SMEX04 Landsat TM/ETM+ NDVI and NDWI

The Normalized Difference Vegetation Index (NDVI) is widely used in a variety of biospheric and hydrologic studies, e.g. to estimate fractional vegetation cover and leaf area index etc. The Normalized Difference Water Index (NDWI) and NDVI are also very important factors in estimating vegetation water content, which is needed for soil moisture estimation using microwave methods.

NDVI standard products are readily available from several sources. These are generally based on data collected by the NOAA AVHRR instrument and NASA MODIS instrument. For AVHRR, there are a variety of products with varying temporal and spatial resolutions (http://www2.ncdc.noaa.gov:80/docs/gviug/). Ten day and longer interval products are generated in order to have cloud free coverage. Although the maximum resolution of the AVHRR products is 1 km, much of the archived data is at a coarser resolution (8 km). MODIS NDVI products are at 1 km and 500 m resolutions and sixteen days composite periods (http://tbrs.arizona.edu/projects/modis.htm).

As part of SMEX04, six Landsat Thematic Mapper (TM) scenes from Landsat 5 were acquired during the summer. These data were used to produce high-resolution (30 m) NDVI and NDWI data sets. These data sets should be used with the recognition that they represent a single point in time and the estimates were obtained during the SMEX04 or just before or after the experiment.

Citing These Data

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Overview Table

Category	Description
Data format 8-bit	Binary
Spatial coverage	32.7° N, 111.4° W to 29.3° N, 108.6° W
Temporal coverage	June 11 2004, July 29 2004, August 30 2004 with daily interpolations
File naming convention	NDVI_DOY.bin NDWI_DOY.bin

File size	109 MB per file, 16 GB
Parameter(s) NDVI	and NDWI
Procedures for obtaining data	Data are available via FTP.

Table of Contents

1. Contacts and Acknowledgments:

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The Data

Background

The TM images acquired are listed in the following table:

Landsat TM Coverage for SMEX04			
Date Landsat	No	Path	Row
June 11, 2004	5	35	38
July 29, 2004	5	35	38
August 30, 2004	5	35	38
June 11, 2004	5	35	39
July 29, 2004	5	35	39
August 30, 2004	5	35	39

The original TM images were level 1G products, and was not geo-registered and atmospherically corrected.

The data provided include the Walnut Gulch watershed for all scenes. There was no significant cloud cover; June 11, 2004 (<1%), July 29, 2004 (<5%), and August 30,2004 (<1%).

Surface reflectance calculation

Radiance from a satellite platform is strongly affected by the presence of the atmosphere. So, atmospheric correction is needed to convert satellite based radiance to an estimate of ground reflectance. The atmospheric correction for all channels was conducted using MODTRAN. As input data for the MODTRAN, sun photometer data obtained through the AERONET network (http://aeronet.gsfc.nasa.gov) and radiosonde data is obtained from (http://raob.fsl.noaa.gov/). Since the visibility is one of the major input of MODTRAN effecting the result significantly, it is obtained separately using the Second Simulation of the Satellite Signal in the Solar Spectrum (6S) code.

The sun photometer is designed to view the sun and sky at preprogrammed intervals for the retrieval of aerosol optical thickness, water vapor amounts, particle size distribution, aerosol scattering, phase function, and single scattering albedo. It measures the intensity of sunlight arriving directly from the Sun. Although some Sun photometers respond to a wide range of colors or wavelengths of sunlight, most include special filters that admit only a few narrow bands of wavelengths. These measurements are used for atmospherically correction of satellite imagery in all bands using the interpreted information about atmospheric aerosols.

If the area surrounding a target is assumed to be the same as the target and we assume the target is Lambertian and uniform, the reflectance at the target can be expressed conveniently as (Vermote, et al., 1997b; Vermote and Vermeulen,1999; Adler-Golden et al., 1999):

$$\rho = \frac{\pi(Lt - Lp)}{(Edir + Ediff)T + \pi S(Lt - Lp)}$$

where Lt is the satellite based radiance
S is the reflectance of the atmosphere
Lp is the atmospheric path radiance
Edir is the direct irradiance at the surface
Ediff is the diffuse irradiance at the surface
T is the total diffuse transmittance from the ground to the top of the atmosphere in the view direction of the satellite.

Even when these assumptions may not fully apply, the formula provides a useful normalization of the data and was used here to standardize the NDVI and NDWI indices.

NDVI and NDWI calculation

The NDVI and NDWI were computed for each pixel using the following equations (Gao, 1996):

$$NDVI = \frac{\rho(band4) - \rho(band3)}{\rho(band4) + \rho(band3)} \quad \text{and}$$

$$NDWI = \frac{\rho(band4) - \rho(band5)}{\rho(band4) + \rho(band5)}$$

Values of NDVI and NDWI are in the range between –1 and +1.

Specifications

The data product produced here was 8 bit binary or byte data. In order to maximize the dynamic range the following scaling was performed

NDVI = DN/255

NDWI = DN/255 - 0.5

The geographic descriptions of the data sets are as follows:

Specifications of the classified image for Arizona and Sonora		
Projection: Universal	Transverse Mercator Zone 12	
Earth Ellipsoid	WGS-84	
Upper Left Corner	462504 E	3617159 N
Upper Right Corner	728879 E	3617159 N
Lower Left Corner	462239 E	3246690 N
Lower Right Corner	728880 E	3246690 N
Pixel Size	30 E	30 N
Upper Left Corner	111.40281 W Lon	32.69150 N Lat
Upper Right Corner	108.55928 W Lon	32.66840 N Lat
Lower Left Corner	111.38899 W Lon	29.34876 N Lat
Lower Right Corner	108.64295 W Lon	29.32851 N Lat
Note	*Direct satellite data available for June 11, June 29 and August30,2004*	

The Files

File Name and Format Information

File names are NDVI_DOY.bin or NDWI_DOY.bin for the Arizona/Sonora region, where DOY is the Julian Day of Year.

The file type is binary, Nrows is 8889 and Ncols 12350. The files are listed as following:

File Date	
NDVI_163.bin	June 11, 2004
NDWI_163.bin	June 11, 2004
NDVI_211.bin	July 29, 2004
NDWI_211.bin July	29,2004
NDVI_243.bin August	30,2004
NDWI_243.bin August	30,2004

From these direct satellite images, daily scenes were generated by linearly interpolating each scene between the nearest available scenes.

Data Access and Contacts

Points of Contact

The principal investigator for the NDVI data set is:

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