MRLC National Land Cover Dataset

Identification_Information:
  Citation:
    Citation_Information:
      Originator: U.S. Geological Survey (USGS)
      Publication_Date: 20000506
      Title: Montana Land Cover Data Set
      Edition: 1
      Geospatial_Data_Presentation_Form: raster digital data
      Publication_Information:
        Publication_Place: Sioux Falls, SD USA
        Publisher: U.S. Geological Survey
      Online_Linkage: http://edcwww.cr.usgs.gov/programs/lccp/natllandcover.html
  Description:
    Abstract:
      These data can be used in a geographic information system (GIS) for any number of purposes such as assessing wildlife habitat, water quality, pesticide runoff, land use change, etc. The State data sets are provided with a 300 meter buffer beyond the State border to faciliate combining the State files into larger regions.

      The user must have a firm understanding of how the datasets were compiled and the resulting limitations of these data. The National Land Cover Dataset was compiled from Landsat satellite TM imagery (circa 1992) with a spatial resolution of 30 meters and supplemented by various ancillary data (where available). The analysis and interpretation of the satellite imagery was conducted using very large, sometimes multi-state image mosaics (i.e. up to 18 Landsat scenes). Using a relatively small number of aerial photographs for 'ground truth', the thematic interpretations were necessarily conducted from a spatially-broad perspective. Furthermore, the accuracy assessments (see below) correspond to 'federal regions' which are groupings of contiguous states.
      Thus, the reliability of the data is greatest at the state or multi-state level.
      The statistical accuracy of the data is known only for the region.

      Important Caution Advisory

      With this in mind, users are cautioned to carefully scrutinize the data to see if they are of sufficient reliability before attempting to use the dataset for larger-scale or local analyses. This evaluation must be made remembering that the NLCD represents conditions in the early 1990s.

      The Montana portion of the NLCD was created as part of land cover mapping activities for Federal Region VIII that includes the States of North Dakota, South Dakota, Wyoming, Montana, Utah, and Colorado. The NLCD classification contains 21 different land cover categories with a spatial resolution of 30 meters. The NLCD was produced as a cooperative effort between the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (US EPA) to produce a consistent, land cover data layer for the conterminous U.S. using early 1990s Landsat

thematic mapper (TM) data purchased by the Multi-resolution Land Characterization (MRLC) Consortium. The MRLC Consortium is a partnership of federal agencies that produce or use land cover data. Partners include the USGS (National Mapping, Biological Resources, and Water Resources Divisions), US EPA, the U.S. Forest Service, and the National Oceanic and Atmospheric Administration.

Purpose:

The main objective of this project was to generate a generalized and nationally consistent land cover data layer for the entire conterminous United States. These data can be used as a layer in a geographic information system (GIS) for any number of purposes such assessing wildlife habitat, water quality and pesticide runoff, land use change, etc.

Supplemental_Information:

The land cover data files are provided as a 'Geo-TIFF'. The land cover data sets are single band raster images. The X/Y corner coordinates (projection coordinates, center of pixel) for Montana are:
Upper Left Corner: -1498260/3044730 meters,
Lower Right Corner: -595290/2471940 meters.

Time_Period_of_Content:

Time_Period_Information:

Range_of_Dates/Times:

Beginning_Date: 1986

Ending_Date: 1993

Currentness_Reference: ground condition

Status:

Progress: Complete

Maintenance_and_Update_Frequency: As needed

Spatial_Domain:

Bounding_Coordinates:

West_Bounding_Coordinate: -116.365

East_Bounding_Coordinate: -103.570

North_Bounding_Coordinate: 48.958

South_Bounding_Coordinate: 45.022

Keywords:

Theme:

Theme_Keyword_Thesaurus: None

Theme_Keyword: Land Use/Land Cover

Theme_Keyword: Land Management

Theme_Keyword: Land Resources

Theme_Keyword: EDC

Theme_Keyword: EPA

Theme_Keyword: EROS

Theme_Keyword: Imagery

Theme_Keyword: Land Characterization

Theme_Keyword: Land Cover

Theme_Keyword: Landsat

Theme_Keyword: MRLC

Theme_Keyword: Remote Sensing

Theme_Keyword: Satellite

Theme_Keyword: Space Imaging

Theme_Keyword: USGS

Place:

Place_Keyword_Thesaurus:

