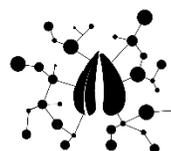


Agriculture Mapping Tool

User Guide and Documentation



Contents

Overview	1
Data Viewer	1
Select a Study Area	1
Select a Dataset	2
Query Builder	4
Analysis Tools	5
Change Analysis Tool	5
Natural Land Cover Risk Tool	6
Restoration Prioritization Tool	8
Dataset Manager	9
Importing Data	9
Exporting Data	9
Sharing Data	9
Datasets	9
Using the Mapping Application to Address Project Objectives.....	13
Objective 1 – Create a baseline map (inventory) of agricultural land attributes and land management practices.....	14
Prepare a map of agricultural land use	14
Map individual agricultural land use types.....	16
Map the adoption of land use practices.....	16
Identify areas satisfying a land use adoption threshold	17
Objective 2 - Map the condition of agricultural areas using agri-environmental indicators.....	19
Map agri-environmental status and assess change over time.....	19
Identify areas whose agri-environmental status is above or below a target	19
Objective 3 - Assess Conversion Risk for Grassland and Other Types of Natural Land Cover ..	21
Map natural land cover types	21
Assess change in natural land cover	22
Map the relative risk of conversion based on the intensity of recent development	24
Map the relative risk of conversion based on projected cropland expansion	25
Identify areas with the highest conversion risk	26
Objective 4 – Identify marginal agricultural land to be restored	28
Map agricultural capability	28

Identify marginal agricultural land	29
Prioritize marginal agricultural land for restoration based on surrounding natural land cover	30
Identify areas satisfying a restoration priority threshold	32
Identify areas satisfying a restoration priority threshold and an agri-environmental target	33
Objective 5 – View Maps Forecasting Agricultural Land Use.....	34
Map cropland projections under SSP scenarios.....	34
Compare cropland projections under different SSP scenarios	35
Identify natural land cover overlapping with areas of projected cropland expansion	36
Objective 6 – Assess agricultural land use change	36
Map agricultural land use over time	36
Identify areas of agricultural land use expansion or contraction	36
Identify locations of specific types of change such as conversion of agriculture to urban	38

Overview

The Agriculture Mapping Tool is a mapping web application for Canadian agricultural land-use, land management practices, and agri-environmental indicators. The tool has two main components: 1) a data viewer to map and query agricultural datasets; and 2) analysis tools that generate new datasets to explore landscape change, risk of natural land cover conversion, and priorities for restoration of marginal cropland. The data viewer is available to all users, thereby providing public access to a powerful yet user-friendly tool for exploring Canadian agricultural land use. The analysis tools are available to users with analyst accounts in order to manage the processing and data storage load associated with their application. Analyst users can share datasets generated using the analysis tools, thereby providing public users with the ability to view datasets related to landscape change, conversion risk, and prioritization of restoration opportunities.

The Agriculture Mapping Tool is accessed at <https://capi.alces-flow.com/>. This document describes how to use the various components of the tool (Data Viewer, Query Builder, Analysis Tools, Dataset Management, User Management), the datasets that are available in the tool, and how the tool can be used to address objectives identified by CAPI for the project.

Data Viewer

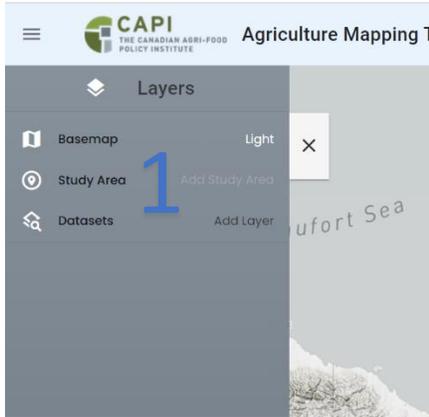
Once the user logs into the tool they are taken to the Data Viewer. The left “Layers” panel in the Data Viewer allows you to select a basemap, a study area, and one or more datasets. By default, satellite imagery is selected as the basemap.

Select a Study Area

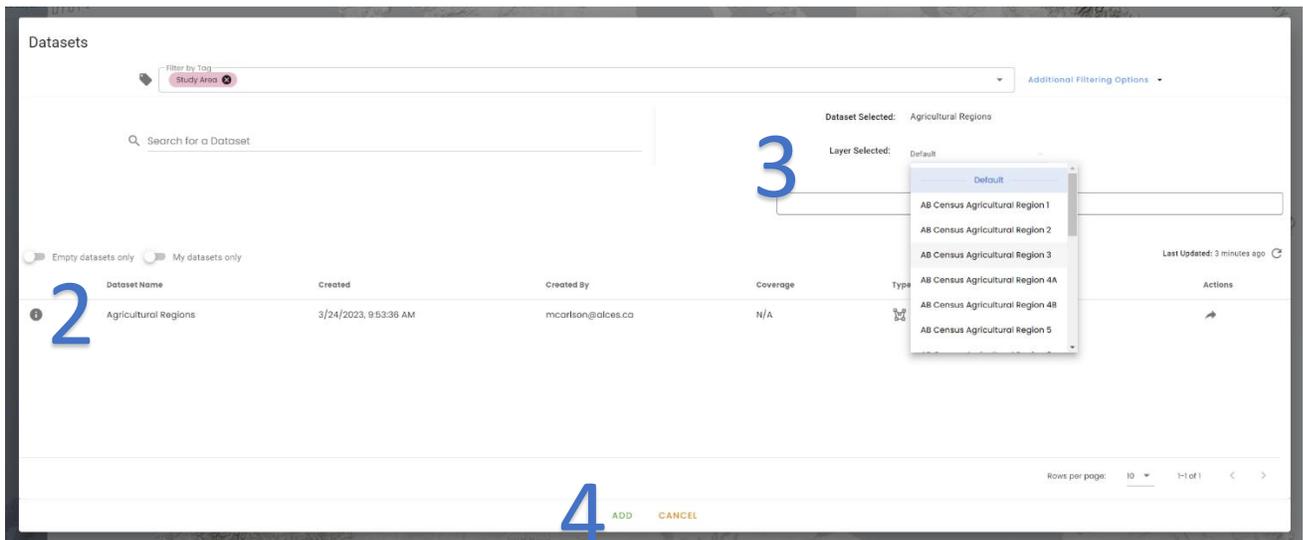
The default study area is the full extent of a dataset, which is the agricultural portion of Canada in most cases. Alternatively, agricultural attributes can be mapped for individual provinces, agricultural census regions (n=82), census subdivisions (n=5,250), or the first 3 digits of a postal code also referred to as forward sortation areas (n=1,620).

- Agricultural Regions are used for reporting purposes by the Census of Agriculture and are composed of groups of adjacent census divisions. Maps identifying the location of agricultural census regions are available at <https://www150.statcan.gc.ca/n1/pub/95-630-x/95-630-x2022001-eng.htm>.
- Census subdivisions are municipalities or areas treated as municipal equivalents for statistical purposes. There are 1,804 census subdivisions in Canada. Maps identifying the location census subdivisions are available at <https://publications.gc.ca/Collection/Statcan/92F0149X/92F0149XIB-e.html>.
- The first 3 digits of a postal code, also referred to as forward sortation areas, is an alternatively spatial unit for mapping local agricultural land use. Postal codes associated with an address can be found here: <https://www.canadapost-postescanada.ca/cpc/en/tools/find-a-postal-code.page>.

For example, to select an agricultural region as a study area, click Add Study Area in the left panel (1).



Next click Agricultural Regions in the Datasets box (2). Next select an agricultural region from the Layer Selected dropdown menu in the upper right of the Datasets box (3). Then click ADD (4).



NOTE: additional study area regions can be added to the tool by importing shapefiles. See the Dataset Manager section for details.

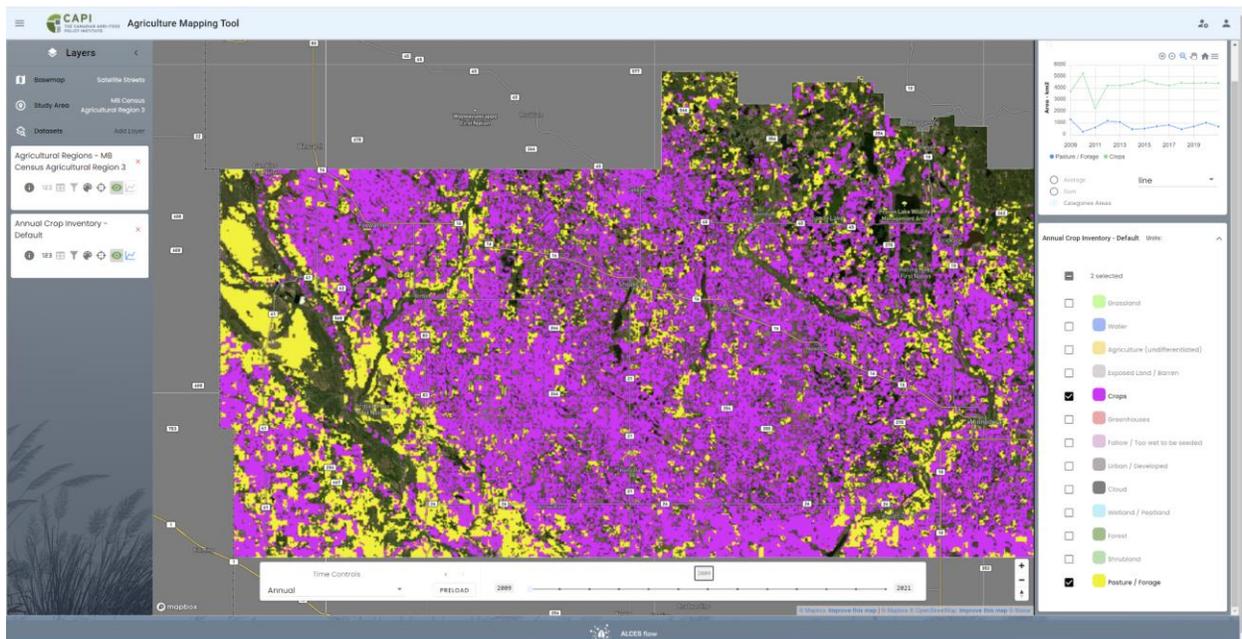
Select a Dataset

To add a dataset to the map, click Add Layer in the left panel. Next select a dataset in the Datasets box. Information about datasets can be accessed by clicking **i**. **The Agri-Environmental Indicators dataset, the Census of Agriculture dataset, and the Canada Land Inventory – Land Capability for Agriculture dataset contain multiple layers, each of which represents an indicator. To view these indicators, select a layer from the Layer Selected dropdown menu in the upper right of the Datasets box.** For example, the Agri-Environmental Indicators dataset contains layers for a number of indicators including greenhouse gas emissions, ammonia emissions, pesticides, soil organic carbon, nitrogen, soil erosion, and wildlife habitat capacity. You can also use the Layer Selected dropdown menu to choose classification schemes for the Annual Crop Inventory and AAFC Semi-Decadal Land Use

datasets. Note that some datasets only contain a single layer. Once a dataset and layer is selected click ADD.

