```
Identification_Information:
  Citation:
    Citation_Information:
      Originator:
        Canada Centre for Remote Sensing (CCRS)/Canada Centre for Mapping and Earth Observation (CCMEO), Natural Resources Canada (NRCan)
      Originator: Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO)
      Originator: Comisión Nacional Forestal (CONAFOR)
      Originator: Instituto Nacional de Estadística y Geografía (INEGI)
      Originator: U.S. Geological Survey (USGS)
      Publication_Date: March 2023
      Title: 2020 Land Cover of North America at 30 meters
      Edition: 1.0
      Geospatial_Data_Presentation_Form: Raster digital data
      Publication_Information:
        Publication_Place: Ottawa, Ontario, Canada
        Publisher: CCRS/CCMEO/NRCan
      Publication_Information:
        Publication_Place: Sioux Falls, South Dakota, USA
        Publisher: U.S. Geological Survey
      Publication_Information:
        Publication_Place: Mexico City, México
        Publisher: CONABIO
      Publication_Information:
        Publication_Place: San Juan de Ocotán, Jalisco, México
        Publisher: CONAFOR
      Publication_Information:
        Publication_Place: Aguascalientes, México
        Publisher: INEGI
      Publication_Information:
        Publication_Place: Montréal, Québec, Canada
        Publisher: Commission for Environmental Cooperation
      Online_Linkage: http://www.cec.org/nalcms
  Description:
    Abstract:
      The 2020 North American Land Cover 30-meter dataset was produced as part of the North American Land Change Monitoring
      System (NALCMS), a trilateral effort between Natural Resources Canada, the United States Geological Survey, and three Mexican
      organizations including the National Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía),
      National Commission for the Knowledge and Use of the Biodiversity (Comisión Nacional Para el Conocimiento y Uso de la
      Biodiversidad), and the National Forestry Commission of Mexico (Comisión Nacional Forestal). The collaboration is facilitated
      by the Commission for Environmental Cooperation, an international organization created by the Canada, Mexico, and United States
      governments under the North American Agreement on Environmental Cooperation to promote environmental collaboration between the
      three countries.

      The general objective of NALCMS is to devise, through collective effort, a harmonized multi-scale land cover monitoring
      approach which ensures high accuracy and consistency in monitoring land cover changes at the North American scale and
      which meets each country's specific requirements.
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This 30-meter dataset of North American Land Cover reflects land cover information for 2020 from Mexico and Canada, 2019 over the conterminous United States and 2021 over Alaska. Each country developed its own classification method to identify Land Cover classes and then provided an input layer to produce a continental Land Cover map across North America. Canada, Mexico, and the United States developed their own 30-meter land cover products; see specific sections on data generation below.

The main inputs for image classification were 30-meter Landsat 8 Collection 2 Level 1 data in the three countries (Canada, the United States and Mexico). Image selection processes and reduction to specific spectral bands varied among the countries due to study-site-specific requirements. While Canada selected most images from the year 2020 with a few from 2019 and 2021, the Conterminous United States employed mainly images from 2019, while Alaska land cover maps are mainly based on the use of images from 2021. The land cover map for Mexico was based on land cover change detection between 2015 and 2020 Mexico Landsat 8 mosaics.

In order to generate a seamless and consistent land cover map of North America, national maps were generated for Canada by the CCRS; for Mexico by CONABIO, INEGI, and CONAFOR; and for the United States by the USGS. Each country chose their own approaches, ancillary data, and land cover mapping methodologies to create national datasets. This North America dataset was produced by combining the national land cover datasets. The integration of the three national products merged four Land Cover map sections, Alaska, Canada, the conterminous United States and Mexico.

Purpose:
  Information on land cover across North America provided by this dataset is valuable for a range of audiences, including international organizations such as the United Nations Environment Programme, nongovernmental conservation organizations, land managers, and scientific researchers. The continental scale land cover data generated under NALCMS can be used to address issues such as climate change, carbon sequestration, biodiversity loss, and changes in ecosystem structure and function, by helping users to better understand the dynamics and continental-scale patterns of North America's changing environment.

  The North American Environmental Atlas data are intended for geographic display and analysis at the national and continental level. These 30-meter land cover data should be displayed and analyzed at scales appropriate for 1:100,000-scale data. No responsibility is assumed by Natural Resources Canada, Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Comisión Nacional Forestal, Instituto Nacional de Estadística y Geografía, the U.S. Geological Survey, or the Commission for Environmental Cooperation in the use of these data.

Supplemental_Information:

  Natural Resources Canada has North American Land Cover information available online at
  https://open.canada.ca/data/en/dataset/ee1580ab-a23d-4f86-a09b-79763677eb47

  The National Commission for the Knowledge and Use of Biodiversity has North American Land Cover information available online at https://www.biodiversidad.gob.mx/monitoreo/cobertura-suelo

  The U.S. Geological Survey has North American Land Cover information available online at www.mrlc.gov

  The following list describes the display of land cover classification in the .tif file.
