Soil Reflectance Data (FIFE)

Summary:

Soil reflectance properties are an important factor in determining landscape reflectance characteristics. No soil reflectance data were collected as part of the FIFE experiment. Therefore, the FIS staff choose spectra from soils similar to those in the FIFE study area from the atlas of soil reflectance properties (Stoner et al., 1980). The atlas represents a wide range of soil types, and FIS staff choose spectra from soils similar to those in the FIFE study area. The selection of spectra was based on soil particle size, organic carbon content, taxonomic classification, and geography of soils found in the FIFE study area.

All measurements were made on uniformly moist, sieved soils, which were equilibrated for 24 hours at a one-tenth bar moisture tension. Soil reflectance was measured using an Exotech Model 20 C spectroradiometer adapted for indoor use with a reflectometer equipped with an artificial illumination source, transfer optics, and sample stage. Spectral readings were taken in 0.01 micrometer increments over the 0.52 to 2.32 micrometer wavelength range.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

Soil Reflectance Data (FIFE).
(Soil Reflectance Reference).

Data Set Introduction:

The Soil Reflectance Reference Data Set contains FIFE soil series, reference soil series, wavelength, and reflectance data from soils similar to those in the FIFE study area.

Objective/Purpose:

The FIFE Information System staff acquired soil spectral reflectance data from the published data of Stoner et al., 1980, for soils similar to the soils found at the FIFE study area.

Summary of Parameters:

FIFE soil series, reference soil series, wavelength, and reflectance.

Discussion:

Soil reflectance properties are an important factor in determining landscape reflectance characteristics. No soil reflectance data were collected as part of the FIFE experiment, so the FIFE Information System staff acquired reflectance spectra for soils from the atlas of soil reflectance properties (Stoner et al., 1980). The atlas represents a wide range of soil types, and FIS staff choose spectra from soils similar to those in the FIFE study area. The selection of spectra was based on soil particle size, organic carbon content, taxonomic classification, and geography of soils found in the FIFE study area.

Related Data Sets:

- Soil Properties Reference Information.
- Surface Reflectance Measured with a Mast-borne MMR.
- SE-590 Spectroradiometer Reflectance Factors from GSFC.

FIS Data Base Table Name:

SOIL_REFLECTANCE_REF.

2. Investigator(s):

Investigator(s) Name and Title:

Staff Science.

Title of Investigation:

Staff Science Ancillary Data Acquisition Program.

Contact Information:

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Requested Form of Acknowledgment.

The Soil Reflectance Reference data were obtained by the FIFE Information System staff from Stoner et al., 1980. The permission of Stoner et. al. to use these data is greatly appreciated.

3. Theory of Measurements:

FIS obtained soil spectral reflectance data from the "Atlas of soil reflectance properties" by Stoner et al. (1979). All measurements were made on uniformly moist, sieved soils, which were equilibrated for 24 hours at a one-tenth bar moisture tension. Specially constructed wire mesh holders held the soil in place through the stages of saturation, equilibration, and spectral reading. Soil reflectance was measured using an Exotech Model 20 C spectroradiometer adapted for indoor use with a reflectometer equipped with an artificial illumination source, transfer optics, and sample stage. The sensing head of the spectroradiometer was mounted in a vertical position approximately 2.4 m above the sample stage. The ¾ degree field of view of the spectroradiometer detected a sample area of about 3.2 cm in diameter. Spectral readings were taken in 0.01 micrometer increments over the 0.52 to 2.32 micrometer wavelength range. The illumination source was a 1000-watt tungsten iodine coiled filament lamp with a paraboloidal mirror to produce a collimated beam. Incident irradiation was about 6 degrees off vertical.

4. Equipment:

Sensor/Instrument Description:

Soil reflectance was measured using an Exotech Model 20C spectroradiometer adapted for indoor use with a reflectometer equipped with an artificial illumination source, transfer optics, and sample stage.