Once a layer has been mapped the legend can be viewed by clicking legend and charts icon  in the upper right, and then clicking the indicator's name to show the legend. You can zoom in and out using the +/- in the bottom right or using the wheel of your mouse. The time bar at the bottom of the map page is used to change years. The data layer box in the left panel is used to access data layer information , and statistics  ¹²³, to perform a query , to modify symbology , to zoom to the study area extent , to turn the map layer on and off , and to prepare a chart . For quantitative datasets (e.g., Agri-Environmental Indicators, Census of Agriculture), the chart and statistics present summary values for the study area (mean, sum, min, max, std). For categorical datasets (Annual Crop Inventory, AAFC Semi-Decadal Land Use), the chart and statistics present area by each category (e.g., by land cover type). Note that datasets that are not associated with a timeline (e.g., Canada Land Inventory – Land Capability for Agriculture) do not have charts but summary values can be viewed using the statistics table.

Categorical datasets, for example land cover data, have interactive legends that can be used to limit the map, chart, and statistics on a subset of land cover types. Once a categorical dataset is opened, it's interactive legend can be accessed by clicking the legend in the right panel. Check boxes next to land cover types can be used to limit the map, chart, and statistics to a subset of categories. An example is shown below.



Multiple layers can be view simultaneously by using Add Layer multiple times. The map and graph can be toggled between layers, or opacity can be adjusted by modifying symbology. When viewing multiple layers, note that the first layer's time span, time step, and study area is applied to all layers. This can result in empty maps for some years if the temporal extent of the first layer does not completely overlap the temporal extent of subsequent layers.

Charts can be exported by clicking the menu icon in the top right corner of a chart . Datasets can be exported using the Dataset Manager.

Query Builder

The Query Builder can be used to map areas that satisfy user-defined agricultural criteria, such as an agri-environmental threshold or an agricultural input level. The Query Builder works by applying one or both of the following types of conditions to limit the coverage of a land cover dataset: a) limiting the land cover dataset to a subset of cover types; and b) limiting the land cover dataset to the portion of the study area satisfying a condition for an agri-environmental indicator or an agricultural practice. In this manner, the user can map and calculate the area of land cover satisfying (or violating) an environmental or management practice.

The Query Builder is located in the Data Viewer. The following steps are followed to apply a query:

1. Select a Study Area. Note: if a study area is not selected, the query will be applied to the entire extent of the data layers used in the query, which is typically all of Canada.
2. Add a land cover dataset to the map (i.e., Annual Crop Inventory or the AAFC Semi-Decadal Land Use dataset).
3. Add an Agri-Environmental or Census of Agriculture data layer to the map. Agri-environmental layers are measures of key environmental conditions, risks, and changes resulting from agriculture. Census of Agriculture layers available in the tool include those representing the adoption of tillage practices and the use of various types of agricultural inputs. When using an Agri-Environmental layer, it is helpful to use the “classification” versions. When using a Census of Agriculture layer, it is helpful to use the “proportion” versions. These are easier to interpret when applying query conditions.
4. In the left panel, click the query icon () for the land cover dataset that you selected in step 2. The Query Builder panel will appear at the bottom of the map window.
5. Use the Query Builder panel to apply conditions to the Query Layer and Target Layer. The Query Layer is the land cover dataset that was selected in step 2. The Target Layer is the Agri-Environmental or Census of Agriculture dataset that was selected in step 3.
6. Output from the query is mapped by limiting the query layer to the requested cover type(s) and masking areas that do not satisfy the target layer condition. The statistics and chart present the extent (km²) of the requested cover type(s) in areas satisfying the target layer condition.

The above description of the Query Builder indicates that the Query Layer should be a land cover data layer and that the Target Layer should be an Agri-Environmental or Census of Agriculture layer. It is also possible to apply the Query Builder to other data layers as long as the Query Layer is a raster layer and the Target Layer is a vector layer. For example, output from the restoration prioritization tool (described in the next section) could be used as the Query Layer and an Agri-Environmental data layer could be used as the Target Layer to identify priority restoration areas that satisfy an environmental threshold.

The temporal range of a query is the overlapping portion of the Query Layer and Target Layer temporal ranges. In the previous example, the temporal range of the AAFC Semi-Decadal Land

Use layer is 2000 to 2020 whereas the temporal range of the wildlife habitat capacity classification is 2000 to 2015. The temporal range of the query is therefore 2000 to 2015.

Note: when using the Annual Crop Inventory as the Query Layer, output for 2009 and 2010 will be blank (0 km²) if the study area is not within the area that was initially included in the Annual Crop Inventory (Alberta, Saskatchewan, and Manitoba).

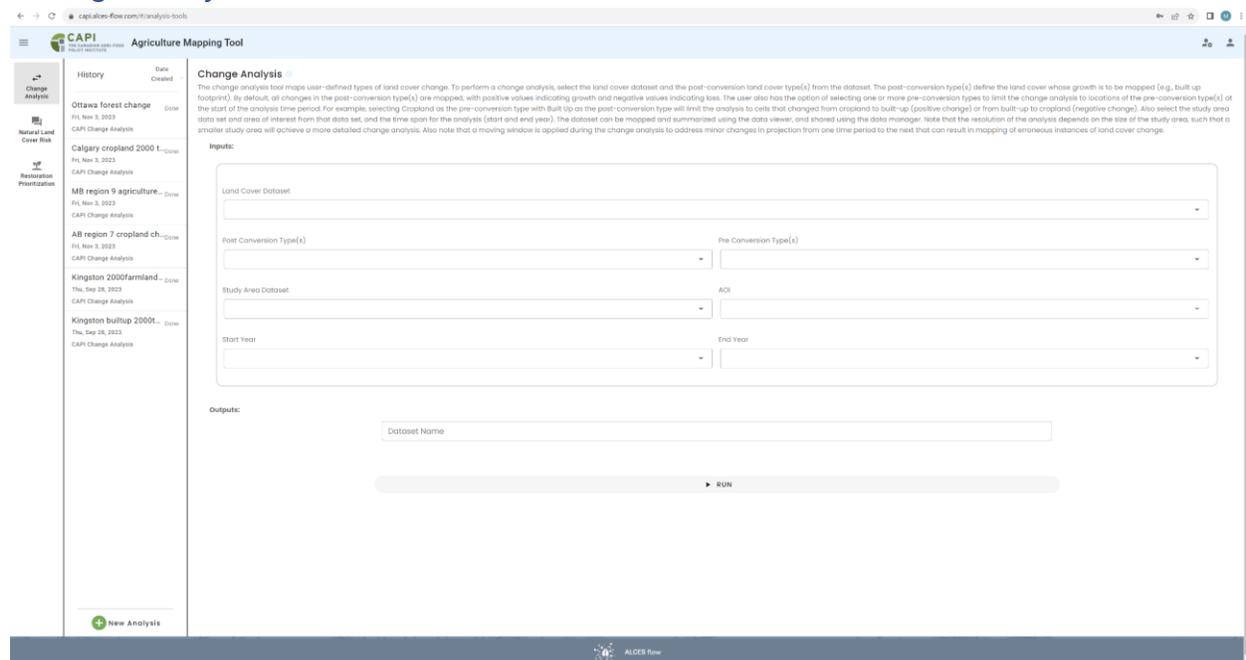
Analysis Tools

The Agriculture Mapping Tool includes a set of analysis tools to explore 3 questions related to agricultural land use:

1. Where is land cover or land use changing?
2. Where is natural land cover at greater risk of conversion?
3. Where should marginal farmland be prioritized for restoration?

The analysis tools, which are available to analyst but not public users, generate new raster datasets. An analyst user can share output datasets with other analysts or with public users.

Change Analysis Tool



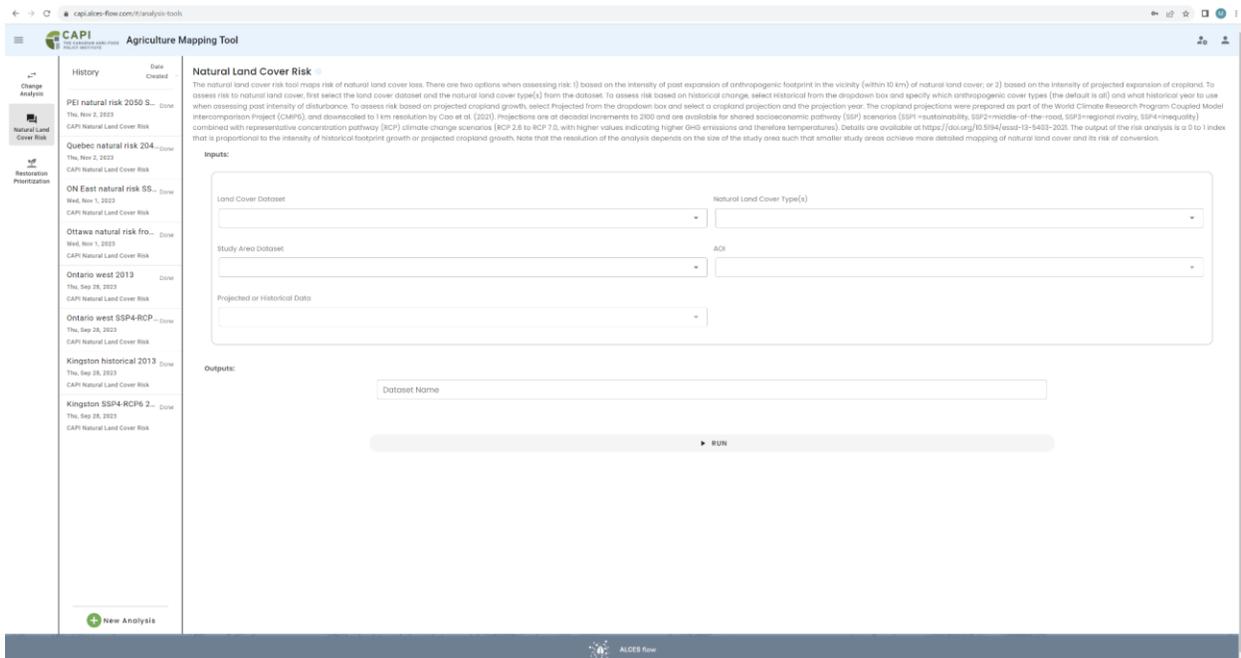
The Change Analysis tool is used to map user-defined types of land cover change, such as growth of a crop type or conversion of cropland to urban footprint. To use the tool, the user specifies the following:

- The Land Cover Dataset to use in the analysis. The two datasets available are the Annual Crop Inventory and the AAFC Semi-Decadal Land Use dataset.
- Post Conversion Type(s). This refers to the land cover type(s) from the Land Cover Dataset for which change is being assessed. A positive result from the change analysis indicates growth in the post conversion type, while a negative result indicates reduction in the post conversion type.

- Pre Conversion Type(s). This is an optional input that allows the user to limit that change analysis to locations belonging to the specified land cover type(s) prior to converting to the post conversion type. For example, setting the Pre Conversion Type to cropland and the Post Conversion Type to built up will identify areas where cropland has been lost to built up footprint (e.g., urban expansion). By default, all land cover types except for the Post Conversion types are selected as the Pre Conversion types.
- Study Area Dataset and AOI. These inputs define the study area.
- Start Year and End Year. These inputs define the temporal extent of the change analysis.