U.S. Department of Commerce, 1977, Countries, dependencies, areas

of special sovereignty, and their principal administrative divisions (Federal Information Processing Standard 10-3):Washington, D.C., National Institute of Standards and Technology.
Place_Keyword: North America
Place_Keyword: United States of America
Place:
Place_Keyword_Thesaurus:
U.S. Department of Commerce, 1987, Codes for the identification of the States, the District of Columbia, and the outlying areas of the United States and associated areas Federal Information Processing Standard 5-20; Washington, D.C., National Institute of Standards and Technology.
Place_Keyword: Montana
Place_Keyword: MT
Access_Constraints: None.
Use_Constraints:
None. Acknowledgement of the U.S. Geological Survey would be appreciated in products derived from these data.
Point_of_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization:
U.S. Geological Survey
EROS Data Center
Contact_Position: Customer Services Representative
Contact_Address:
Address_Type: mailing and physical address
Address: U.S. Geological Survey, EROS Data Center
City: Sioux Falls
State_or_Province: SD
Postal_Code: 57198
Country: USA
Contact_Voice_Telephone: (605) 594-6151
Contact_TDD/TTY_Telephone: (605) 594-6933
Contact_Facsimile_Telephone: (605) 594-6589
Contact_Electronic_Mail_Address: CUSTSERV@EDCMAIL.CR.USGS.GOV
Data_Set_Credit:
This work was performed by the Raytheon STX Corporation under U.S. Geological Survey Contract 1434-92-C-40004.
Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
An accuracy assessment is done on all NLCD on a Federal Region basis following a revision cycle that incorporates feedback from MRLC Consortium partners and affiliated users. The accuracy assessments are conducted by private sector vendors under contract to the USEPA. A protocol has been established by the USGS and USEPA that incorporates a two-stage, geographically stratified cluster sampling plan (Zhu et al., 1999)utilizing National Aerial Photography Program (NAPP) photographs as the sampling frame and the basic sampling unit. In this design a NAPP photograph is defined as a 1st stage or primary sampling unit (PSU), and a sampled pixel within each PSU is treated as a 2nd stage or secondary sampling unit (SSU).

PSU's are selected from a sampling grid based on NAPP flight-lines and photo centers, each grid cell measures 15' X 15' (minutes of latitude/longitude) and consists of 32 NHAP photographs. A geographically

stratified random sampling is performed with 1 NAPP photo being randomly selected from each cell (geographic strata), if a sampled photo falls outside of the regional boundary it is not used. Second stage sampling is accomplished by selecting SSU's (pixels) within each PSU (NAPP photo) to provide the actual locations for the reference land cover classification.

The SSU's are manually interpreted and misclassification errors are estimated and described using a traditional error matrix as well as a number of other important measures including the overall proportion of pixels correctly classified, user's and producer's accuracies, and omission and commission error probabilities.

At the time of CD release (Spring 2001), the accuracy assessment was not complete. For the Region VIII accuracy assessment please check the NLCD Website: http://edcwww.usgs.gov/programs/lccp/natllandcover.html. The accuracy assessment numbers will be posted there around Fall, 2001.

The biggest concern for this area of Region VIII is below:

Both irrigated and dryland agriculture are practiced in this region. In the dryland areas small grains precominate; fields are classifed as fallow when there is no evidence of visible vegetation indicating a prescribed alternation between cropping and tillage. Crop types in the irrigated areas were difficult to reliably distinguish; row crops are likely to be under represented where no field observations or other ancillary information was incorporated.

Logical_Consistency_Report:
An unsupervised classification algorithm was used to classify the mosaicked multiple leaf-off TM scenes. Aerial photographs were used to interpret and label classes into land cover categories and ancillary data sources resolved the class confusion. Further land cover information from leaf-on TM data, NWI data, and other sources were incorporated to refine and augment the "basic" classification.
Completeness_Report: All photo-interpretable data are mapped.
Positional_Accuracy:
Horizontal_Positional_Accuracy:
Horizontal_Positional_Accuracy_Report:
Each Landsat Thematic Mapper image used to create the NLCD was precision terrain-corrected using 3-arc-second digital terrain elevation data (DTED), and georegistered using ground control points. This resulted in a root mean square registration error of less than 1 pixel (30 meters).
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Source_Citation:
Citation_Information:
Originator:
U.S. Geological Survey
EROS Data Center
Publication_Date: unknown
Title: Landsat TM scene
Geospatial_Data_Presentation_Form: remote sensing image
Publication_Information:
Publication_Place:

