharge from valleys of the Great Basin (Nichols, 2000b). In 1988, the U.S. Geological Survey (USGS) began a series of field studies (Nichols, 1992, 1993, 2000a; Nichols and Rapp, 1996; Nichols and others, 2000) to measure ground-water evapotranspiration by typical Great Basin phreatophytes. These studies provided new data and a better understanding of ground-water evapotranspiration processes, from which new estimates of ground-water discharge by evapotranspiration could be made.

These data sets were used to develop a method for estimating the magnitude and distribution of ground-water evapotranspiration by phreatophyte shrubs and grasses in the Great Basin as a function of plant cover, based on Landsat-data-derived vegetation indexes (Nichols, 2000a). The boundaries of phreatophytic vegetation were determined from field work in 1995 and 1996 and from color-infrared Landsat Thematic Mapper (TM) data at 28.5-meter cell resolution. The vegetation indexes were used to determine the type and density of phreatophytes within the boundaries. The modified soil-adjusted vegetation index (Qi and others, 1994) was used for the final estimation of evapotranspiration. TM data acquired during June 1985 and June 1989, the time of year for maximum leaf area of phreatophytes and evapotranspiration (Nichols and others, 2000) were used to estimate annual ground-water evapotranspiration. Hydrographic-area[1] (HA) boundaries were used to summarize discharge by ground-water evapotranspiration for each of 16 contiguous valleys in eastern Nevada. To aid in the analysis of the information, digital-elevation-model (DEM) data at 90-meter cell resolution and shaded-relief images from the DEM were used. Also, a precipitation data set was used for further analysis. This data set was acquired from the Oregon Climate Service and the Parameter-elevation Regressions on Independent Slopes Model (PRISM) Services. A documentation file accompanies each data set indicating the source of the data, time frame with which it is associated, and other information.

The open-file data sets are divided into 16 HA's (valleys). The HA names and numbers are listed in table 1. The data sets are provided in a generic or public-domain binary-image format with ancillary American Standard Code for Information Interchange (ASCII) files. The basin and phreatophyte boundaries and precipitation contours are provided in Spatial Data Transfer Standard (SDTS) (U.S. Geological Survey, 1994) vector format.

Table 1. Hydrographic area (HA) name and number

HA Name	HA Number
Little Fish Lake Valley	150
Newark Valley	154
Little Smoky Valley	155
Hot Creek Valley	156
Railroad Valley	173
Jakes Valley	174
Long Valley	175
Ruby Valley	176
Clover Valley	177
Butte Valley	178
Steptoe Valley	179
Spring Valley	184
Tippett Valley	185
Antelope Valley	186
Goshute Valley	187
Independence Valley	188

Graphic images of the data sets and other photographs are provided in Graphics Interchange Format (GIF) files. GIF files are easily displayed on many computer systems using readily available software. These images provide a simplified view of the data sets available. The GIF files portray much less spatial resolution and information content than the actual data sets. Selected evapotranspiration-related photographs from the 16-valley study area also are provided.

Published journal articles (Nichols, 1993, 1994) and other tables are also in this report. The report by Nichols (2000a) for which these data where developed, as well as other reports that give background information on ground-water evapotranspiration, are provided in Adobe Acrobat(R) Portable Document Format or in Hypertext Markup Language (HTML). These reports include illustrations, data sets, tables, and interpretations.

An HTML interface and geographic-information-system (GIS) software are provided on the CD-ROM to readily browse and explore its contents. Internet browser software such as Netscape Navigator(R) or Microsoft Internet Explorer(R) is necessary to use the HTML interface capability. (Any use of trade names in this publication is for descriptive purposes only, and does not constitute endorsement by the U.S. Geological Survey). If internet access is available to the user, the interface allows the user to connect to several sites to gain other information. The Environmental Systems Research Institute (ESRI) ArcExplorer(R) software is provided to explore the spatial data files using a personal computer. This software allows users to access the generic format data, integrate other GIS data, and perform other geographic operations.

This Open-File Report was prepared by the U.S. Geological Survey in cooperation with the Las Vegas Valley Water District and the Nevada Division of Water Resources.

The authors acknowledge those who helped in the development of the data sets and this report. William D. Nichols of the USGS initiated most of the ground-water evapotranspiration studies that led to the development of this CD-ROM. He did or directed all the field mapping of phreatophyte areas for the 16-valley study area and was instrumental in verifying the satellite data sets. Alan H. Rea of the USGS was instrumental in the initial development and design components of the CD-ROM. Lisa A. Shevenell and Ron H. Hess of the Nevada Bureau of Mines and Geology, and Robert L. Baskin of the USGS, were technical reviewers of the final data sets, documentation, and the resulting open-file report.