Collection Environment:

Ground-based.

Source/Platform:

Ground.

Source/Platform Mission Objectives:

To provide laboratory measured soil reflectance measurements.

Key Variables:

Spectral reflectance, wavelength, soil series.

Principles of Operation:

The sensing head of the spectroradiometer is mounted in a vertical fixed position approximately 2.4 m above the sample stage. Spectral readings were taken in 0.01 micrometer increments over the 0.52 to 2.32 micrometer wavelength range. The illumination source is a 1000-watt tungsten iodine coiled filament lamp, which transfers a highly collimated beam by means of a paraboloidal mirror to the sample-viewing plane.

Sensor/Instrument Measurement Geometry:

Specially constructed 10 cm diameter by 2 cm rings with 60 mesh wire bottoms held the soil in place through the stages of saturation, equilibration, and spectral reading. Incident irradiation is about 6 degrees off vertical. The ¾ degree field-of-view mode of the spectroradiometer is used to detect a sample area of about 3.2 cm diameter.

Manufacturer of Sensor/Instrument:

Not available at this revision.

Calibration:

Specifications:

Pressed barium sulfate was used as a calibration standard.

Tolerance:

Not applicable.

Frequency of Calibration:

Measurements were taken after every fifth soil sample to account for possible changes in the intensity of the illumination source.

Other Calibration Information:

The repeatable quantitative nature of the reflectance measurements using this procedure was evident from spectral curves of check samples measured on each of the 10 days needed to run all the samples.

5. Data Acquisition Methods:

FIS obtained these data from the "Atlas of soil reflectance properties" by Stoner et al. (1979). Stoner et al. used a sieved soil fraction less than 2 mm in diameter for reflectance measurements. All measurements were made on uniformly moist soils which were equilibrated for 24 hours at a one-tenth bar moisture tension on asbestos tension tables. Two separate soil samples were collected for each soil series, one at a site near the type location for the current official series, and another at a site from 1 to 20 miles distant from the first site in a different mapping delineation of the same series. The mean of these two values are reported by FIS.

6. Observations:

Data Notes:

Not available.

Field Notes:

None.

7. Data Description:

Spatial Characteristics:

The FIFE study area with areal extent of 15 km by 15 km, is located south of the Tuttle Reservoir and Kansas River, and about 10 km from Manhattan, Kansas, USA. The northwest corner of the area has UTM coordinates of 4,334,000 Northing and 705,000 Easting in UTM zone 14.

The physical location where the soil samples were collected is not relevant. The type of soil series is relevant.

Spatial Coverage:

Five different soil series are represented in this data set.

FIFE soil series name	Atlas soil series name
BENFIELD	LANCASTER
CLIME	LANCASTER
DWIGHT	FOARD

FLORENCE HASTINGS
TULLY IRWIN

Spatial Coverage Map:

Not available.

Spatial Resolution:

These were point data.

Projection:

Not available.

Grid Description:

Not available.

Temporal Characteristics:

Temporal Coverage:

Spectral measurements were made in 1979 on soil samples that were collected earlier.

Temporal Coverage Map:

Not available.

Temporal Resolution:

Not applicable.

Data Characteristics:

The SQL definition for the table found in the SOILREFL.TDF file located on FIFE CD-ROM Volume 1.

Parameter/Variable Name

Parameter/Variable Description **Range** **Units** **Source**

FIFE_SOIL_SERIES The soil series names of soils found at the FIFE site. UNIVERSITY	min = BENFIELD, max = TULLY		PURDUE
REF_SOIL_SERIES The soil series names of soils comparable to FIFE soils that are found the Atlas of Soil Reflectance Properties by Stoner, E.R., Baumgardner, M.F., Biehl, L.L., and Robinson, B.F. UNIVERSITY	min = FOARD, max = LANCASTER		PURDUE
WAVLEN The wavelength at which the observation was made. RADIOMETER	min = .45, max = 2.34	[microns]	EXOTECH
REFLECTANCE The spectral reflectance. max = 23.96	min = -1, RADIOMETER	[percent]	EXOTECH

Sample Data Record:

FIFE_SOIL_SERIES	REF_SOIL_SERIES	WAVLEN	REFLECTANCE
TULLY	IRWIN	2.280	13.500
TULLY	IRWIN	2.290	13.380
TULLY	IRWIN	2.300	12.470
TULLY	IRWIN	2.310	12.830

8. Data Organization:

Data Granularity:

This data set contains point data representing five different soil series.