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  Source_Citation_Abbreviation: image24
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator:
        U.S. Geological Survey
        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM scene
      Geospatial_Data_Presentation_Form: remote sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD 57198
          USA
        Publisher: EROS Data Center
      Other_Citation_Details: Path/Row 040/028
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19860528
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image25
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator:
        U.S. Geological Survey
        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM scene
      Geospatial_Data_Presentation_Form: remote sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD 57198
          USA
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        Publisher: EROS Data Center
      Other_Citation_Details: Path/Row 040/029
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19860613
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image26
  Source_Contribution:
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    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator:
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        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM scene
      Geospatial_Data_Presentation_Form: remote-sensing image
      Series_Information:
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD  57198
          USA
        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 041/026
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19860609
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image27
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator:
        U.S. Geological Survey
        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM scene
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD  57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 041/027
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
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    Time_Period_Information:
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        Calendar_Date: 19920503
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  Source_Citation_Abbreviation: image28
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator:
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        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM scene
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD  57198
          USA
        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 041/028
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19880524
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image29
  Source_Contribution:
    The image provides the base from which the land cover
    classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
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      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD  57198
          USA
        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 042/026
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19880524
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image30
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    land cover classification is determined.
Source_Information:
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    Citation_Information:
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        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD 57198
        Publisher:
          EROS Data Center
          U.S. Geological Survey
      Other_Citation_Details: Path/Row 042/027
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19920909
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image31
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
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      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD
        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 034/028
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930809
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image32
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
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      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
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        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 034/029
  Type_of_Source_Media: remote-sensing image
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930809
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image33
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD  57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 035/026
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930816
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image34
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD 57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 035/027
  Type_of_Source_Media: raster digital image
  Source_Time_Period_of_Content:
    Time_Period_Information:
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      Single_Date/Time:
        Calendar_Date: 19930816
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image35
  Source_Contribution:
    The image provides the base from which
    the land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD  57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 035/028
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930816
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image36
  Source_Contribution:
    The image provides the base from which the land
    cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD  57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 035/029
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930816
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image37
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
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    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD  57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 036/026
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930807
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image38
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD  57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 036/027
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930807
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image39
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: raster digital data
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD  57198
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          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 036/028
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930807
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image40
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator:
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        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM scene
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD 57198
          USA
        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 036/029
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19920804
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image41
  Source_Contribution:
    The image provides the base from which
    the land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
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      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD 57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 037/026
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
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      Single_Date/Time:
        Calendar_Date: 19930814
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  Source_Citation_Abbreviation: image42
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    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
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        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD  57198
          USA
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 037/027
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930814
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image43
  Source_Contribution:
    The image provides the base from which the land
    cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
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        EROS Data Center
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          EROS Data Center
          Sioux Falls, SD  57198
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 037/028
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930814
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image44
  Source_Contribution:
    The image provides the base from
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    which the land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
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      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD 57198
        Publisher: U.S. Geological Survey
      Other_Citation_Details: Path/Row 037/029
  Type_of_Source_Media: remote-sensing image
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19920928
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image45
  Source_Contribution:
    The image provides the base from which
    the land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD 57198
          USA
        Publisher:
          EROS Data Center
          U.S. Geological Survey
      Other_Citation_Details: Path/Row 038/026
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930922
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image46
  Source_Contribution:
    The image provides the base from which the
    land cover classfication is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM scene
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD 47198
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          USA
        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 038/027
  Type_of_Source_Media: raster digital data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930922
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image47
  Source_Contribution:
    The image provides the base from which the land
    cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM scene
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD  57198
          USA
        Publisher:
          U. S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 038/028
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930922
  Source_Citation_Abbreviation: image48
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM Scene
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD  57198
          USA
        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 038/029
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
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      Single_Date/Time:
        Calendar_Date: 19930922
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image49
  Source_Contribution:
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    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place:
          Sioux Falls, SD  57198
          USA
        Publisher:
          U.S. Geological Survey
          EROS Data Center
      Other_Citation_Details: Path/Row 039/026
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19920910
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image50
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: digital raster data
      Publication_Information:
        Publication_Place: Sioux Falls, SD  57198 USA
        Publisher: U.S. Geological Survey, EROS Data Center
      Other_Citation_Details: Path/Row 039/027
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19920809
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image51
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
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      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD  57198  USA
        Publisher: U.S. Geological Survey, EROS Data Center
      Other_Citation_Details: Path/Row 039/028
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19920809
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image52
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD  57198  USA
        Publisher: U.S. Geological Survey, EROS Data Center
      Other_Citation_Details: Path/Row 039/029
  Type_of_Source_Media:
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19920809
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image53
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
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    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD  57198  USA
        Publisher: U.S. Geological Survey, EROS Data Center
      Other_Citation_Details: Path/Row 040/026
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19930819
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image54
  Source_Contribution:
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Source_Information:
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      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD  57198  USA
        Publisher: U.S. Geological Survey, EROS Data Center
      Other_Citation_Details: Path/Row 040/027
  Type_of_Source_Media:
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19880720
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image55
  Source_Contribution:
    The image provides the base from which thte
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Source_Information:
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    Citation_Information:
      Originator: U.S. Geological Survey
      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD  57198  USA
        Publisher: U.S. Geological Survey, EROS Data Center
      Other_Citation_Details: Path/Row 040/028
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
    Time_Period_Information:
      Single_Date/Time:
        Calendar_Date: 19920713
    Source_Currentness_Reference: ground condition
  Source_Citation_Abbreviation: image56
  Source_Contribution:
    The image provides the base from which the
    land cover classification is determined.
Source_Information:
  Source_Citation:
    Citation_Information:
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      Publication_Date: unknown
      Title: Landsat TM image
      Geospatial_Data_Presentation_Form: remote-sensing image
      Publication_Information:
        Publication_Place: Sioux Falls, SD  57198  USA
        Publisher: U.S. Geological Survey, EROS Data Center
      Other_Citation_Details: Path/Row 040/029
  Type_of_Source_Media: digital raster data
  Source_Time_Period_of_Content:
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    Time_Period_Information:
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Land Cover Characterization:
The project is being carried out on the basis of 10 Federal Regions that make up the conterminous United States; each region is comprised of multiple states; each region is processed in subregional units that are limited to the area covered by no more than 18 Landsat TM scenes. The general NLCD procedure is to: (1) mosaic subregional TM scenes and classify them using an unsupervised clustering algorithm, (2) interpret and label the clusters/classes using aerial photographs as reference data, (3) resolve the labeling of confused clusters/classes using the appropriate ancillary data source(s), and (4) incorporate land cover information from other data sets and perform manual edits to augment and refine the "basic" classification developed above.