DATA-SET DOCUMENTATION

A documentation file for each data set is in the fgdc directory, and is named with a file extension of .txt. The documentation files comply with the Content Standards for Digital Geospatial Metadata by the Federal Geographic Data Committee (FGDC) (1998). The FGDC-compliant metadata files are detailed descriptions of the data sets, and include a narrative section describing the procedures used to produce the data set in digital form. The FGDC-compliant metadata files are ASCII text files. An a_readme.txt file exists in other directories, providing an overview of the contents of the files or subdirectories in the directory. These files should be read before using the data sets.

FILE FORMATS

The data sets on this disc are stored in one of two generic or public-domain formats, depending on the type of data represented. Most raster (cell-based) data sets are stored as an image in byte (8-bit integer) format. The DEM is stored as an image in 16-bit integer format. Image information is described in header and other associated files, which are stored as ASCII files in Arc/INFO(R) format. The data sets of the phreatophyte and valley boundaries and precipitation contours are provided as vector data in SDTS format. These vector data sets are provided also in the ESRI(R) shapefile format.

Raster Format

The data sets are stored in a generic, binary-image raster file format with name extension .bsq. All data sets are single banded images with no header, or leading bytes, or trailing bytes. An associated header file with the extension .hdr provides image-structure information. An associated file with the extension .bqw provides georeferencing information of cell size and the Universal Transverse Mercator (UTM) projection (Snyder, 1987) coordinate of the upper left corner of each image file. Also included is a file with the extension .stx that provides statistical information in a space-delimited format showing channel number, minimum data value, maximum data value, mean data value, and standard deviation. For the basinph and cir85 data sets, an associated file with the extension .clr is provided, which is a color table. The .stx and .clr files are used by the Arc/INFO(R) software to enhance image display of the data sets.

Vector Format

The vector data-set files in this report are in SDTS format and Arc/INFO(R) shapefile formats. The SDTS format is designed for data interchange and allows for the simple creation of a vector polygon or line-data structure. The topological linkages are explicitly encoded for node, area, and line elements. Information about SDTS and software for SDTS is on the internet at the USGS site http://mcmcweb.er.usgs.gov/sdts/. The shapefile can be displayed by Arc/INFO(R) software.

ASCII-File Format

The ASCII files are fixed-record-length, fixed-field, plain-text files. Most fields are separated by at least one space. Fields not completely filled are padded with spaces. All ASCII files use MS-DOS record delimiters (carriage-return, line-feed). Conversion of record delimiters in these files may be necessary for operating systems other than MS-DOS.

DATA QUALITY STATEMENT

The TM data sets were compiled from many scenes and different dates. For 1 year of data, four individual scenes (approximately 185 by 185 kilometers each scene) were required to include all the hydrographic areas. Yet, the southern parts of Railroad and Hot Creek Valleys and an eastern edge of Spring Valley are not included. Most of the scenes had little or no cloud cover. Little or no restoration of the data was done. The quality of the source TM data was considered good. Atmospheric and radiometric corrections of the data were made; the results may differ when corrected using other techniques. Complete and thorough checking of the image data was not possible, though throughout the processing the data were checked for consistency and accuracy. Users should exercise caution and judgment in applying these data, and be aware that errors may be present in any or all of the digital data sets.

GEOMETRIC REGISTRATION

The UTM projection was used for the data sets. This projection is appropriate for satellite imagery (American Society of Photogrammetry, 1983, p. 901). The projection information is provided in table 2. The basin-and- phreatophyte data sets and the precipitation-contour data set are also in the UTM projection, zone 11.

Table 2. Universal Transverse Mercator map projection parameters and Geodetic Model parameters

UTM parameters	Geodetic Model parameters
UTM Zone Number: 11	Horizontal Datum Name: North American Datum of 1927
Scale Factor at Central Meridian: 0.9996	Ellipsoid Name: Clarke 1866
Longitude of Central Meridian: -117.0	Semi-major Axis: 6378206.4
Planer Distance Units: meters	Denominator of Flattening Ratio: 294.98

Image geometric correction for these data sets used ground control points (GCP's) and global polynomial models. The 1985 TM data was geocorrected using GCP's identified on the image and on 1:24,000-scale USGS topographic maps. About 30-40 GCP's were identified and digitized for each scene. First-order global polynomial models were used during model evaluation. Generally, 30-36 GCP's were retained to achieve subcell root-mean-square (RMS) error. RMS error in the X and Y directions was 15-25 meters. Some individual points had an RMS error of about 40 meters. Most GCP's were acquired on the valley floors. Greater error can exist in the surrounding mountainous areas. Once the 1985 data were geocorrected, they were used to make image-to-image correction of the 1989 TM scenes. In this process, points on the 1989 image were identified on the 1985 geocorrected image. Evenly distributed through the image, 36 GCP's were identified and used in the geometric correction. These models also produced RMS errors equivalent to the 1985 models.