After clicking run, a status bar will appear indicating whether the analysis has completed. Once the analysis is complete, the Output Dataset link in the top right corner of the screen can be clicked to view the output. Alternatively, you can view output by opening the Data Viewer and using the Filter by Scenario option with the scenario set to the Dataset Name that you specified in the Change Analysis tool.

Natural Land Cover Risk Tool



The Natural Land Cover Risk tool is used to assign a risk index to natural land cover based on recent loss of natural land cover in the vicinity or based on the location of projected cropland expansion. The index has a 0 to 1 value, with 1 indicating the highest relative risk. To use the tool, the user specifies the following:

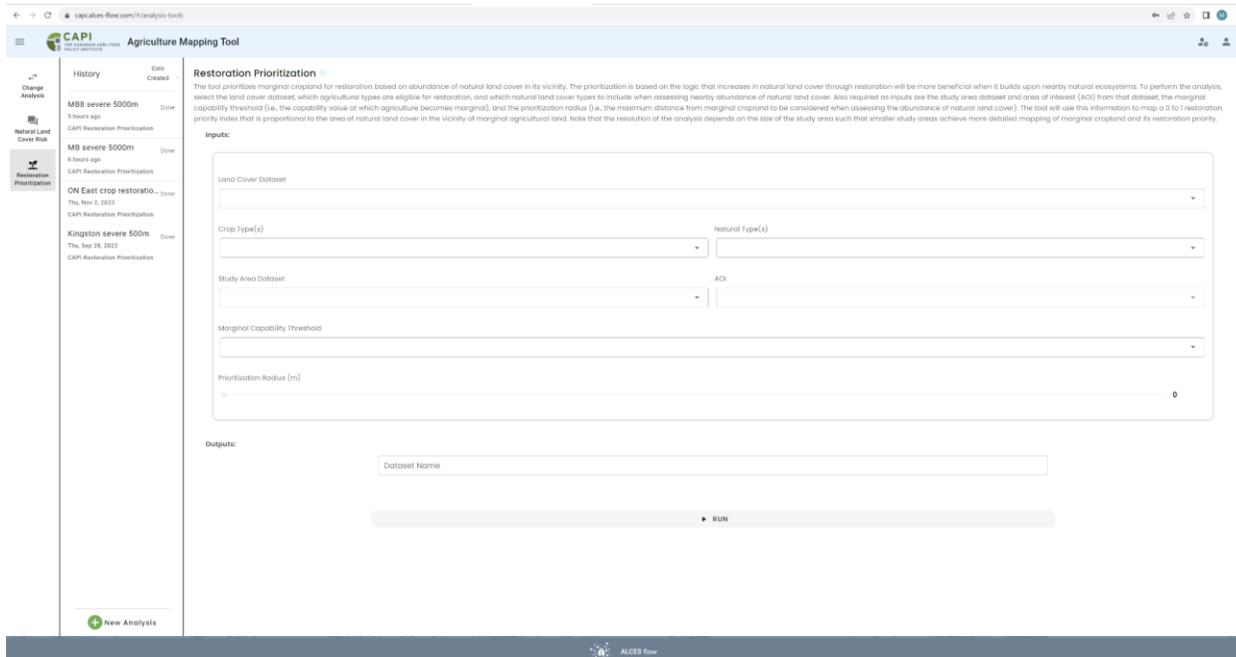
- The Land Cover Dataset to use in the analysis. The two datasets available are the Annual Crop Inventory and the AAFC Semi-Decadal Land Use dataset.
- Natural Land Cover Type(s). This refers to the land cover types from the Land Cover Dataset that should be included when identifying natural land cover.
- Study Area Dataset and AOI. These inputs define the study area.
- Projected or Historical Data. This input allows the user to select between two approaches for assessing risk. The Projected option assesses risk based on overlap

with a cropland projection. The Historical option assesses risk based on recent change in natural land cover.

- Additional inputs if the Projected option is selected
 - Cropland Projection Dataset. Five cropland projection datasets are available to be used to estimate where natural land cover may be converted to cropland in the future. The cropland projections were prepared as part of the World Climate Research Program Coupled Model Intercomparison Project (CMIP6), and downscaled to 1 km resolution by Cao et al. (2021). Projections are at decadal increments to 2100 and are available for shared socioeconomic pathway (SSP) scenarios (SSP1 =sustainability, SSP2=middle-of-the-road, SSP3=regional rivalry, SSP4=inequality) combined with representative concentration pathway (RCP) climate change scenarios (RCP 2.6 to RCP 7.0, with higher values indicating higher GHG emissions and therefore temperatures). Details are available at <https://doi.org/10.5194/essd-13-5403-2021>.
 - Projection End Year. The cropland projection datasets are available at decadal increments from 2030 to 2100. The user selects which decade should be used when assessing risk to natural land cover. Risk is assessed by calculating growth in cropland by the projection end year according to the cropland projection dataset. Higher cropland growth translates to a higher risk index value.
- Additional inputs if the Historical option is selected
 - Anthropogenic Land Cover Type(s). The user selects which anthropogenic land cover types should be used when assessing development pressure in the vicinity of natural land cover (within 10 km)
 - Start Year. The user selects the historical time period to use when assessing recent development pressure in the vicinity of natural land cover. For example, if 2015 is selected, risk is assessed by calculating growth in the selected anthropogenic land cover type(s) between 2015 and the most recent year of the land cover dataset. Higher growth of anthropogenic land cover over the selected time period translates to a higher risk index value.

After clicking run, a status bar will appear indicating whether the analysis has completed. Once the analysis is complete, the Output Dataset link in the top right corner of the screen can be clicked to view the output. Alternatively, you can view output by opening the Data Viewer and using the Filter by Scenario option with the scenario set to the Dataset Name that you specified in the Natural Land Cover Risk tool.

Restoration Prioritization Tool



The Restoration Prioritization tool is used to assign a priority index to marginal farmland based on the abundance of natural land cover in the surrounding area. The availability of natural land cover in the surrounding area is relevant when prioritizing marginal farmland for restoration because surrounding natural land cover can contribute native colonizers and reduce edge effects from developed land. Furthermore, focusing restoration on areas with surrounding natural land cover acts to build larger natural landscapes with the capacity to support a wider range of species. The prioritization index has a 0 to 1 value, with 1 indicating the greatest abundance of natural land cover in the surrounding area. To use the tool, the user specifies the following:

- The Land Cover Dataset to use in the analysis. The two datasets available are the Annual Crop Inventory and the AAFC Semi-Decadal Land Use dataset.
- Crop Type(s). The user selects which agricultural land cover types should be considered eligible for restoration in the analysis.
- Natural Land Cover Type(s). The user selects which natural land cover types should be included when assessing the abundance of natural land cover in the vicinity of marginal farmland.
- Study Area Dataset and AOI. These inputs define the study area.
- Marginal Capability Threshold. The user selects an agricultural capability rating from the Canada Land Inventory – Land Capability for Agriculture dataset to use when identifying marginal farmland. All farmland with the capability rating or with a lower capability rating is interpreted as marginal in the analysis.
- Prioritization Radius (m). The user specifies the maximum distance from marginal cropland to be included when assessing the abundance of natural land cover. Higher abundance of natural land cover within the prioritization radius of marginal cropland translates to a higher prioritization index value.

After clicking run, a status bar will appear indicating whether the analysis is complete. Once the analysis is complete, the Output Dataset link in the top right corner of the screen can be clicked to view the output. Alternatively, you can view output by opening the Data Viewer and using the Filter by Scenario option with the scenario set to the Dataset Name that you specified in the Restoration Prioritization tool.

Dataset Manager

The Dataset Manager is available to analyst users and is accessed using the menu icon in the top left corner . The main roles of the dataset manager is importing and exporting data and sharing data.

Importing Data

To import a dataset, click + NEW DATASET in the Dataset Manager. Select the data type. If you are importing a shapefile to be used as a study area select the vector data type. Enter a name and click Create Dataset. A Dataset Properties box will prompt you to Add File To Dataset. Select the dataset to import; if it is a shapefile, the dataset files need to be in a zip folder. When importing datasets to be used as study areas you do not need to specify the Temporal Range. You also do not need to specify the layer field unless your dataset is a .kml or .gpkg with multiple internal layers.

After uploading the file, click Information from the menu along the left of the Dataset Properties box. Click the pencil icon next to the Description and enter a description of the dataset. Then click the pencil icon next to the Tags icon and enter relevant Tags. Tags are used by ALCES to categorize datasets. More than one tag can be selected. **IMPORTANT:** If you are importing a shapefile that is to be used as a study area, you must select Study Area as a tag.

Exporting Data

To export a dataset, click the dataset's information icon  in the Dataset Manager and select Files. Only raster datasets can be downloaded.

Sharing Data

If you want a dataset that you have imported or created using an analysis tool to be available to others, it must be shared. This is done by clicking the arrow for the dataset under the actions column in the dataset window. To share a dataset across all users, check View for the CAPI group. Alternatively, datasets can be shared with individual analysts.

Datasets

The main datasets available in the tool are described below.

Annual Crop Inventory

- Description: The satellite derived inventory delineates various crop types, urban/developed areas, and a set of natural land cover types (grassland, shrubland, wetland, forest types, exposed, water). The inventory was prepared by AAFC using a decision tree methodology to classify optical and radar satellite images based on known crop types at a subset of locations.

- Source: <https://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9>
- How the data will be used in the app
 - Map current land cover (e.g., crop types)
 - Explore change in a land cover type (e.g., a crop type) over time
 - Identify locations of user-requested types of land cover change (e.g., change from one crop type to another between time periods)
 - In combination with the Canada Land Inventory's agriculture capability layer, identify the current extent of cropland when prioritizing marginal cropland for restoration.
 - Assess natural land cover when prioritizing marginal cropland for restoration. For example, marginal cropland may be prioritized based on the area of grassland (according to the AAFC Annual Cropland Inventory) occurring within 5 km of the cropland.
 - Identify the current extent of natural land cover types (e.g., grassland) when assessing risk of conversion.
- Resolution: 30 m for all years except for 2009 and 2010 which has a resolution of 56 m
- Time period: The dataset is available annually from 2009 to 2021
- Limitations:
 - The dataset is not available prior to 2009.
 - The spatial coverage of the dataset differs depending on the time period. Years 2009 and 2010 only cover the agricultural portion of the prairie provinces. Years 2011 and 2012 cover the agricultural portion of Canada except for Newfoundland. Years 2013 to 2021 cover the entire agricultural portion of Canada.
 - The level of detail in crop types varies across the country. In some provinces (Alberta, Saskatchewan, Quebec), cereal crops are divided into sub-categories (barley, oats, wheat, etc.) whereas in other provinces cereal crops are not divided.
 - Target accuracy is 85%.