  NALCMS Level 2 classification scheme:

  Value 1, Temperate or sub-polar needleleaf forest, RGB 0 61 0;
  Value 2, Sub-polar taiga needleleaf forest, RGB 148 156 112;
  Value 3, Tropical or sub-tropical broadleaf evergreen forest, RGB 0 99 0;

Value 4, Tropical or sub-tropical broadleaf deciduous forest, RGB 30 171 5;
Value 5, Temperate or sub-polar broadleaf deciduous forest, RGB 20 140 61;
Value 6, Mixed Forest, RGB 91 117 43;
Value 7, Tropical or sub-tropical shrubland, RGB 179 158 43;
Value 8, Temperate or sub-polar shrubland, RGB 179 138 51;
Value 9, Tropical or sub-tropical grassland, RGB 232 220 94;
Value 10, Temperate or sub-polar grassland, RGB 225 207 138;
Value 11, Sub-polar or polar shrubland-lichen-moss, RGB 156 117 84;
Value 12, Sub-polar or polar grassland-lichen-moss, RGB 186 212 143;
Value 13, Sub-polar or polar barren-lichen-moss, RGB 64 138 112;
Value 14, Wetland, RGB 107 163 138;
Value 15, Cropland, RGB 230 174 102;
Value 16, Barren lands, RGB 168 171 174;
Value 17, Urban, RGB 220 33 38;
Value 18, Water, RGB 76 112 163;
Value 19, Snow and Ice, RGB 255 250 255.

NALCMS Level 1 classification scheme:

Value 1, Needleleaved forest, RGB 0 61 0;
Value 2, Broadleaved Forest, RGB 0 99 0;
Value 3, Mixed Forest, RGB 91 117 43;
Value 4, Shrubland, RGB 178 158 43;
Value 5, Herbaceous, RGB 232 219 94;
Value 6, Lichens/moss, RGB 186 211 142;
Value 7, Wetland, RGB 107 163 138;
Value 8, Cropland, RGB 230 174 102;
Value 9, Barren lands, RGB 168 171 174;
Value 10, Urban, RGB 220 33 38;
Value 11, Water, RGB 76 112 163;
Value 12, Snow and Ice, RGB 255 250 255.

The Commission for Environmental Cooperation (CEC) is an international organization created by Canada, Mexico, and the United States of America under the North American Agreement on Environmental Cooperation (NAAEC). The CEC was established to address regional environmental concerns, help prevent potential trade and environmental conflicts, and to promote the effective enforcement of environmental law. The Agreement complements the environmental provisions of the North American Free Trade Agreement (NAFTA). Further information on the CEC is available from http://www.cec.org/ or from
Commission for Environmental Cooperation;
700, de la Gauchetière Street West;
Suite 1620;
Montréal (Québec) H3B 5M2;
Canada;
Telephone: 1 514 350 4300;
Facsimile: 1 514 350 4314;
Electronic mail: info@cec.org

The following references provide additional information on processing methodologies and may be referenced in the process steps, below.

Breiman, L. (2001) Random forests. Machine learning, 45(1), 5-32.

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Masek, J.G., Vermote, E.F., Saleous, N.E., Wolfe, R., Hall, F.G., Huemmrich, K.F., Gao, F., Kutler, J., & Lim, T.-K. (Jan. 2006) A Landsat surface reflectance dataset for North America, 1990-2000. IEEE Geoscience and Remote Sensing Letters, Volume 3, no. 1:68-72.

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Wickman, J., Stehman, Stephen V., Sorenson, Daniel G., Gass, Leila, Dewitz, Jon A., (2023) Thematic accuracy assessment of the NLCD 2019 land cover for the conterminous United States. GIScience & Remote Sensing, 60(1), DOI: 10.1080/15481603.2023.2181143

Yang, L., Jin, S., Danielson, P., Homer, C., Gass, L., Bender, S.M., Case, A., Costello, C., Dewitz, J., Fry, J. and Funk, M., (2018). A new generation of the United States National Land Cover Database: Requirements, research priorities, design, and implementation strategies. ISPRS Journal of Photogrammetry and Remote Sensing, 146, pp.108-123.

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Time_Period_of_Content:
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    Range_of_Dates/Times:
      Beginning_Date: 2019
      Ending_Date: 2021
  Currentness_Reference: Ground condition
Status:
  Progress: Complete
  Maintenance_and_Update_Frequency: As needed

Spatial_Domain:

  Bounding_Coordinates:
    West_Bounding_Coordinate: 175
    East_Bounding_Coordinate: -50
    North_Bounding_Coordinate: 84
    South_Bounding_Coordinate: 14

Keywords:
  Theme:
    Theme_Keyword_Thesaurus: GCMD Science keywords
    Theme_Keyword: Land Surface > Land Use/Land Cover > Land Cover
    Theme_Keyword: Land Surface > Surface Radiative Properties > Reflectance

  Theme:
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    Theme_Keyword: Land cover
    Theme_Keyword: Landsat
    Theme_Keyword: Reflectance
  Place:

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Access_Constraints: None.
Use_Constraints:
    None. Acknowledgement of Natural Resources Canada, Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Comisión
    Nacional Forestal, Instituto Nacional de Estadística y Geografía, and the U.S. Geological Survey is required in products derived
    from these data.
    Acknowledgement of the Commission for Environmental Cooperation would be appreciated in products derived from these data.