The HA boundaries were created from 1:750,000-scale maps. The error inherent from the scale is at least 320 meters easting and northing. Errors derived from the quality of the original map or produced during the automation process also may affect the accuracy of this data. The maximum error is estimated at 508 meters.

The precipitation contours were acquired from the Oregon Climate Service. Accuracy of this data set is based on the original

specification of the Defense Mapping Agency 1 degree DEMs. The stated accuracy of the original DEM's is 130 meters circular error with 90 percent probability.

SOFTWARE

Users of this CD-ROM report may employ commercial software to browse the contents and the supplied software to explore the digital data sets. Internet browser software is necessary to use the browsing capability. The data sets can be accessed and limited GIS operations can be done with the software provided. The raster files are in a compressed and archived format. Software is provided to uncompress the files.

Browse

The capability to browse the contents of the Open-File Report is initiated by accessing the index.htm file in the ofr99-242 directory of the CD-ROM. From this home page, users can follow links to other home pages for all 16 hydrographic areas. Each HA home page shows overview images of all data sets that are available, as well as other information about the valleys. Other links from the index.htm file allow users to retrieve data-set documentation, summary tables of processing and results information, a comprehensive bibliography, two journal articles that are related to the estimation of ground-water evapotranspiration (Nichols, 1993, 1994), and a photograph gallery of evapotranspiration-related field images.

Some of the included links lead to several internet locations. Users must have internet access to retrieve these pages. These internet locations may change during the useful lifetime of this CD-ROM; therefore, users may have difficulty reaching external pages even with an internet connection.

ArcExplorer(R)

The data sets may be viewed with ArcExplorer(R) software Version 1.0.137, by Environmental Systems Research Institute, Inc., which is provided herein. ArcExplorer is built with 32-bit MapObjects(R) technology. Therefore, Microsoft Windows(R)95, Microsoft Windows(R)NT 4.0, or a later version must be installed to use ArcExplorer. Table 3 provides minimum and recommended system requirements for running ArcExplorer.

Table 3. System requirements for running ArcExplorer

System feature	Minimum requirements	Recommended requirements
RAM	8 MB[1]	16 MB or greater
CPU	486 DX 33	Pentium 60 or better
Video adapter	VGA	PCI video card
Free disk space	5 MB	10 MB

[1]12 MB minimum requirement for Windows(R) NT 4.0 version or later.

ArcExplorer requires at least 5 megabytes of free disk space to install. ArcExplorer must be installed using Windows(R)95 or Windows(R)NT systems. To install, use Run on the Start Bar or double click on aesetup.exe in the /ofr99-242/software/arc_expl directory. Follow the wizard through the installation.

Getting Started

Once installed, ArcExplorer is a stand-alone data explorer. If ArcExplorer is installed on your computer, go to the Start Bar, Programs, ESRI, and click on ArcExplorer. When ArcExplorer starts, a window with three parts will pop up. The top part of the window houses three bars that allow access to the functions of the software: menu bar, button bar, and tool bar. The menu bar provides basic operations such as save, open, copy, and help and also supports many of the buttons and tools. The button bar also provides basic functionality with buttons for save, open, close, add theme, and printing. The tool bar provides pan, zoom in and out, find, identify, and query capabilities. The second part of the window is the white map view window where data are displayed, explored, and queried. The third part of the window is the table of contents that lists all the themes loaded in the map view. This has two tabs labeled "Local" which supports themes locally, and "WWW" which supports themes on the World Wide Web.

Adding Data

Data are added to the map view as a theme. Click on the "Add theme" button, which looks like a plus sign on the button bar. Change to the drive on which the CD-ROM is installed. Change directories to /ofr99-242/data. Change directories to a /ha### and click on the image files or shapefiles, or both, to add. Image-format data cannot be queried, but can be viewed with the pan and zoom in-and-out tools and be overlaid with other data. When adding image files as themes, ArcExplorer will uncompress the data and ask where uncompressed data should be saved.