Two seasonally distinct TM mosaics are produced, a leaves-on version (summer) and a leaves-off (spring/fall) version. TM bands 3, 4, 5, and 7 are mosaicked for both the leaves-on and leaves-off versions. For mosaick purposes, a base scene is selected for each mosaic and the other scenes are adjusted to mimic spectral properties of the base scene using histogram matching in regions of spatial overlap. Following mosaicking, either the leaves-off version or leaves-on version Is selected to be the "base" for the land cover mapping process. The 4 TM bands of the "base" mosaic are clustered to produce a single 100-class image using an unsupervised clustering algorithm. Each of the spectrally distinct clusters/classes is then assigned to one or more Anderson level 1 and 2 land cover classes using National High Altitude Photography program (NHAP)and National Aerial Photography program (NAPP) aerial photographs as a reference. Almost invariably, individual spectral clusters/classes are confused between two or more land cover classes.

Separation of the confused spectral clusters/classes into appropriate NLCD class is accomplished using ancillary data layers. Standard ancillary data layers include: the "non-base" mosaic TM bands and 100-class cluster image; derived TM normalized vegetation index (NDVI), various TM band ratios, TM date bands; 3-arc second Digital Terrain Elevation Data (DTED) and derived slope, aspect and shaded relief; population and housing density data; USGS land use and land cover (LUDA); and National Wetlands Inventory(NWI) data if available. Other ancillary data sources may include soils data, unique state or regional land cover data sets, or data from other federal programs such as the National Gap Analysis Program (GAP) of the USGS Biological Resources Division (BRD). For a given confused spectral cluster/class, digital values of the various ancillary data layers are compared to determine: (1) which data layers are the most effective for splitting the confused cluster/class into the appropriate NLCD class, and (2) the appropriate layer thresholds for making the split(s). Models are then developed using one to several ancillary data layers to split the confused cluster/class into the NLCD class. For example, a population density threshold is used to separate high-intensity residential areas from commercial/industrial/transportation. Or a cluster/class might be confused between row crop and grasslands. To split this particular cluster/class, a TM NDVI threshold might be identified and used with an elevation threshold in a class-splitting model to make the appropriate NLCD class assignments. A purely spectral example is using the temporally opposite TM layers to discriminate confused cluster/classes such as hay pasture vs. row crops and deciduous forests vs. evergreen forests; simple thresholds that contrast the seasonal differences in

vegetation between leaves-on vs. leaves-off.