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary.

Data Format:

The CD-ROM file format consists of numerical and character fields of varying length separated by commas. The character fields are enclosed with a single apostrophe. There are no spaces between the fields. Each file begins with five header records. Header records contain the

following information: Record 1 Name of this file, its table name, number of records in this file, path and name of the document that describes the data in this file, and name of principal investigator for these data. Record 2 Path and filename of the previous data set, and path and filename of the next data set. (Path and filenames for files that contain another set of data taken at the same site on the same day.) Record 3 Path and filename of the previous site, and path and filename of the next site. (Path and filenames for files of the same data set taken on the same day for the previous and next sites (sequentially numbered by SITEGRID_ID)). Record 4 Path and filename of the previous date, and path and filename of the next date. (Path and filenames for files of the same data set taken at the same site for the previous and next date.) Record 5 Column names for the data within the file, delimited by commas. Record 6 Data records begin.

Each field represents one of the attributes listed in the chart in the *Data Characteristics Section* and described in detail in the TDF file. These fields are in the same order as in the chart.

9. Data Manipulations:

Not applicable.

10. Errors:

Sources of Error:

Not available at this revision.

Quality Assessment:

Data Validation by Source:

Not available at this revision.

Confidence Level/Accuracy Judgment:

Not available at this revision.

Measurement Error for Parameters:

Not available at this revision.

Additional Quality Assessments:

Not available at this revision.

Data Verification by Data Center:

The data verification performed by the ORNL DAAC deals with the quality of the data format, media, and readability. The ORNL DAAC does not make an assessment of the quality of the data itself except during the course of performing other QA procedures as described below.

The FIFE data were transferred to the ORNL DAAC via CD-ROM. These CD-ROMs are distributed by the ORNL DAAC unmodified as a set or in individual volumes, as requested. In addition, the DAAC has incorporated each of the 98 FIFE tabular datasets from the CD-ROMs into its online data holdings. Incorporation of these data involved the following steps:

- Copying the entire FIFE Volume 1, maintaining the directory structure on the CD-ROM;
- Using data files, documentation, and SQL code provided on the CD-ROM to create a database in Statistical Analysis System (SAS); and
- Creating transfer files to transfer the SAS metadata database to Sybase tables.

Each distinct type of data (i.e. "data set" on the CD-ROM), is accompanied by a documentation file (i.e., .doc file) and a data format/structure definition file (i.e., .tdf file). The data format files on the CD-ROM are Oracle SQL commands (e.g., "create table") that can be used to set up a relational database table structure. This file provides column/variable names, character/numeric type, length, and format, and labels/comments. These SQL commands were converted to SAS code and were used to create SAS data sets and subsequently to input data files directly from the CD-ROM into a SAS dataset. During this process, file names and directory paths were captured and metadata was extracted to the extent possible electronically. No files were found to be corrupted or unreadable during the conversion process.