AAFC Semi-Decadal Land Use

- Description: *"The AAFC Land Use Time Series is a culmination and curated meta-analysis of several high-quality spatial datasets produced between 1990 and 2021 using a variety of methods by teams of researchers as techniques and capabilities have evolved. The information from the input datasets was consolidated and embedded within each 30m x 30m pixel to create consolidated pixel histories, resulting in thousands of unique combinations of evidence ready for careful consideration. Informed by many sources of high quality evidence and visual observation of imagery in Google Earth, we apply an incremental strategy to develop a coherent best current understanding of what has happened in each pixel through the time series."*
- Source: <https://open.canada.ca/data/en/dataset/fa84a70f-03ad-4946-b0f8-a3b481dd5248>
- How the data will be used in the app
 - Explore change in a coarse set of land cover types (cropland, forest, settlement, grassland, wetland) over time.

- Identify locations of user-requested types of land cover change (e.g., change from cropland to settlement between time periods)
- Resolution: 30 m
- Time period: The dataset is available at 5-year intervals from 2000 to 2020
- Limitations
 - Cropland is not divided into categories.
 - Data is only available at 5-year intervals.

Census of Agriculture

- Description: The Census of Agriculture is a statistical portrait of Canada’s agriculture industry. The census is completed by Statistics Canada by surveying every agricultural operation and operator in Canada. While a wide range of data are gathered, the data that are being used in the app are those related to land management practices. The following two Census of Agriculture datasets are being incorporated: tillage and seedling practices; and land inputs, manure and irrigation. The tillage and seeding practices dataset identifies number of hectares for each type of tillage: no-till; tillage with crop residue on surface; and tillage with crop residue in soil. The land inputs, manure and irrigation dataset identifies the number of hectares for each of the following types of inputs: treated seed; herbicides; insecticides; fungicides; commercial fertilizer; lime; trace minerals and nutrients; type of manure application (solid vs liquid, incorporated vs not incorporated); and irrigation.
- Source: <https://www.statcan.gc.ca/en/census-agriculture>
- How the data will be used in the app
 - Map current land management practices
 - Assess change in land management practices over time
 - Compare land management practices between areas
- Resolution: Consolidated Census Subdivisions
- Time period: 2011, 2016, and 2021
- Limitations
 - Consolidated census subdivisions are relatively coarse spatial units. As such, the data do not allow for spatially detailed assessment of changes in land management practices.
 - The land management data are only available for a relatively brief period (at most 2011 to 2021) and at 5-year intervals. As such, the data do not allow for long-term assessment of changes in land management practices

Agri-Environmental Indicators

- Description: *“Agri-environmental indicators (AEIs) are measures of key environmental conditions, risks, and changes resulting from agriculture and of the management practices that producers use to mitigate risks”*. Examples of each of four AEI categories are available in this application: air quality and greenhouse gas (agricultural greenhouse gases, agricultural ammonia); soil health (soil erosion, soil organic matter); water quality (nitrogen, pesticides); and biodiversity (wildlife habitat capacity on farmland). Two layers are available for each: a quantitative layer in AEI’s measurement units (e.g.,

Agricultural Greenhouse Gas Emissions, which is measured in units of kg CO₂ per hectare); and a classification layer (e.g., Agricultural Greenhouse Gas Emissions Classification) which classifies polygons into 5 levels (very low, low, moderate, high, very high).

- Source: <https://agriculture.canada.ca/en/environment/indicators>
- How the data will be used in the app
 - Map current (2016) state of agri-environmental indicators
 - Assess change in agri-environmental indicators over time
 - Compare status of agri-environmental indicators between areas
- Resolution: Soil Landscapes of Canada polygons
- Time period: annually from 1981 to 2018. Exceptions are pesticides (available every 5 years from 1981 to 2011) and wildlife habitat capacity (available every 5 years from 2000 to 2015).
- Limitations
 - Soil Landscapes of Canada polygons are relatively coarse spatial units
 - Agri-environmental indicators are only available up to 2016

Canada Land Inventory – Land Capability for Agriculture

- Description: Assesses potential for agricultural production based on mineral soils grouped according to their potential and limitations for agricultural use. Categories are: no significant limitations; moderate limitations; moderately severe limitations; severe limitations; forage crops – improvement practices feasible; forage crops – improvement practices not feasible; no capability; and organic soils.
- Source: <https://open.canada.ca/data/en/dataset/0c113e2c-e20e-4b64-be6f-496b1be834ee>
- How the data will be used in the app
 - In combination with the AAFC Annual Cropland Inventory layer, identify the current extent of marginal cropland when prioritizing marginal cropland for restoration.
- Resolution
 - Soil polygons
- Time period: prepared between then 1960's and 1980's
- Limitations:
 - The data behind the capability classifications is relatively old. Some of the classifications are out of date due to management changes like soil drainage that would tend to improve the class of certain soils.
 - Classifications are based on suitability for one crop (wheat in the west and corn in the east) and is therefore somewhat biased in the classification.
 - Despite these limitations the interpretations are still considered to be largely valid and is the best national information available. The CanSIS unit has been working on an updated classification system but the results are not available at this time.

Global Cropland Dataset

- Description: Prepared by Cao et al. (2021) by downscaling global land use projections. The global land use projections were prepared as part of the World Climate Research Program Coupled Model Intercomparison Project (CMIP6) at 0.25 x 0.25 resolution. CMIP6 projections (Hurtt et al. 2020) are available for shared socioeconomic pathway (SSP) scenarios: SSP1 (sustainability); SSP2 (middle-of-the-road); SSP3 (regional rivalry); SSP4 (inequality); and SSP5 (fossil-fueled development). The scenarios vary in terms of assumed levels of land-use change regulation, land productivity growth, food consumption (e.g., level of meat consumption), international trade, globalization, and land-based mitigation policies (Popp et al. 2017). As a result, the scenarios differ with respect to implications for the rate and spatial distribution of agricultural expansion. For example, SSP1 exhibits a decline in agricultural land whereas SSP3 exhibits the highest increase in cropland due to increasing global population and low agricultural intensification. Cao et al. (2021) downscaled the projections using a random forest approach applied to terrain, climate, soil, and population data.
- Source: https://zenodo.org/record/5759237#.Y-_nznbMIQ8
- How the data will be used in the app
 - Identify areas projected to experience growth in cropland when assess risk of conversion of natural land cover by agriculture.
- Resolution: 1 km²
- Time period: decadal time steps from 2020 to 2100
- Limitations:
 - As with other projections of agricultural activity (e.g., Zable et al. 2019), Canadian cropland expansion is low relative other global regions and is generally projected to occur in the vicinity of existing agricultural areas in Canada. As such, projected growth in cropland and associated risk to natural land cover will likely be low.
 - The projections and downscaling approach was based on a set of global rules that do not necessarily incorporate the best local data. As such, the dataset is primarily for global as opposed to local analysis. However, it is beyond the scope of the project to derive new cropland projections so the dataset provides an approach to approximate areas that are expected to experience growth in agricultural activity.

Using the Mapping Application to Address Project Objectives

The Canadian Agricultural Mapping Application was created to address the following objectives:

- Create a baseline map (inventory) of agricultural land attributes and land management practices
- Map the condition of agricultural areas using agri-environmental indicators
- Assess the risk of grassland conversion
- Identify marginal crop lands to be restored
- Create maps forecasting agricultural land use that take into account climate change models, increased demand for food and plant-based fuel production

- Assess how the agricultural land use change (expansion) has affected urbanization

The tool has been designed to be flexible by providing a range of data sets, study areas, and analysis tools that can be used to explore and visualize agricultural data. An implication is that there are a variety of ways to explore data to address the objectives. While this flexibility is beneficial, an associated challenge is that it is easy to become overwhelmed by the range of options. This section describes how the tool can be used to address the objectives list above. The approaches should be considered examples to help users become familiar with the tool that they can subsequently modify to address specific questions.

Objective 1 – Create a baseline map (inventory) of agricultural land attributes and land management practices

The tool allows the user to generate maps of agricultural land use and management practices for numerous study areas and explore change in agricultural activities over time through time series maps, charts, and statistics. Examples of analyses that can be completed in support of objective 1 are described below.

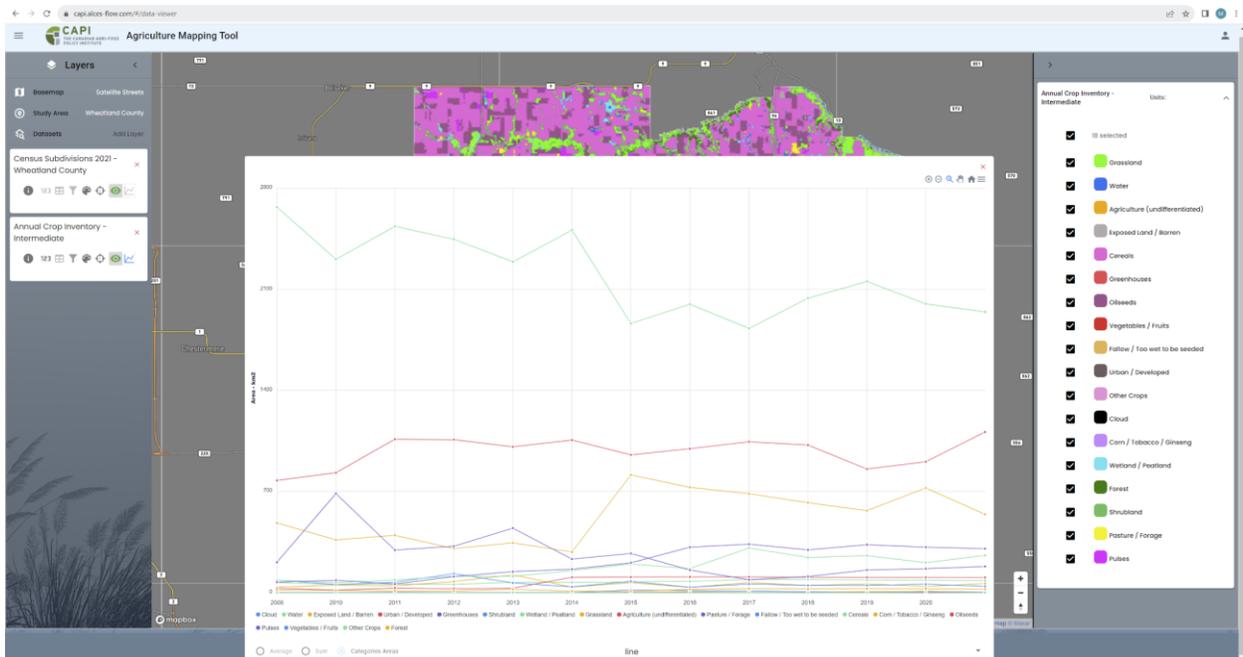
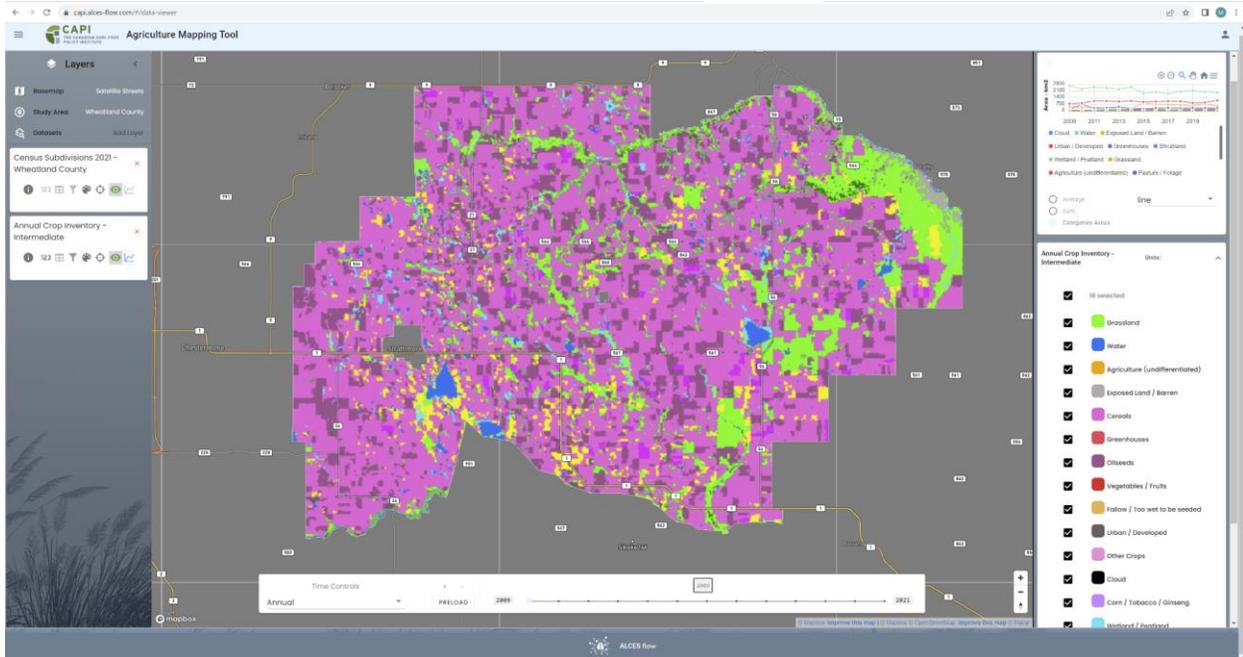
Prepare a map of agricultural land use