DATA COMPRESSION

All of the image-data sets are stored in a compressed, archived form. This form significantly reduces the size of the data files and organizes all the ancillary data files. The files are in the Info-ZIP(R) group's portable zipfile format. The ArcExplorer(R) software can uncompress (inflate) these files. Software is included herein that can copy software on many computer operating systems to uncompress the zipfiles. The software is in the subdirectory unzip-5.12 below the software directory. See the readme file in this directory for installation and other information. The file size will increase significantly when uncompressed. Table 4 shows the compressed and uncompressed file sizes of one Landsat TM data set for each hydrographic area. The elevation and shaded-relief data sets are much smaller because of the 90-meter cell size. If all data sets are uncompressed, the disc storage requirements would be approximately 0.950 gigabyte.

Table 4. Sizes of compressed and uncompressed files of a single Landsat data set for each hydrographic area. The compressed size can vary among individual data sets

Hydrographic-area name	Compressed size (bytes)	Uncompressed size (bytes)
Little Fish Lake	803,746	2,211,828
Newark Valley	1,347,973	4,203,047
Little Smoky Valley	1,797,833	6,488,548
Hot Creek Valley	1,214,211	5,912,382
Railroad Valley	3,358,677	13,251,844
Jakes Valley	852,881	4,375,092
Long Valley	1,022,404	4,617,904
Ruby Valley	1,799,292	6,564,159
Clover Valley	807,832	2,013,480
Butte Valley	1,579,156	5,598,450
Steptoe Valley	4,344,694	25,598,520
Spring Valley	2,945,806	9,712,923
Tippett Valley	514,242	1,514,920
Antelope Valley	566,998	2,105,724
Goshute Valley	1,409,464	6,369,792
Independence Valley	878,752	2,457,688

DISC ORGANIZATION

The disc on which this Open-File Report resides complies with the ISO 9660 standard for CD-ROM's. It is intended for use with personal computers using the MS-DOS operating system. The disc is compatible with UNIX, Macintosh, and other computers equipped with the appropriate CD-ROM reader and software. The overall layout of the report on this disc is as follows.

\ofr99-242		The Open-File Report (OFR) 99-242 directory
	\a_readme.txt	This file
	\index.htm	The startup HTML interface program

browse\	GIF images for browsing and for use with the HTML interface program. Below this directory are subdirectories of each HA and precipitation.
data\	Generic formats of the data layers. Below this directory are subdirectories of each HA and precipitation and another subdirectory of basinph.
fgdc\	Documentation files of the data layers
html\	HTML files used by the internet browser interface
photo\	Selected photographs in GIF format
report\	Previously published reports in subdirectories in HTML format, GIF images, and a bibliography file
software\	Programs for viewing and uncompressing the data. Below this directory are subdirectories for each software package.
table\	Selected tables for creating, processing, or describing the data sets

Subdirectories beneath the data and browse directories organize data sets by hydrographic area. The name of the directory is the assigned HA number, prefixed with the characters "ha". Table 1 shows the hydrographic name and number. A subdirectory precip also exists that contains state-wide precipitation contours for Nevada.

Each HA subdirectory contains compressed data files or browsing GIF files of individual data layers. The prefix name of the files and their content are listed in table 5. In each HA subdirectory under the data directory is a subdirectory basinph. In this directory are SDTS files of the basinph data set. Also stored in this directory is the basinph data set in ESRI(R) shapefile format.

Table 5. Description of individual data layers in each hydrographic area

Name	Description
elev	1:250,000 elevation data
shade	1:250,000 shaded relief of elevation data
cir85	Color-infrared Landsat Thematic Mapper image, August 1985
basinph	Hydrographic-area and phreatophyte boundaries as raster and vector (basph) formats
ndvi85	Normalized-difference vegetation index, June 1985
wdvi85	Weighted-difference vegetation index, June 1985
msavi85	Modified soil-adjusted vegetation index, June 1985
et85	Computed evapotranspiration rates for each cell in phreatophyte boundaries, June 1985
ndvi89	Normalized-difference vegetation index, June 1989
wdvi89	Weighted-difference vegetation index, June 1989
msavi89	Modified soil-adjusted vegetation index, June 1989
et89	Computed evapotranspiration rates for each cell in phreatophyte boundaries, June 1989

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Footnotes

[1] Formal hydrographic areas in Nevada were delineated systematically by the U.S. Geological Survey and Nevada Division of Water Resources in the late 1960's (Rush, 1968; Cardinalli and others, 1968) for scientific and administrative purposes. The official hydrographic-area names, numbers, and geographic boundaries continue to be used in Geological Survey scientific reports and Division of Water Resources administrative activities.

OFR 99-242 Home Page

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URL: file:///ofr99-242/html/a_readme.htm