Additional Quality Assurance procedures were performed as follows:

- Statistical operations were performed to calculate minimum and maximum values for all numeric fields and to create a listing of all values of the character fields. During this process, it was determined that various conventions were used to represent missing values. (Note: no modifications were made to any data by the DAAC). In most cases, missing value identification conventions were discussed in the accompanying .doc file. Based on a visual check of the minimum and maximum values, no glaring errors or holes were identified that might indicate errors introduced during CD-ROM mastering by the FIFE project or data ingest by the DAAC.
- Some minor inconsistencies and typographical errors were identified in some of the character fields and column labels, however, no modifications were made to the data by the DAAC.
- Some conversions of ASCII data were necessary to move the data from a DOS platform to a UNIX platform. Standard operating system conversion utilities were used (e.g., dos2unix).
- Much of the metadata required for archival is imbedded in the narrative documentation accompanying the data sets and extracted manually by DAAC staff who have read the .doc files provided on the CD-ROM and have hand entered this information into the metadata database maintained by the DAAC. QA procedures have been performed on these metadata to identify and eliminate typographical errors and inconsistencies in

naming conventions, to ensure that all required metadata is present, and to ensure the accuracy of file names and paths for retrieval.
- Data requested for distribution to users are checked to verify that files copied from disk to other media remain uncorrupted.

As errors are discovered in the online tabular data by investigators, users, or DAAC staff, corrections are made in cooperation with the principal investigators. These corrections are then distributed to users. CD-ROM data are corrected when re-mastering occurs for replenishment of CD-ROM stock.

11. Notes:

Limitations of the Data:

Not available.

Known Problems with the Data:

None.

Usage Guidance:

These spectral reflectances represent laboratory measurements of sieved soils at a uniform moisture. Variations in soil moisture and structure may alter the observed reflectance in the field. Also, the soils reported in this data set were not collected at the FIFE study area and are of similar, but not identical soils.

Any Other Relevant Information about the Study:

Prediction models indicate that site characteristics such as climate, parent material, and drainage are important variables along with organic matter, moisture content, texture, and iron oxide content in explaining reflectance differences among soils. Regression equations using reflectance data in ten wavelength bands as the independent variables showed high predictive values for organic matter content, moisture content, content of specific particle size classes, iron oxide content, and caution exchange capacity when inferences are drawn among soils from specific climatic zones.

12. Application of the Data Set:

This data set can be used to help determine landscape reflectance characteristics.

13. Future Modifications and Plans:

The FIFE field campaigns were held in 1987 and 1989 and there are no plans for new data collection. Field work continues near the FIFE site at the Long-Term Ecological Research (LTER) Network Konza research site (i.e., LTER continues to monitor the site). The FIFE investigators are continuing to analyze and model the data from the field campaigns to produce new data products.

14. Software:

Software to access the data set is available on the all volumes of the FIFE CD-ROM set. For a detailed description of the available software see the *Software Description Document*.

15. Data Access:

Contact Information:

ORNL DAAC User Services
Oak Ridge National Laboratory

Telephone: (865) 241-3952
FAX: (865) 574-4665

Email: ornldaac@ornl.gov

Data Center Identification:

ORNL Distributed Active Archive Center
Oak Ridge National Laboratory
USA

Telephone: (865) 241-3952
FAX: (865) 574-4665

Email: ornldaac@ornl.gov

Procedures for Obtaining Data:

Users may place requests by telephone, electronic mail, or FAX. Data is also available via the World Wide Web at http://daac.ornl.gov.

Data Center Status/Plans:

FIFE data are available from the ORNL DAAC. Please contact the ORNL DAAC User Services Office for the most current information about these data.

16. Output Products and Availability:

The Soil Reflectance Reference data are available on FIFE prototype CD-ROM and FIFE CD-ROM Volume 1. The CD-ROM filename is as follows:

\DATA\SUR_REFL\SOILREFL\aaaaFIFE.SRR

Note: capital letters indicate fixed values that appear on the CD-ROM exactly as shown here, lower case indicates characters (values) that change for each path and file.

The format used for the filenames is: *aaaaFIFE.sfx*, where *aaaa* is one of the five types of soil series found within the FIFE study area (i.e., BENF, CLIM, DWIG, FLOR, or TULL). The filename extension (*.sfx*), identifies the data set content for the file (see the *Data Characteristics Section*) and is equal to .SRR for this data set.