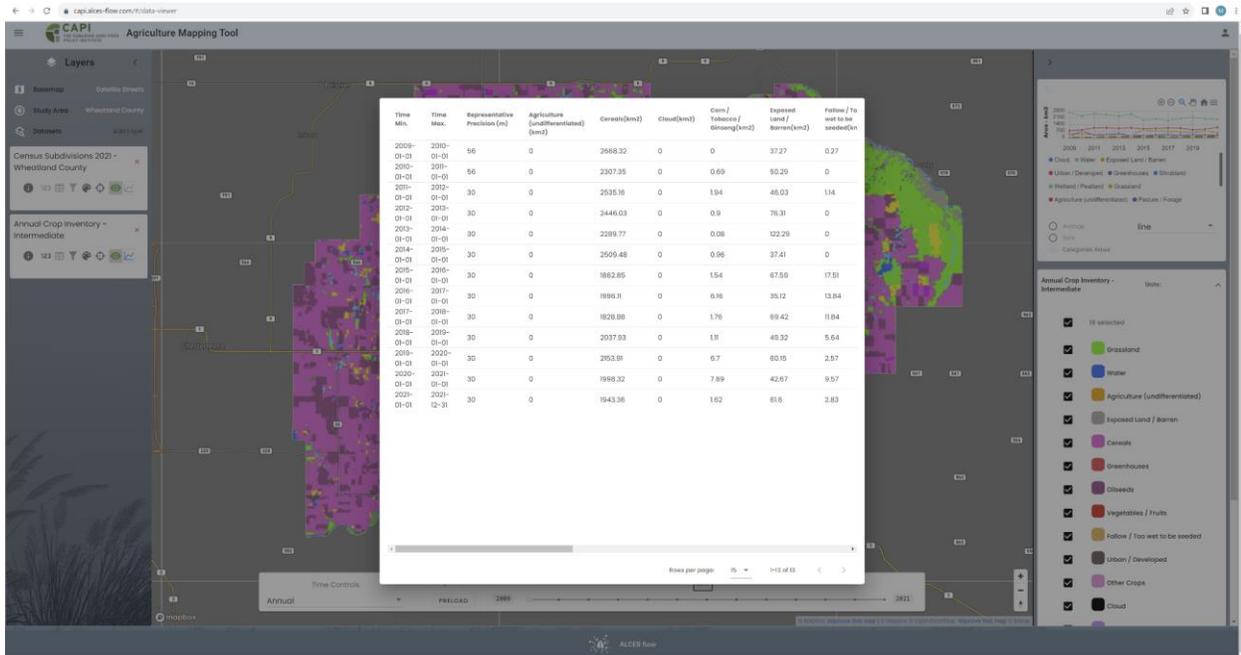
The Annual Crop Inventory can be accessed in the **Data Viewer** to prepare maps of agricultural land attributes. When mapping the Annual Crop Inventory dataset, three versions are available as layers. The Default layer is a general representation of land cover in agricultural areas that identifies 13 cover types, including 5 summary agricultural types (crops, pasture/forage, fallow/too wet to be seeded, undifferentiated, and greenhouses). The Intermediate layer uses more detailed but still aggregated agricultural land use into categories such as cereals, oilseeds, and pulses. The Detailed layer identifies 77 land cover types and is useful for exploring the distribution of individual crop types (e.g. spelt, triticale, wheat, etc.).

The AAFC Semi-decadal Land Use dataset can also be accessed in the Data Viewer to prepare maps of agricultural land attributes. This dataset is less detailed in its categorizing of agricultural land use but provides a longer term perspective on land use change as it is available in five-year increments since the year 2000.

Maps of agricultural land attributes can be prepared for a range of study areas. If a study area is not selected, a map will be prepared for all of Canada. Alternatively, agricultural land attributes can be mapped for individual provinces, agricultural census regions (n=82), census subdivisions (n=5,250), or 3 digit postal codes (n=1,620). Analyst users can also import shapefiles to add study areas to the tool.

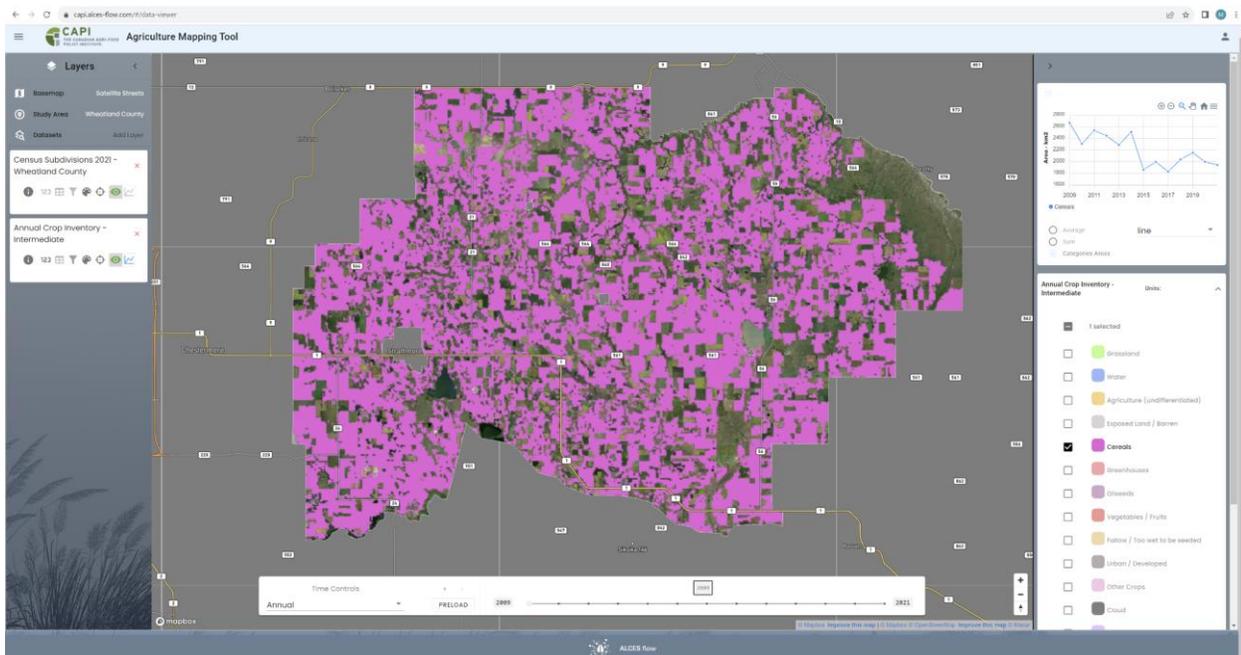
Mapping the Annual Crop Inventory will generate a map time series covering all years for which the Annual Crop Inventory is available. In addition to the map, a table and chart for the study area can be viewed to assess total area by cover type and year. The graph can be download as a csv to use in other applications such as excel.





Map individual agricultural land use types

If the user is interested in mapping and charting individual land use types, the interactive legend in the **Data Viewer** can be used to limit a land cover map to one or more cover types to explore the location of individual agricultural land use types.

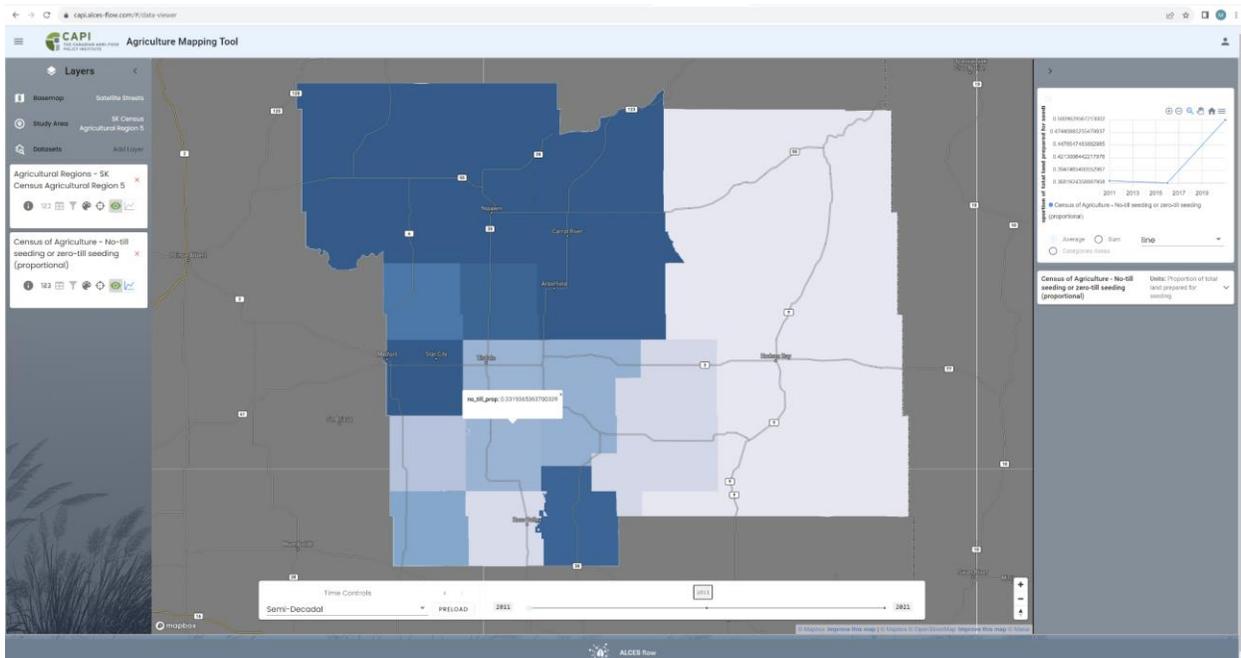


Map the adoption of land use practices

Census of Agriculture data can be accessed in the **Data Viewer** to prepare maps depicting adoption rates for agricultural practices. Land use practices that are available are inputs

(proportion of farms applying commercial fertilizer, fungicides, herbicides, insecticides, lime, or trace minerals and nutrients) and tillage (proportion of farms using no-fill seeding, tillage that incorporates most crop residue into soil, or tillage retaining most crop residue on the surface). Two data layers are available for each practice, one that presents the area of the practice within an Agricultural Region and another that presents the proportion of agricultural land receiving the practice in the Agricultural Region. The proportional data layers will likely be more useful when mapping the adoption of land use practices. As described previously, maps can be prepared for a range of study areas. The overall average value for a study area is the average adoption rate for the study area expressed as a proportion of the study area's agricultural area or as absolute area (ha). The adoption rate for an individual Agricultural Region within the study area can be selected by clicking a location on the map.