Not all cluster/class confusion can be successfully modeled out. Certain classes such as urban/recreational grasses or quarries/strip mines/gravel pits that are not spectrally unique require manual editing. These class features are typically visually identified and then reclassified using on-screen digitizing and recoding. Other classes such as wetlands require the use of specific data sets such as NWI to provide the most accurate classification. Areas lacking NWI data are typically subset out and modeling is used to estimate wetlands in these localized areas. The final NLCD product results from the classification (interpretation and labeling) of the 100-class "base" cluster mosaic using both automated and manual processes, incorporating both spectral and conditional data layers. For a more detailed explanation please see Vogelmann et al. 1998 and Vogelmann et al. 1998.

Discussion:

While we believe that the approach taken has yielded a very good general land cover classification product for the nation, it is important to indicate to the user where there might be some potential problems. The biggest concerns are listed below:

1) Some of the TM data sets are not temporally ideal. Leaves-off data sets are heavily relied upon for discriminating between hay/pasture and row crop, and also for discriminating between forest classes. The success of discriminating between these classes using leaves-off data sets hinges on the time of data acquisition. When hay/pasture areas are non-green, they are not easily distinguishable from other agricultural areas using remotely sensed data. However, there is a temporal window during which hay and pasture areas green up before most other vegetation (excluding evergreens, which have different spectral properties); during this window these areas are easily distinguishable from other crop areas. The discrimination between hay/pasture and deciduous forest is likewise optimized by selecting data in a temporal window where deciduous vegetation has yet to leaf out. It is difficult to acquire a single-date of imagery (leaves-on or leaves-off) that adequately differentiates between both deciduous/hay and pasture and hay pasture /row crop.

2) The data sets used cover a range of years (see data sources), and changes that have taken place across the landscape over the time period may not have been captured. While this is not viewed as a major problem for most classes, it is possible that some land cover features change more rapidly than might be expected (e.g. hay one year, row crop the next).

3) Wetlands classes are extremely difficult to extract from Landsat TM spectral information alone. The use of ancillary information such as National Wetlands Inventory (NWI) data is highly desirable. We relied on GAP, LUDA, or proximity to streams and rivers as well as spectral data to delineate wetlands in areas without NWI data.

4) Separation of natural grass and shrub is problematic. Areas observed on the ground to be shrub or grass are not always distinguishable spectrally. Likewise, there was often disagreement between LUDA and GAP on these classes.

Acknowledgments

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References

More detailed information on the methodologies and techniques employed In this work can be found in the following:

Kelly, P.M., and White, J.M., 1993. Preprocessing remotely sensed data for efficient analysis and classification, Applications of Artificial Intelligence 1993: Knowledge-Based Systems in Aerospace and Industry, Proceeding of SPIE, 1993, 24-30.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe, 1979. Classification of Wetlands and Deepwater Habitats of the United States, Fish and Wildlife Service, U.S. Department of the Interior, Washington, D.C.

Vogelmann, J.E., Sohl, T., and Howard, S.M., 1998. "Regional Characterization of Land Cover Using Multiple Sources of Data." Photogrammetric Engineering & Remote Sensing, Vol. 64, No. 1, pp. 45-57.

Vogelmann, J.E., Sohl, T., Campbell, P.V., and Shaw, D.M., 1998. "Regional Land Cover Characterization Using Landsat Thematic Mapper Data and Ancillary Data Sources." Environmental Monitoring and Assessment, Vol. 51, pp. 415-428.

Zhu, Z., Yang, L., Stehman, S., and Czaplewski, R., 1999. "Designing an Accuracy Assessment for USGS Regional Land Cover Mapping Program." (In review) Photogrametric Engineering & Remote Sensing.