17. References:

Satellite/Instrument/Data Processing Documentation.

Stoner, E.R., M.F. Baumgardner, L.L. Biehl, and B.F. Robinson. 1980. Atlas of soil reflectance properties. Res. Bull. 962. Agric. Exp. Stn. Purdue University, Indiana.

Journal Articles and Study Reports.

Bauer, M.E., L.L. Biehl, C.S.J. Daughtry, B.F. Robinson, and E.R. Stoner. 1978. Final Report: Agricultural scene understanding and supporting field research. LARS Contract Report no. 112879. Purdue Univ. West Lafayette, IN.

Baumgardner, M.F., E.R. Stoner, L.F. Silva, and L.L. Biehl. 1985. Reflectance properties of soils. In: N. Brady (ed). Adv. Agron. 38:1- 44.

Obukhov, A.I., and D.S. Orlov. 1964. Spectral reflectivity of major soil groups and the possibility of using diffuse reflection in soil investigation. Sov. Soil Sci. 2:174-184.

Silva, L.F., R.M. Hoffer, and J.E. Cipra. 1971. Extended wavelength field spectroradiometer. 7 th Proc. Int. Symp. on Remote Sens. Environ. Ann Arbor, Michigan.

Soil Survey Staff. 1972. List of benchmark soils in the United States and Caribbean Area. Soil Conservation Service. U.S. Dept. of Agric. National Soils Handbook Notice 19. Washington, DC.

Soil Survey Staff. 1975. Soil taxonomy - a basic system of soil classification for making and interpreting soil survey. Soil Conservation Service. U.S. Dept. of Agric. Agriculture Handbook No. 436. U.S. Govt. Print. Office. Washington, DC.

Stoner, E.R., and M.F. Baumgardner. 1980. Physicochemical, site, and bi-directional reflectance factor characteristics of uniformly moist soils. LARS Technical Report 111679. Purdue Univ. West Lafayette, IN.

Stoner, E.R., and M.F. Baumgardner. 1981. Characteristic variations in reflectance from surface soils. Soil Sci. Soc. Am. J. 45:1161-1165.

Archive/DBMS Usage Documentation.

Contact the EOS Distributed Active Archive Center (DAAC) at Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee (see the *Data Center Identification Section*). Documentation about using the archive and/or online access to the data at the ORNL DAAC is not available at this revision.

18. Glossary of Terms:

A general glossary for the DAAC is located at Glossary.

19. List of Acronyms:

CD-ROM Compact Disk (optical), Read-Only Memory DAAC Distributed Active Archive Center EOSDIS Earth Observing System Data and Information System FIFE First ISLSCP Field Experiment FIS FIFE Information System ISLSCP International Satellite Land Surface Climatology Project ORNL Oak Ridge National Laboratory URL Uniform Resource Locator UTM Universal Transverse Mercator

A general list of acronyms for the DAAC is available at Acronyms.

20. Document Information:

May 6, 1994 (citation revised on October 16, 2002).

Warning: This document has not been checked for technical or editorial accuracy by the FIFE Information Scientist. There may be inconsistencies with other documents, technical or editorial errors that were inadvertently introduced when the document was compiled or references to preliminary data that were not included on the final CD-ROM.

Previous versions of this document have been reviewed by the Principal Investigator, the person who transmitted the data to FIS, a FIS staff member, or a FIFE scientist generally familiar with the data.

Document Review Date:

August 21, 1996.

Document ID:

ORNL-FIFE_SOILREFL.

Citation:

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Also published in D. E. Strebel, D. R. Landis, K. F. Huemmrich, and B. W. Meeson (eds.), Collected Data of the First ISLSCP Field Experiment, Vol. 1: Surface Observations and Non-Image Data Sets. CD-ROM. National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland, U.S.A. (available from http://www.daac.ornl.gov).

Document Curator:

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