The example below shows the adoption of no-till seeding increasing from about 37% to 50% between the 2011 and 2021 census in Saskatchewan Census Agricultural Region 5. The adoption of no-till seeding in a selected (i.e., clicked) census sub-division in the screenshot is 33% in the year 2011.

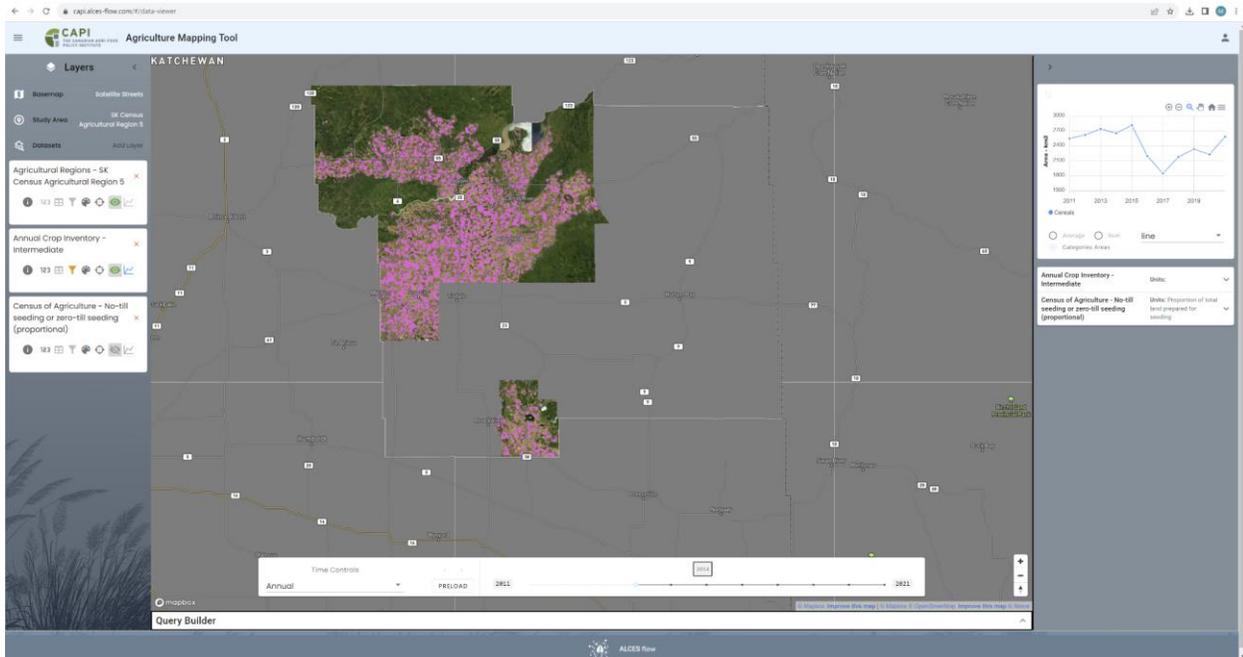
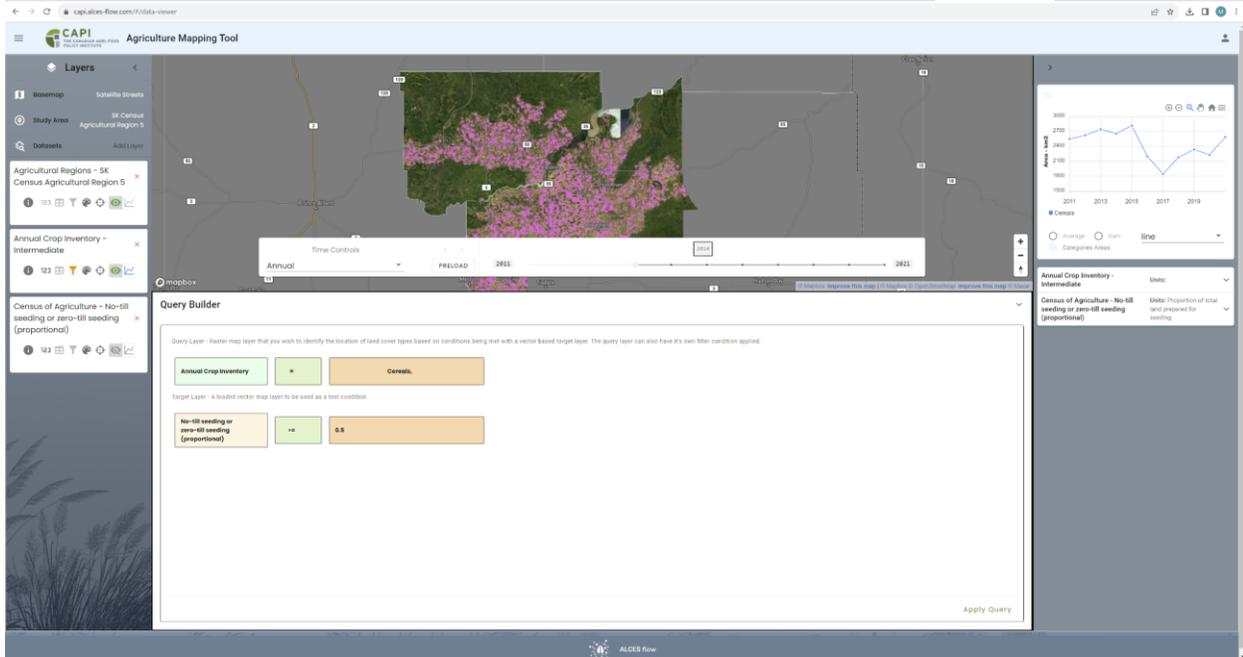


Identify areas satisfying a land use adoption threshold

The **Query Builder** can be used to identify agricultural land where the adoption of a land use practice either exceeds or is below a threshold. Selecting one or more agricultural land use types (e.g., wheat or cereals) as the query layer and then applying a condition to a Census of Agriculture target layer (e.g., <50% adoption of herbicides) will generate a map identifying locations of the agricultural land use type where adoption of the land use practice meets the condition.

The example query below identifies cereal crops occurring in portions of Saskatchewan Census Agricultural Region 5 where adoption of no-till seeding is at least 50% (i.e., proportion of 0.5). In

the map, portions of the study area where average adoption of no-till seeding are less than 50% are excluded (greyed out) in the map. The chart presents the area of cereal crops occurring in the part of the agricultural region where adoption of no-till seeding is at least 50%. When preparing the chart and maps, Census of Agriculture data for no-till seeding from the 2011 census is applied to years 2011 to 2015, data from the 2016 census is applied to years 2016 to 2020, and data from the 2021 census is applied to year 2021. The year to year variation in the chart (e.g., from 2011 and 2015) is caused by changes in the extent of cereal crops in the region according to the annual crop inventory.



Objective 2 - Map the condition of agricultural areas using agri-environmental indicators

The status of numerous agri-environmental indicators can be mapped for a wide range of study areas to assess and compare environmental performance of agricultural areas and change in environmental performance through time. Examples of analyses that can be completed in support of objective 2 are listed below.

Map agri-environmental status and assess change over time

Agri-environmental layers can be accessed using the **Data Viewer** to prepare maps depicting the status of agri-environmental indicators and how the status has changed over time. The following agri-environmental indicators are available: agricultural greenhouse gas emissions, ammonia emissions, pesticide contamination, relative soil organic carbon, soil organic carbon change, risk of water contamination by nitrogen, soil erosion risk, and wildlife habitat capacity. Two versions of each indicator is available. One version presents the absolute value of the indicator (e.g., kg/ha/year of ammonia emissions), while the other version presents categories (e.g., very low, low, moderate, high, and very high). Descriptions of the categories can be accessed by clicking the information button for a layer once the layer has been accessed in the Data Viewer. The agri-environmental indicator status for a subset (i.e., a Soil Landscapes of Canada polygon) of the study area be viewed by clicking a location on the map.

In the example below, agricultural greenhouse gas emissions increased from very low (~1) to low (~2) between in Manitoba Census Agricultural Region 3 between 1981 and 2018. Agricultural greenhouse gas emissions in a selected (i.e., clicked) Soil Landscapes of Canada polygon in the screenshot is moderate (3) in the year 2017.