Point_of_Contact:
  Contact_Information:
    Contact_Organization_Primary:
      Contact_Organization: Canada Centre for Remote Sensing/ Canada Centre for Mapping and Earth Observation, Natural Resources Canada
      Contact_Person: Dr. Rasim Latifovic
    Contact_Address:
      Address_Type: Mailing and physical address
      Address: 560 Rochester Street
      City: Ottawa
      State_or_Province: Ontario
      Postal_Code: K1A 0E4
      Country: Canada
    Contact_Voice_Telephone: 1 613 759 7002
    Contact_Facsimile_Telephone: 1 613 759 6344
    Contact_Electronic_Mail_Address: rasim.Latifovic@NRCan-RNCan.gc.ca
Point_of_Contact:
  Contact_Information:
    Contact_Organization_Primary:
      Contact_Organization: Comisión Nacional para el Conocimiento y Uso de la Biodiversidad
      Contact_Person: Dr. Rainer A. Ressl
    Contact_Address:
      Address_Type: Mailing and physical address
      Address: Av. Liga Periférico-Insurgentes Sur 4903
      Address: Parques del Pedregal, Tlalpan 14010, México D.F.
      City: Mexico City
      State_or_Province: Ciudad de Mexico
      Postal_Code: 14010
      Country: México
    Contact_Voice_Telephone: +52-55-50045009
    Contact_Electronic_Mail_Address: rressl@oconabio.gob.mx
```

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   Point_of_Contact:
     Contact_Information:
       Contact_Organization_Primary: CONAFOR
         Contact_Organization: Comisión Nacional Forestal
         Contact_Person: José Armando Alanís de la Rosa
       Contact_Address:
         Address_Type: Mailing and physical address
         Address: Periférico Poniente 5360,
         Address: San Juan de Ocotán
         City: Zapopan
         State_or_Province: Jalisco
         Postal_Code: 45019
         Country: México
       Contact_Voice_Telephone: +52 33 3777 7000 Ext 4200
       Contact_Electronic_Mail_Address: jalanis@conafor.gob.mx
   Point_of_Contact:
     Contact_Information:
       Contact_Organization_Primary:
         Contact_Organization: Instituto Nacional de Estadística y Geografía (INEGI)
       Contact_Position: Director of Natural Resources and Environment Information
       Contact_Address:
         Address_Type: Mailing and physical address
         Address: Av. Héroe de Nacozari Sur 2301. Fraccionamiento Jardines del Parque
         City: Aguascalientes
         State_or_Province: Aguascalientes
         Postal_Code: 20270
         Country: Mexico
       Contact_Voice_Telephone: 52 44 99 10 53 65
       Contact_Electronic_Mail_Address: jose.ornelas@inegi.org.mx
   Point_of_Contact:
     Contact_Information:
       Contact_Organization_Primary:
         Contact_Organization: U.S. Geological Survey
         Contact_Person: Jon Dewitz
       Contact_Address:
         Address_Type: Mailing and physical address
         Address: U.S. Geological Survey, CORE SCIENCE SYSTEMS
         Address: 47914 252nd Street
         City: Sioux Falls
         State_or_Province: South Dakota
         Postal_Code: 57198
         Country: USA
       Contact_Voice_Telephone: 1 605 594 2715
       Contact_Electronic_Mail_Address: dewitz@usgs.gov

Data_Quality_Information:
   Attribute_Accuracy:
```

Attribute_Accuracy_Report:
  Canada:
  The land cover dataset for Canada is produced using observation from Operational Land Imager (OLI) Landsat sensor. An accuracy assessment based on 832 randomly distributed samples shows that land cover data produced with this new approach has achieved 86.9% accuracy with no marked spatial disparities.

  Mexico:
  No accuracy assessment has been performed by the time this map is being published.

  United States:
  For the Conterminous United states, Land Cover data is as follows. The National Land Cover Database (NLCD), a product suite produced through the MultiResolution Land Characteristics (MRLC) consortium, is an operational land cover monitoring program. Starting from A base year of 2001, NLCD releases a land cover database every 2–3 years. The recent release of NLCD2019 extends the database to 18 years. We implemented a stratified random sample to collect land cover reference data for the 2016 and 2019 components of the NLCD2019 database at Level II and Level I of the classification hierarchy. For both dates, Level II land cover overall accuracies (OA) were 77.5%±1% (± value is the standard error) when agreement was defined as a match between the map label and primary reference label only, and increased to 87.1%±0.7% when agreement was defined as a match between the map label and either the primary or alternate reference label. At Level I of the classification hierarchy, land cover OA was 83.1%±0.9% for both 2016 and 2019 when agreement was defined as a match between the map label and primary reference label only, and increased to 90.3%±0.7% when agreement also included the alternate reference label. The Level II and Level I OA for the 2016 land cover in the NLCD2019 database were 5% higher compared to the 2016 land cover component of the NLCD2016 database when agreement was defined as a match between the map label and primary reference label only. No improvement was realized by the NLCD2019 database when agreement also included the alternate reference label. User's accuracies (UA) for forest loss and grass gain were>70% when agreement included either the primary or alternate label, and UA was generally<50% for all other change themes. Producer's accuracies (PA) were>70% for grass loss and gain and water gain and generally<50% for the other change themes. We conducted a post-analysis review for map-reference agreement to identify patterns of disagreement, and these findings are discussed in the context of potential adjustments to mapping and reference data collection procedures that may lead to improved map accuracy going forward.