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      Water
      11 Open Water
      12 Perennial Ice/Snow

      Developed
      21 Low Intensity Residential
      22 High Intensity Residential
      23 Commercial/Industrial/Transportation

      Barren
      31 Bare Rock/Sand/Clay
      32 Quarries/Strip Mines/Gravel Pits
      33 Transitional

      Vegetated; Natural Forested Upland
      41 Deciduous Forest
      42 Evergreen Forest
      43 Mixed Forest

      Shrubland
```

51 Shrubland

Non-natural Woody
61 Orchards/Vineyards/Other

Herbaceous Upland
71 Grasslands/Herbaceous

Herbaceous Planted/Cultivated
81 Pasture/Hay
82 Row Crops
83 Small Grains
84 Fallow
85 Urban/Recreational Grasses

Wetlands
91 Woody Wetlands
92 Emergent Herbaceous Wetlands

NLCD Land Cover Classification System Land Cover Class Definitions:

Water All areas of open water or permanent ice/snow cover.

11. Open Water - areas of open water, generally with less than 25 percent or greater cover of water (per pixel).

12. Perennial Ice/Snow - All areas characterized by year-long cover of ice and/or snow.

Developed - areas characterized by high percentage (approximately 30% or greater) of constructed materials (e.g. asphalt, concrete, buildings, etc).

21. Low Intensity Residential - Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.

22. High Intensity Residential - Includes heavily built up urban centers where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80-100 percent of the cover.

23. Commercial/Industrial/Transportation - Includes infrastructure (e.g. roads, railroads, etc.) and all highways and all developed areas not classified as High Intensity Residential.

Barren - Areas characterized by bare rock, gravel, sad, silt, clay, or other earthen material, with little or no "green" vegetation present regardless of its inherent ability to support life. Vegetation, if present, is more widely spaced and scrubby than that in the "green"vegetated categories; lichen cover may be extensive.

31. Bare Rock/Sand/Clay - Perennially barren areas of bedrock, desert,

pavement, scarps, talus, slides, volcanic material, glacial debris, and other accumulations of earthen material.

32. Quarries/Strip Mines/Gravel Pits - Areas of extractive mining activities with significant surface expression.

33. Transitional - Areas of sparse vegetative cover (less than 25 percent that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.)

Forested Upland - Areas characterized by tree cover (natural or Semi-natural woody vegetation, generally greater than 6 meters tall); Tree canopy accounts for 25-100 percent of the cover.

41. Deciduous Forest - Areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.

42. Evergreen Forest - Areas characterized by trees where 75 percent or more of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. Mixed Forest - Areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

Shrubland - Areas characterized by natural or semi-natural woody vegetation with aerial stems, generally less than 6 meters tall with individuals or clumps not touching to interlocking. Both evergreen and deciduous species of true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions are included.

51. Shrubland - Areas dominated by shrubs; shrub canopy accounts for 25-100 percent of the cover. Shrub cover is generally greater than 25 percent when tree cover is less than 25 percent. Shrub cover may be less than 25 percent in cases when the cover of other life forms (e.g. herbaceous or tree) is less than 25 percent and shrubs cover exceeds the cover of the other life forms.

Non-natural Woody - Areas dominated by non-natural woody vegetation; non-natural woody vegetative canopy accounts for 25-100 percent of the cover. The non-natural woody classification is subject to the availability of sufficient ancillary data to differentiate non-natural woody vegetation from natural woody vegetation.

61. Orchards/Vineyards/Other - Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

Herbaceous Upland - Upland areas characterized by natural or semi- natural herbaceous vegetation; herbaceous vegetation accounts for 75-100 percent of the cover.

71. Grasslands/Herbaceous - Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25 percent, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.

Planted/Cultivated - Areas characterized by herbaceous vegetation That has been planted or is intensively managed for the production of food, feed, or fiber; or is maintained in developed settings for specific purposes. Herbaceous vegetation accounts for 75-100 percent of the cover.

81. Pasture/Hay - Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.

82. Row Crops - Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.

83. Small Grains - Areas used for the production of graminoid crops such as wheat, barley, oats, and rice

84. Fallow - Areas used for the production of crops that are temporarily barren or with sparse vegetative cover as a result of being tilled in a management practice that incorporates prescribed alternation between cropping and tillage.

85. Urban/Recreational Grasses - Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.

Wetlands - Areas where the soil or substrate is periodically saturated with or covered with water as defined by Cowardin et al.

91. Woody Wetlands - Areas where forest or shrubland vegetation accounts for 25-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

92. Emergent Herbaceous Wetlands - Areas where perennial herbaceous vegetation accounts for 75-100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

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State_or_Province: SD
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      2.  Calling 1-888-ASK-USGS
      3.  Ordering online via the USGS Global Land Information System at:
      http://edcwww.cr.usgs.gov/Webglis/
      Users of the Global Land Information System should search under the
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      4.  Visiting and ordering online through the NLCD availability page
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State_or_Province: SD
Postal_Code: 57198
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Contact_Voice_Telephone: 605-594-6551
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