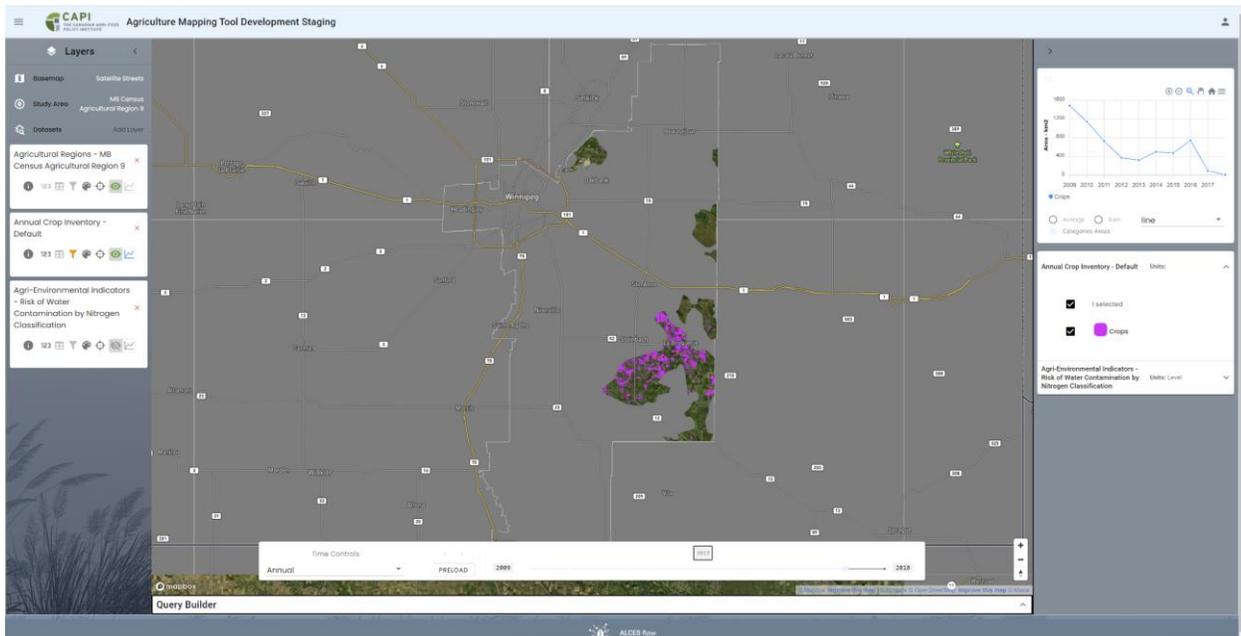
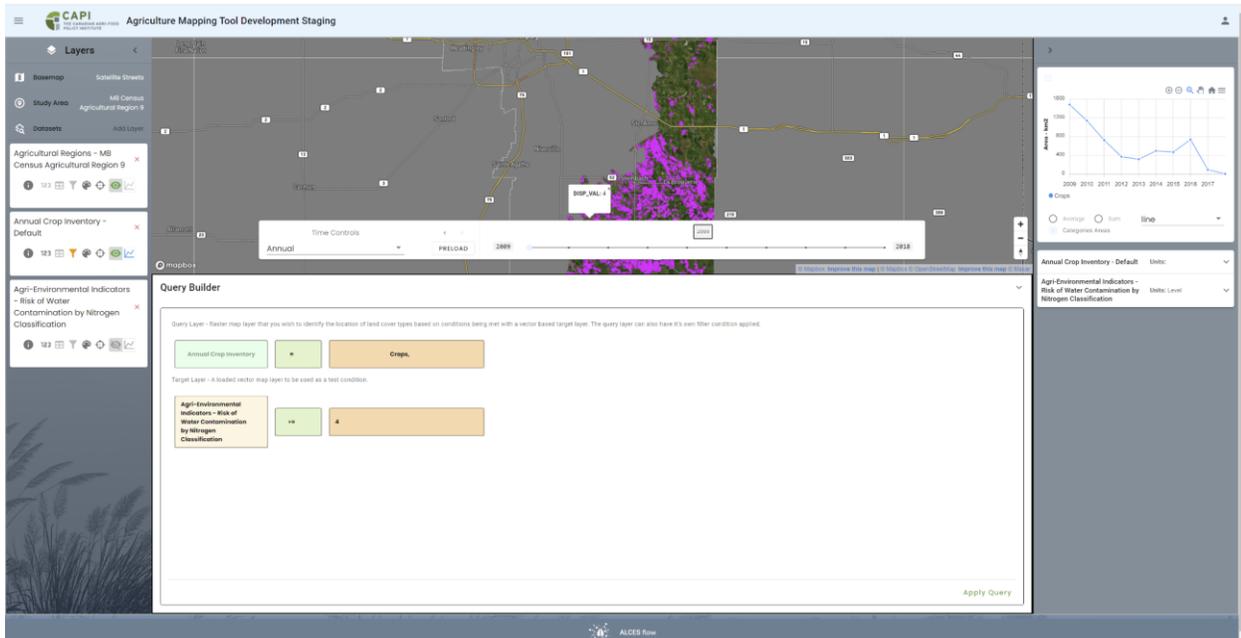


Identify areas whose agri-environmental status is above or below a target

The **Query Builder** can be used to identify agricultural land cover where the status of an agri-environmental indicator either exceeds or is below a user-defined threshold. Selecting one or

more agricultural land use types (e.g., wheat or cereals) as the query layer and then applying a condition to an agri-environmental target layer (e.g., >moderate agricultural greenhouse gas emissions) will generate a map identifying locations of the agricultural land use type where adoption of the land use practice meets the condition.

The example query below identifies cropland occurring within the portion of Manitoba Census Agricultural Region 9 with high (4) or very high (5) risk of water contamination by nitrogen. The first screenshot shows the query settings and the second screenshot shows the output layer. High to very high risk cropland declined from 1,485 km² in 2009 to almost 0 in 2018.



Objective 3 - Assess Conversion Risk for Grassland and Other Types of Natural Land Cover

The status of natural land cover and its change over time can be mapped for a wide range of study areas, and the relative risk of future conversion of natural land cover can be assessed based on the intensity of recent development pressure and overlap with cropland projections. Examples of analyses that can be completed in support of objective 3 are listed below.

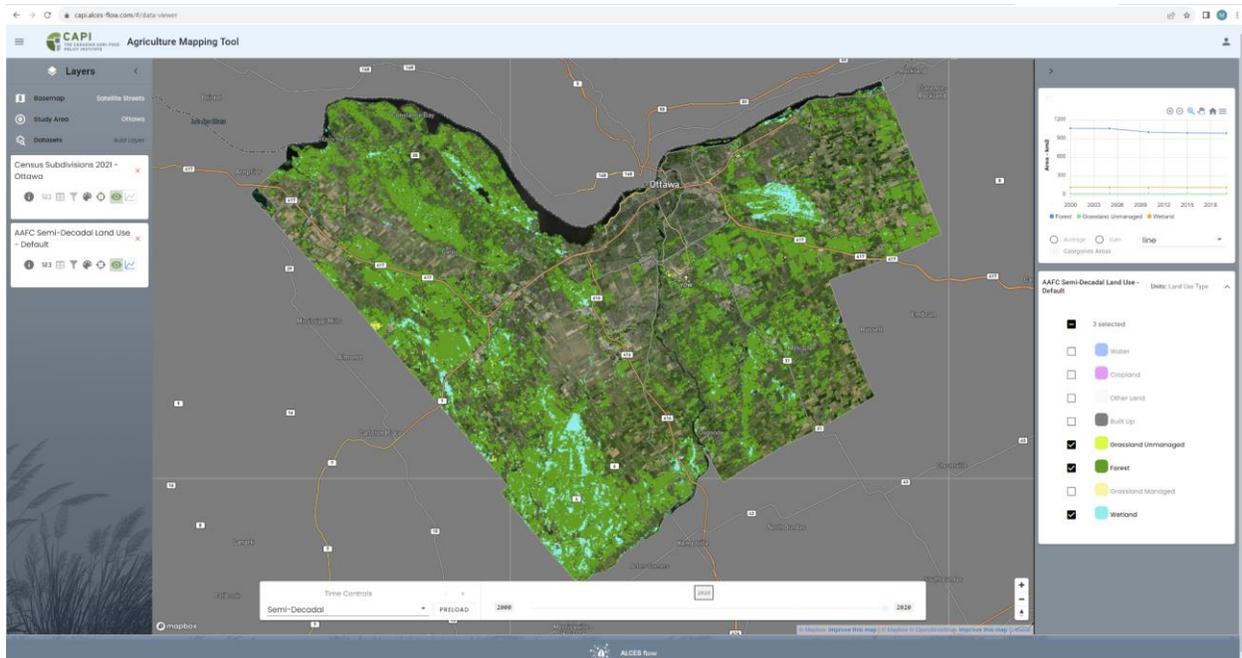
Map natural land cover types

Mapping natural land cover and trends in natural land cover types through time is useful when considering the potential for future conversion of natural land cover types such as grassland.

The Annual Crop Inventory can be accessed in the **Data Viewer** to prepare maps of natural land cover and explore trends in natural land cover over time. The default Annual Crop Inventory layer contains 4 forest types (broadleaf, coniferous, mixedwood, undifferentiated), two wetland types (wetland, peatland), shrubland, exposed land, grassland, and water. The intermediate and general layers group the four forest types into a single forest category and the two wetland types into a single wetland category.

The AAFC Semi-decadal Land Use dataset can also be accessed in the **Data Viewer** to prepare maps of natural land cover. This dataset is less detailed in its categorizing of natural land cover but provides a longer term perspective on land use change as it is available in five-year increments since the year 2000.

Mapping the Annual Crop Inventory or AAFC Semi-decadal Land Use datasets will generate a map, table, and chart time series covering all years for which the dataset is available. The time series can be used to assess trend in natural land cover and the time bar can be used to view change over time. The interactive legend can be used to select which land cover types to include in the map and chart. The example below illustrates a decline in forest in the municipality of Ottawa.



Assess change in natural land cover

Mapping locations where natural land cover has decreased between time periods is useful when considering where natural land cover may decline in the future.

The **Change Analysis Tool** can be used to identify locations where a natural land cover type increased or decreased between time periods. The analysis can assess change in a single natural land cover type (e.g., grassland) or multiple types (e.g., all natural land cover). The analysis can also be specific with respect to the anthropogenic land cover type responsible for the conversion (e.g., cropland) or more general (e.g., all agricultural types as well as urban/developed).

The change analysis example identifies the location of change in forest land cover from 2000 to 2020 in the municipality of Ottawa according to the AAFC Semi-Decadal Land Use dataset. Forest is set as the Post Conversion Type because the analysis is assessing change in that land cover type. All remaining land cover types are included in the list of Pre Conversion Types so that all instances of change in forest land cover are included in the analysis. The blue to purple colours in the map identify locations of forest loss in the Ottawa region. The statistics table for the output layer indicates that forest area declined by 7,632 ha from 2000 to 2020.

caplices flow.com/#/analysis-tools

CAPI Agriculture Mapping Tool

Change Analysis

The change analysis tool maps user-defined types of land cover change. To perform a change analysis, select the land cover dataset and the post-conversion land cover type(s) from the dataset. The post-conversion type(s) define the land cover whose growth is to be mapped (e.g. built up footprint). By default, all changes in the post-conversion type(s) are mapped, with positive values indicating growth and negative values indicating loss. The user also has the option of selecting one or more pre-conversion types to limit the change analysis to locations of the pre-conversion type(s) at the start of the analysis time period. For example, selecting Cropland as the pre-conversion type with built up as the post-conversion type will limit the analysis to cells that changed from cropland to built-up (positive change) or from built-up to cropland (negative change). Also select the study area dataset and area of interest from that dataset and the time span for the analysis (start and end year). The dataset can be mapped and zoomed using the data viewer, and shared using the data manager. Note that the resolution of the analysis depends on the size of the study area, such that a smaller study area will achieve a more detailed change analysis. Also note that a moving window is applied during the change analysis to address minor changes in projection from one time period to the next that can result in mapping of erroneous instances of land cover change.