  https://doi.org/10.1080/15481603.2023.2181143

  For Alaska, data were obtained from a stratified random sample of 103 pixels. The procedure was similar to that used for the conterminous United States, and again, agreement was defined as a match between the map label and either the primary or alternate reference label. Strata were defined based on the single-pixel mmu product but accuracy is for the 5 mmu product. Because of the inherent difficulty in determining accuracy in this remote region, this 2001 accuracy assessment is the only assessment available. All published maps since this are based on this 2001 map with change added and updated. through spectral analysis.
  https://doi.org/10.1016/j.rse.2011.01.020

  Quantitative_Attribute_Accuracy_Assessment:
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      Attribute_Accuracy_Value: 86.9%
    Attribute_Accuracy_Value: Conterminous United States
      Attribute_Accuracy_Value: 77.5%
    Attribute_Accuracy_Explanation:
Logical_Consistency_Report: No tests for logical consistency have been performed on this dataset.
Completeness_Report: Data completeness reflects the content of the original Landsat data for Canada, the United States and Mexico.
Lineage:
  Source_Information:

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      Citation_Information:
        Originator: Canada Centre for Remote Sensing/Canada Centre for Mapping and Earth Observation, Natural Resources Canada
        Publication_Date: 2022
        Title: Dataset Landsat Mosaic of Canada 2019-2021
        Geospatial_Data_Presentation_Form: Raster digital data assembled from 30m Landsat images
        Other_Citation_Details: The data were assembled from all available 2019-2021 reasonably cloud-free 30-meter Landsat images
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      Source_Time_Period_of_Content:
        Time_Period_Information:
          Range_of_Dates/Times:
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            Ending_Date: 2021
        Source_Currentness_Reference: Processing dates
      Source_Citation_Abbreviation: Dataset Landsat Mosaic of Canada 2019-2021
      Source_Contribution: Spatial and attribute information

  Source_Information:
    Source_Citation:
      Citation_Information:
        Originator: National Commission for the Knowledge and Use of Biodiversity (CONABIO)
        Publication_Date: 2023
        Title: Cobertura del suelo de México a 30 m, 2020, version 0.1
    Geospatial_Data_Presentation_Form: Raster digital data assembled from 30m Landsat images
    Type_of_Source_Media: Internal file
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    Source_Citation_Abbreviation: Mexico land cover map 2020, v0.1
    Source_Contribution: Spatial and attribute information

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        Originator: Instituto Nacional de Estadística y Geografía, INEGI
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      Source_Currentness_Reference: Publication date
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  Source_Information:
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        Originator: Canada Centre for Remote Sensing (CCRS)/Canada Centre for Mapping and Earth Observation (CCMEO), Natural Resources
                    Canada (NRCan)
        Originator: Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO)
        Originator: Comisión Nacional Forestal (CONAFOR)
        Originator: Instituto Nacional de Estadística y Geografía (INEGI)
        Originator: U.S. Geological Survey (USGS)
        Publication_Date: 2023
        Title: 2020 Land Cover of North America at 30 meters
        Edition: 1.0
        Geospatial_Data_Presentation_Form: Raster digital data
        Publication_Information:
          Publication_Place: Ottawa, Ontario, Canada
          Publisher: Canada Centre for Remote Sensing (CCRS)/Canada Centre for Mapping and Earth Observation (CCMEO), Natural Resources
                    Canada (NRCan)
        Publication_Information:
          Publication_Place: Sioux Falls, South Dakota, USA
          Publisher: U.S. Geological Survey
      Publication_Information:
        Publication_Place: Mexico City, México
        Publisher: CONABIO
      Publication_Information:
        Publication_Place: San Juan de Ocotán, Jalisco, México
        Publisher: CONAFOR
      Publication_Information:
        Publication_Place: Aguascalientes, México
        Publisher: INEGI
          Publication_Information:
          Publication_Place: Montréal, Québec, Canada
          Publisher: Commission for Environmental Cooperation
        Online_Linkage: http://www.cec.org/tools-and-resources/north-american-environmental-atlas
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          Beginning_Date: 202001
          Ending_Date: 202012
      Source_Currentness_Reference: Ground condition
    Source_Citation_Abbreviation: LandCover2020
    Source_Contribution: Spatial and attribute information

Source_Information: U.S portion of the map based on combining the National Land Cover Database (Yang et al., 2019) and additional
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source data listed below.
      Source_Citation: Yang, L., Jin, S., Danielson, P., Homer, C., Gass, L., Bender, S.M., Case, A., Costello, C., Dewitz, J., Fry, J.
          and Funk, M., 2018. A new generation of the United States National Land Cover Database: Requirements, research priorities,
          design, and implementation strategies. ISPRS Journal of Photogrammetry and Remote Sensing, 146, pp.108-123.

        Citation_Information:
          Originator: U.S. Geological Survey
          Publication_Date: 20210604
          Title: National Land Cover Database (NLCD) 2019 Land Cover Conterminous United States
          Edition: The NLCD product is the version dated June 4, 2021
          Geospatial_Data_Presentation_Form: Raster digital data
          Publication_Information:
            Publication_Place: Sioux Falls, South Dakota, USA
            Publisher: U.S. Geological Survey
          Online_Linkage: https://www.mrlc.gov/data/nlcd-2019-land-cover-conus
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      Citation_Information:
        Originator: Canada Centre for Remote Sensing (CCRS)/Canada Centre for Mapping and Earth Observation (CCMEO), Natural Resources
                    Canada (NRCan)
        Publication_Date: 2022
        Title: Land Cover Map of Canada for 2020 at 30 meters
        Geospatial_Data_Presentation_Form: Raster digital data
        Publication_Information:
          Publication_Place: Ottawa, Ontario
          Publisher: Canada Centre for Remote Sensing (CCRS)/Canada Centre for Mapping and Earth Observation (CCMEO), Natural Resources
                    Canada (NRCan)
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    Source_Citation_Abbreviation: CCRS 2020
    Source_Contribution: Spatial and attribute information

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    Source_Citation:
      Citation_Information:
        Originator:
          Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO)
        Originator: Comisión Nacional Forestal (CONAFOR)
        Originator: Instituto Nacional de Estadística y Geografía (INEGI)
        Publication_Date: Unknown
        Title: Land Cover Map of Mexico for 2020 at 30 meters

Geospatial_Data_Presentation_Form: Raster digital data
        Publication_Information:
          Publication_Place: Mexico City, Mexico
          Publisher: Instituto Nacional de Estadística y Geografía
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      Source_Currentness_Reference: Ground condition
    Source_Citation_Abbreviation: CONABIO, CONAFOR, INEGI 2020
    Source_Contribution: Spatial and attribute information

  Process_Step:
    Process_Description:
      Canada
      Landsat ETM+/OLI scenes were acquired from the U.S. Geological Survey to produce Time series of Canada for period 2009-2021. The
      processing procedure included re-projection, calibration, cloud/cloud shadow detection, compositing, and additional corrections
      as described in Latifovic et al. (2015). The approach to create the Land Cover Map of Canada 2015 included the following steps:
      1) generating National scale LANDSAT 8 time series data 2016 -2021,
      2) generation of training and testing data,
      3) generation of Landsat mosaic of Canada July-August circa 2020,
      4) land cover change detection for period 2015 – 2020 using deep neural network learning,
      5) land cover mapping using Local Optimization Methodology, Latifovic.et al. (2017),
      6) change detection 2015-2020 consistency with landcover 2015 and 2020,
      7) visual quality control and improvement,
      8) cross border Canada-USA consistency,
      9) quantitative accuracy assessment
      Processing was performed using a tile system to facilitate parallel processing and enable handling and loading data.
    Latifovic, R., Pouliot, D., (2005) and Latifovic, R., Pouliot, D., and Olthof, I., (2017) describe the methodology Canada used to
    produce the Landcover of Canada data included in this data set.

      Source_Used_Citation_Abbreviation: Canada ancillary data
      Source_Used_Citation_Abbreviation: Dataset Landsat Mosaic of Canada 2019-2021
      Source_Used_Citation_Abbreviation: Google Earth
      Process_Date: 2022
      Source_Produced_Citation_Abbreviation: CCRS 2020

  Process_Step:
    Process_Description:
    Mexico
    To carry out the classification verification processing, a model was used with the conditional function where non-logical changes
      were eliminated through a matrix where all the combinations of land cover changes that could occur in a period of 5 years were put,
      using the 2015 coverage map and the polygons classified for the 2020 mosaic. The minimum mappable unit criterion was used, selecting
      only the polygons greater than 4,500 meters, of which the visual interpretation method was applied to the vectors greater than or
      equal to 30 hectares.

Subsequently, to improve the product generated by CONABIO, vectors were integrated that indicated changes towards agricultural land and human settlements from a cartography generated by CONAFOR for the states of Tabasco, Chiapas, Yucatán, Campeche and Quintana Roo corresponding to changes in land cover within the period 2016-2020. In addition, edits were made to the map of Mexico to correct problems of overestimation of agricultural zones using the Agricultural Border Series VI SIAP product. With this procedure, agricultural areas classified as tropical pastures were detected in the coverage map of Mexico NALCMS 2015, for which it was decided to classify them as agriculture for the coverage map of Mexico 2020. In the same way, the geostatistical framework of INEGI 2020 was used. and a map on the radiance of lights for the year 2020 in order to eliminate the over-estimation of urban class based on tools for spatial overlapping and generation of areas of influence (buffers) according to the category of human settlement, where 500 meters were applied to urban localities and 250 meters in rural localities.

Finally, a final visual interpretation was made of polygons with change from forests to human settlements, from areas that presented large uniform patterns of change and from areas with non-logical classes according to their geographical location, such as forests to wetlands or bare soils to agricultural areas in high areas. from the country.

Source_Used_Citation_Abbreviation: Mexico ancillary data
Source_Used_Citation_Abbreviation: INEGI 2020
Process_Date: 2022

Process_Step:
  Process_Description:
    In the United States, production of the 2015 North American Land Change Monitoring System (NALCMS) 30-meter land cover was accomplished by cross-walking the National Land Cover Database (NLCD) 2016 land cover classes (Yang et al 2019) to the NALCMS land cover classes. NLCD is generated from Landsat imagery and a change detection process documented here for 2016. https://doi.org/10.3390/rs11242971. For NLCD 2019, the same process steps were used to create the 2020 NALCMS products over CONUS.

    In order to cross-walk NLCD legend classes to NALCMS legend classes a sub-tropical mask for the conterminous United States and a sub-polar mask for Alaska were required. This mask was necessary to differentiate between temperate and sub-tropical/sub-polar areas. To generate the initial sub-tropical mask, NLCD was combined with the Landfire Existing Vegetation Type (EVT) data to identify which EVT classes were considered sub-tropical. This helped define the initial extent of the sub-tropical mask. To further refine the mask, a combination of Elevation data (NED) Ecoregion boundaries, and PRISM climate data were used to delineate sub-tropical areas. Lastly, some additional modeling and hand-editing was required to generate the final mask.

    In order to differentiate sub-polar and temperate areas in Alaska, a dataset identifying areas of permafrost (AKPermafrost) was used to identify potential sub-polar regions. Areas of the dataset with values greater than or equal to a permafrost occurrence greater than 50 percent were   considered sub-polar. Some additional localized modeling and hand-editing was required to generate the final sub-polar mask.

  Source_Used_Citation_Abbreviation: United Sates ancillary data
  Source_Used_Citation_Abbreviation: LandCover2016
  Source_Produced_Citation_Abbreviation: USGS 2020

Process_Step:
  Process_Description:
    To produce the seamless land cover map of North America, the four national land cover map sections (Canada, Mexico, Conterminous United States and Alaska) were reprojected from their national coordinate systems into the WGS 84 Lambert Azimuthal Equal Area projection for the NALCMS map and aligned with a common reference grid for the project. All map sections were merged into a

common bounding box and edge matched along the borders. Empty pixels between sections borders were filled using reference data
        from the previous 2015 Land Cover Map 30-meters. Coastline was defined respecting the terrestrial area (all classes but water)
        from each national map, water of lagoons, bays, estuaries, or other outlets into the sea were separated from sea water by visual
        interpretation using an assemblage of various sources. A minimum map unit of 5 connected pixels was applied using Smart Eliminate
        (NLCD tools. North American 2020 Land Cover Map at 30-meters was exported to 8-bit TIFF format, colormap was added based on
        NALCMS legend color scheme and pyramids were generated to facilitate fast display rendering for final users.
      Source_Used_Citation_Abbreviation: Provinces/territories
      Source_Used_Citation_Abbreviation: National Cartographic Boundary
      Source_Used_Citation_Abbreviation: CCRS 2020
      Source_Used_Citation_Abbreviation: USGS 2020
      Source_Used_Citation_Abbreviation: INEGI 2020
      Source_Used_Citation_Abbreviation: CONAFOR 2020
      Source_Used_Citation_Abbreviation: CONABIO 2020
      Process_Date: 2022-2023

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    Raster_Object_Type: Pixel
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        Lambert_Azimuthal_Equal_Area:
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          Latitude_of_Projection_Center: 45.00
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          False_Northing: 0.0
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        Planar_Coordinate_Encoding_Method: Row and column
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      Ellipsoid_Name: WGS 84
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      Entity_Type_Label: Land cover classification grid cell

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    Any of the data elements in the 30-meter 2020 North American land cover file
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Attribute:
  Attribute_Label: Land cover classification grid cell value
  Attribute_Definition: The value is an indication of the land cover class
  Attribute_Definition_Source: North American Land Change Monitoring System (NALCMS) Group
  Attribute_Domain_Values:
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      Enumerated_Domain_Value: 1
      Enumerated_Domain_Value_Definition:
        Temperate or sub-polar needleleaf forest. Forests generally taller than
        three meters and more than 20 percent of total vegetation cover. This type
        occurs across the northern United States, Canada, and mountainous zones of
        Mexico. The tree crown cover contains at least 75 percent of needleleaved
        species. Land Cover Classification System (LCCS) code: 20134.
      Enumerated_Domain_Value_Definition_Source:
        North American Land Change Monitoring System (NALCMS) Group
  Attribute_Domain_Values:
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      Enumerated_Domain_Value_Definition:
        Sub-polar taiga needleleaf forest. Forest and woodlands with trees generally
        taller than three meters and more than 5 percent of total vegetation cover
        with shrubs and lichens commonly present in the understory. The tree crown
        cover contains at least 75 percent of needleleaved species. This type occurs
        across Alaska and northern Canada and may consist of treed muskeg or
        wetlands. Forest canopies are variable and often sparse, with generally
        greater tree cover in the southern latitude parts of the zone than the north.
        LCCS code: 20229.
      Enumerated_Domain_Value_Definition_Source:
        North American Land Change Monitoring System (NALCMS) Group
  Attribute_Domain_Values:
    Enumerated_Domain:
      Enumerated_Domain_Value: 3
      Enumerated_Domain_Value_Definition:
        Tropical or sub-tropical broadleaf evergreen forest. Forests generally
        taller than five meters and more than 20 percent of total vegetation cover.
        These occur in the southern United States and Mexico. These forests have
        greater than 75 percent of tree crown cover represented by evergreen species.
        LCCS code: 20090.
      Enumerated_Domain_Value_Definition_Source:
        North American Land Change Monitoring System (NALCMS) Group
  Attribute_Domain_Values:
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Tropical or sub-tropical broadleaf deciduous forest. Forests generally
         taller than five meters and more than 20 percent of total vegetation cover.
         These occur in the southern United States and Mexico. These forests have
         greater than 75 percent of tree crown cover represented by deciduous species.
         LCCS code: 20132.
      Enumerated_Domain_Value_Definition_Source:
         North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
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      Enumerated_Domain_Value_Definition:
         Temperate or sub-polar broadleaf deciduous forest. Forests generally taller
         than three meters and more than 20 percent of total vegetation cover. These
         occur in the northern United States, Canada and mountainous zones of Mexico.
         These forests have greater than 75 percent of tree crown cover represented by
         deciduous species. LCCS code: 20227.
      Enumerated_Domain_Value_Definition_Source:
         North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
   Enumerated_Domain:
      Enumerated_Domain_Value: 6
      Enumerated_Domain_Value_Definition:
         Mixed forest. Forests generally taller than three meters and more than 20
         percent of total vegetation cover. Neither needleleaf nor broadleaf tree
         species occupy more than 75 percent of total tree cover but are co-dominant.
         LCCS codes: 20092, 20090, 20134, 20132, 20229, 20227.
      Enumerated_Domain_Value_Definition_Source:
         North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
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      Enumerated_Domain_Value: 7
      Enumerated_Domain_Value_Definition:
         Tropical or sub-tropical shrubland. Areas dominated by woody perennial
         plants with persistent woody stems less than five meters tall and typically
         greater than 20 percent of total vegetation. This class occurs across the
         southern United States and Mexico. LCCS code: 21450-13476.
      Enumerated_Domain_Value_Definition_Source:
         North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
   Enumerated_Domain:
      Enumerated_Domain_Value: 8
      Enumerated_Domain_Value_Definition:
         Temperate or sub-polar shrubland. Areas dominated by woody perennial plants
         with persistent woody stems less than three meters tall and typically greater
         than 20 percent of total vegetation. This class occurs across the northern
         United States, Canada and highlands of Mexico. LCCS code: 21450-12050.
      Enumerated_Domain_Value_Definition_Source:

North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
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    Enumerated_Domain_Value_Definition:
      Tropical or sub-tropical grassland. Areas dominated by graminoid or
      herbaceous vegetation generally accounting for greater than 80 percent of
      total vegetation cover. These areas are not subject to intensive management
      such as tilling but can be utilized for grazing. This class occurs across
      the southern United States and Mexico. LCCS code: 21669.
    Enumerated_Domain_Value_Definition_Source:
      North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
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    Enumerated_Domain_Value: 10
    Enumerated_Domain_Value_Definition:
      Temperate or sub-polar grassland. Areas dominated by graminoid or herbaceous
      vegetation, generally accounting for greater than 80 percent of total
      vegetation cover. These areas are not subject to intensive management such
      as tilling but can be utilized for grazing. This class occurs across
      Canada, United States and highlands of Mexico. LCCS code: 21537-12212.
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      North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
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    Enumerated_Domain_Value: 11
    Enumerated_Domain_Value_Definition:
      Sub-polar or polar shrubland-lichen-moss. Areas dominated by dwarf shrubs
      with lichen and moss typically accounting for at least 20 percent of total
      vegetation cover. This class occurs across northern Canada and Alaska. LCCS
      codes: 20022-12050, 21454-12212, 21439-3012.
    Enumerated_Domain_Value_Definition_Source:
      North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
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    Enumerated_Domain_Value_Definition:
      Sub-polar or polar grassland-lichen-moss. Areas dominated by grassland with
      lichen and moss typically accounting for at least 20 percent of total
      vegetation cover. This class occurs across northern Canada and Alaska. LCCS
      codes: 21454-12212, 20022-12050, 21439-3012.

    Enumerated_Domain_Value_Definition_Source:
      North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
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    Enumerated_Domain_Value: 13

Enumerated_Domain_Value_Definition:
        Sub-polar or polar barren-lichen-moss. Areas dominated by a mixture of bare
        areas with lichen and moss that typically account for at least 20 percent of
        total vegetation cover. This class occurs across northern Canada.
        LCCS codes: 21468, 21454-12212, 20022-12050.
      Enumerated_Domain_Value_Definition_Source:
        North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
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    Enumerated_Domain_Value_Definition:
        Wetland. Areas dominated by perennial herbaceous and woody wetland
        vegetation which is influenced by the water table at or near surface over
        extensive periods of time. This includes marshes, swamps, bogs, mangroves,
        etc., either coastal or inland where water is present for a substantial
        period annually. LCCS codes: 42349, 41809.
    Enumerated_Domain_Value_Definition_Source:
        North American Land Change Monitoring System (NALCMS) Group
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        Cropland. Areas dominated by intensively managed crops. These areas
        typically require human activities for their maintenance. This includes
        areas used for the production of annual crops, such as corn, soybeans, wheat,
        maize, vegetables, tobacco, cotton, etc.; perennial grasses for grazing; and
        woody crops such as orchards and vineyards. Crop vegetation accounts for
        greater than 20 percent of total vegetation. This class does not represent
        natural grasslands used for light to moderate grazing.
        LCCS codes: 10037, 10025, 21441, 21453.
    Enumerated_Domain_Value_Definition_Source:
        North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
  Enumerated_Domain:
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    Enumerated_Domain_Value_Definition:
        Barren lands. Areas characterized by bare rock, gravel, sand, silt, clay, or
        other earthen material, with little or no "green" vegetation present
        regardless of its inherent ability to support life. Generally, vegetation
        accounts for less than 10 percent of total cover. LCCS codes: 6001, 6004.
    Enumerated_Domain_Value_Definition_Source:
        North American Land Change Monitoring System (NALCMS) Group
Attribute_Domain_Values:
  Enumerated_Domain:
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    Enumerated_Domain_Value_Definition:
        Urban and built-up. Areas that contain at least 30 percent or greater urban

```
                constructed materials for human activities (cities, towns, transportation
                etc.) LCCS code: 5003.
          Enumerated_Domain_Value_Definition_Source:
                North American Land Change Monitoring System (NALCMS) Group
      Attribute_Domain_Values:
        Enumerated_Domain:
          Enumerated_Domain_Value: 18
          Enumerated_Domain_Value_Definition:
                Water. Areas of open water, generally with less than 25 percent cover of
                non-water cover types. This class refers to areas that are consistently
                covered by water. LCCS codes: 8001, 7001.
          Enumerated_Domain_Value_Definition_Source:
                North American Land Change Monitoring System (NALCMS) Group
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                Snow and ice. Areas characterized by a perennial cover of ice and/or snow,
                generally greater than 25 percent of total cover. LCCS codes: 8005, 8008.
          Enumerated_Domain_Value_Definition_Source:
                North American Land Change Monitoring System (NALCMS) Group

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      Contact_Organization_Primary:
        Contact_Organization: Commission for Environmental Cooperation
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        Address_Type: Mailing address
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        City: Montréal
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        Postal_Code: H3B 5M2
        Country: Canada
      Contact_Voice_Telephone: 1 514 350 4300
      Contact_Facsimile_Telephone: 1 514 350 4314
      Contact_Electronic_Mail_Address: info@cec.org
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      Contact_Organization_Primary:
        Contact_Organization: Canada Centre for Remote Sensing/Canada Centre for Mapping and Earth Observation, Natural Resources Canada
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        Contact_Organization: Comisión Nacional Forestal
        Contact_Person: José Armando Alanís de la Rosa
      Contact_Address:
        Address_Type: Mailing and physical address
        Address: Periférico Poniente 5360,
        Address: San Juan de Ocotán
        City: Zapopan
        State_or_Province: Jalisco
        Postal_Code: 45019
        Country: México
      Contact_Voice_Telephone: +52 33 3777 7000 Ext 4200
      Contact_Electronic_Mail_Address: jalanis@conafor.gob.mx
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        Contact_Organization: Instituto Nacional de Estadística y Geografía (INEGI)
      Contact_Position: Director of Natural Resources and Environment Information
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        Address: Av. Héroe de Nacozari Sur 2301. Fraccionamiento Jardines del Parque.
        City: Aguascalientes
        State_or_Province: Aguascalientes
        Postal_Code: 20270
        Country: Mexico
      Contact_Voice_Telephone: 52 44 99 10 53 65
      Contact_Electronic_Mail_Address: jose.ornelas@inegi.org.mx
      Hours_of_Service: 0800 - 1600 (-6h GMT)
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        Contact_Organization: U.S. Geological Survey
        Contact_Person: Jon Dewitz
      Contact_Address:
        Address_Type: Mailing and physical address
        Address: U.S. Geological Survey, CORE SCIENCE SYSTEMS
        Address: Mundt Federal Building
        Address: 47914 252nd Street
        City: Sioux Falls
        State_or_Province: South Dakota
        Postal_Code: 57198-0001
        Country: USA
      Contact_Voice_Telephone: 1 605 594 2714
      Contact_Electronic_Mail_Address: dewitz@usgs.gov
      Hours_of_Service: 0800 - 1600 CT, M - F (-6h CST/-5h CDT GMT)

  Distribution_Liability:
      Although these data have been processed successfully on computer systems at the CCRS, CONABIO, INEGI, USGS, and the Commission for
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      system, nor shall the act of distribution constitute any such warranty. Use of trademarks or formats does not constitute endorsement
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        Address: 700, de la Gauchetière Street West, Suite 1620
        City: Montréal
        State_or_Province: Québec
        Postal_Code: H3B 5M2
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        Contact_Person: Dr. Rasim Latifovic
      Contact_Address:
        Address_Type: Mailing and physical address
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        City: Ottawa
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        Contact_Person: Rainer A. Ressl
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        Address: Av. Liga Periférico-Insurgentes Sur 4903, Parques del Pedregal, Tlalpan 14010, México D.F.
        City: Mexico City
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      Hours_of_Service: 0800 - 1600 (-6h GMT)
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      Address: Av. Héroe de Nacozari Sur 2301. Fraccionamiento Jardines del Parque.
      City: Aguascalientes
      State_or_Province: Aguascalientes
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      Contact_Person: Jon Dewitz
    Contact_Address:
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      Address: U.S. Geological Survey, CORE SCIENCE SYSTEMS
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      City: Sioux Falls
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      Postal_Code: 57198-0001
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    Contact_Voice_Telephone: 1 605 594 2714
    Contact_Electronic_Mail_Address: dewitz@usgs.gov
    Hours_of_Service: 0800 - 1600 CT, M - F (-6h CST/-5h CDT GMT)
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