Inputs:

Land Cover Dataset: **AAFC Semi-Decadal Land Use - General**

Post Conversion Type(s): **Forest**

Pre Conversion Type(s): **Forest**

Study Area Dataset: **Census Subdivisions 2021**

AOI: **Ottawa**

Start Year: **2000**

End Year: **2020**

Output:

Ottawa forest change

ALCES flow

caplices flow.com/#/analysis-tools

CAPI Agriculture Mapping Tool Development Staging

Layers

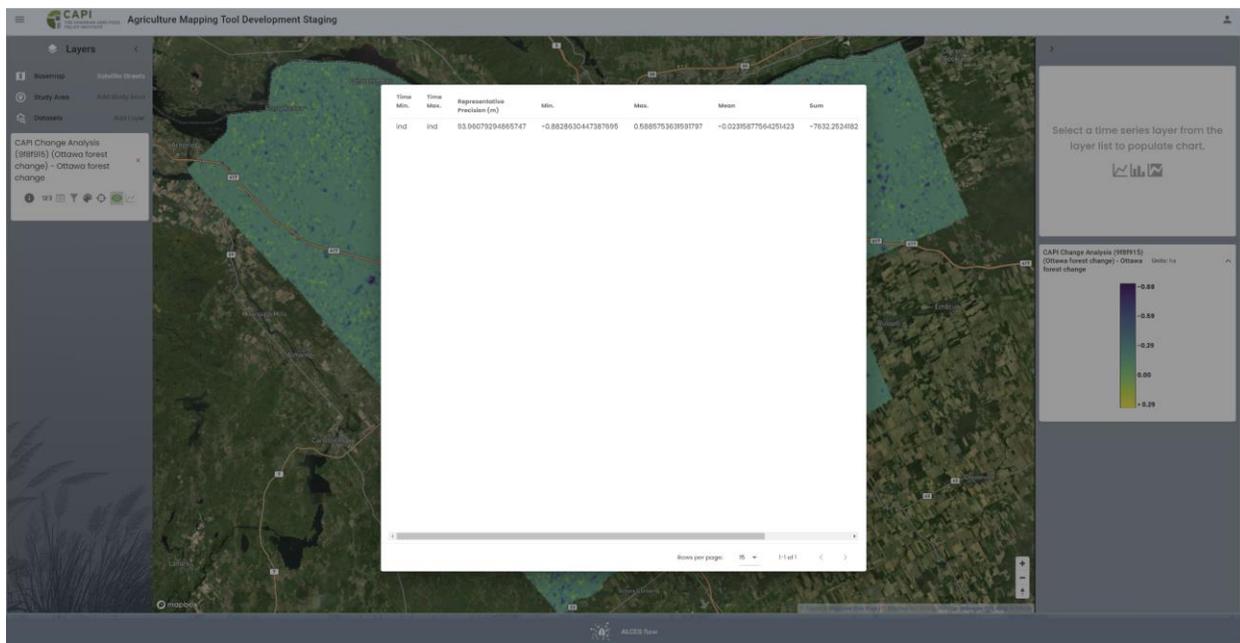
- Basemap
- Study Area
- Datasets
- CAPI Change Analysis (W81915) (Ottawa forest change) - Ottawa forest change

Select a time series layer from the layer list to populate chart.

CAPI Change Analysis (W81915) (Ottawa forest change) - Ottawa forest change

Legend: -0.20, -0.50, 0.00, 0.20

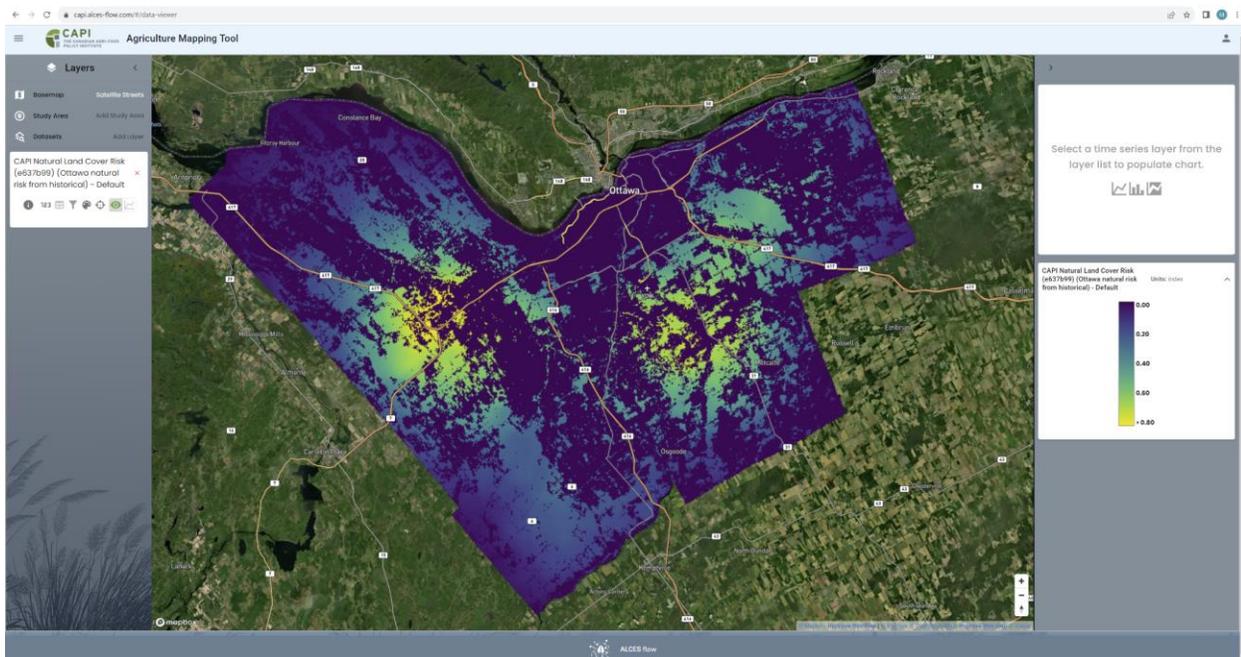
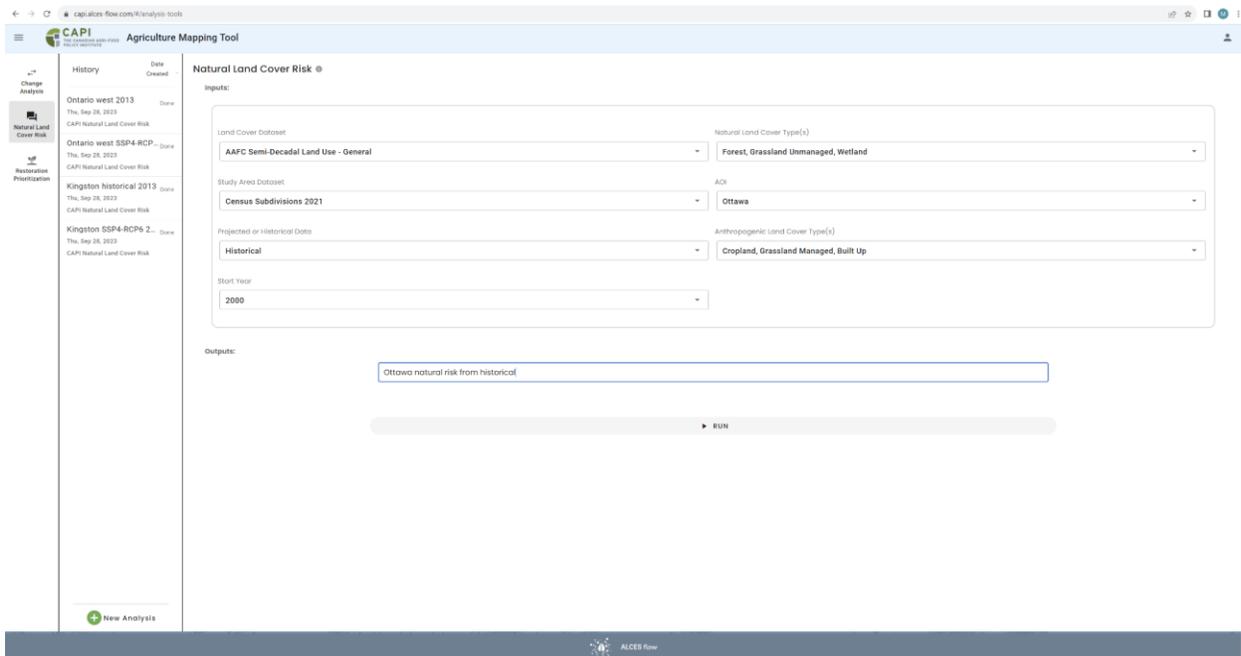
ALCES flow



Map the relative risk of conversion based on the intensity of recent development
 Natural land cover occurring in areas with higher recent rates of conversion is likely to be at greater risk of conversion.

The **Natural Land Cover Risk** tool can be used to map the relative risk of natural land cover conversion across a study area based on the intensity of past change in anthropogenic land cover that has occurred in the vicinity (within 10 km). The analysis can be set to assess conversion risk for a specific type of natural land cover (e.g., grassland) or for natural land cover overall. The analysis can also be specific or general with respect to the type of anthropogenic land cover that is included when assessing intensity of past development.

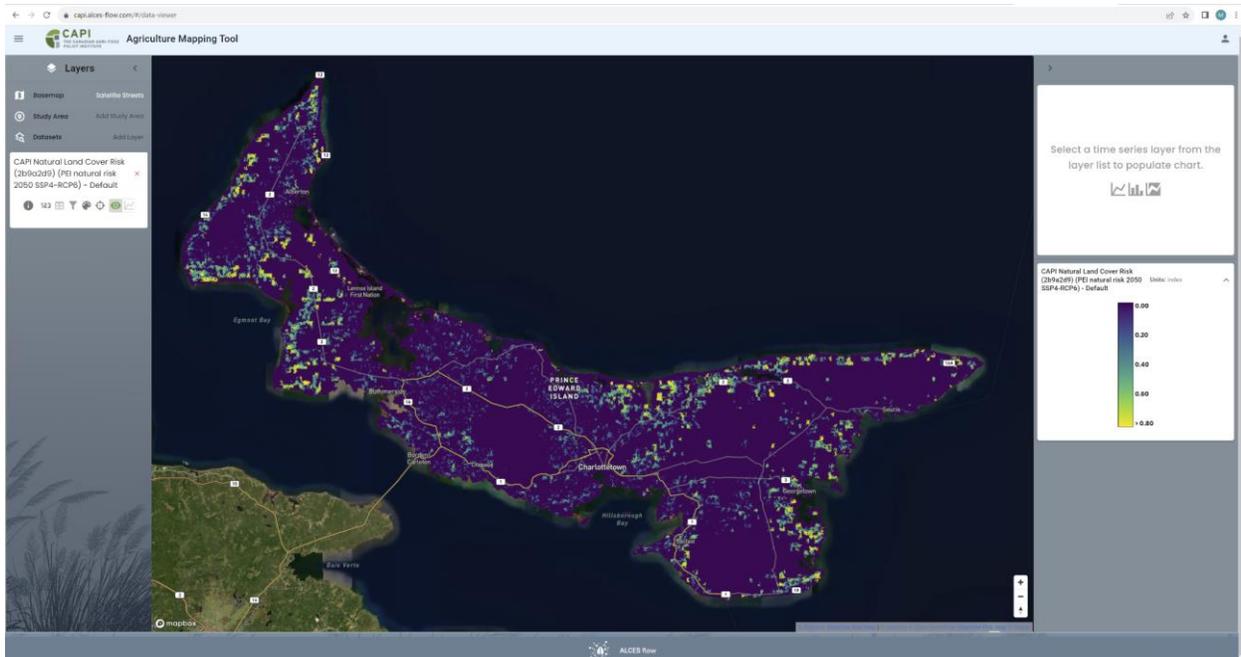
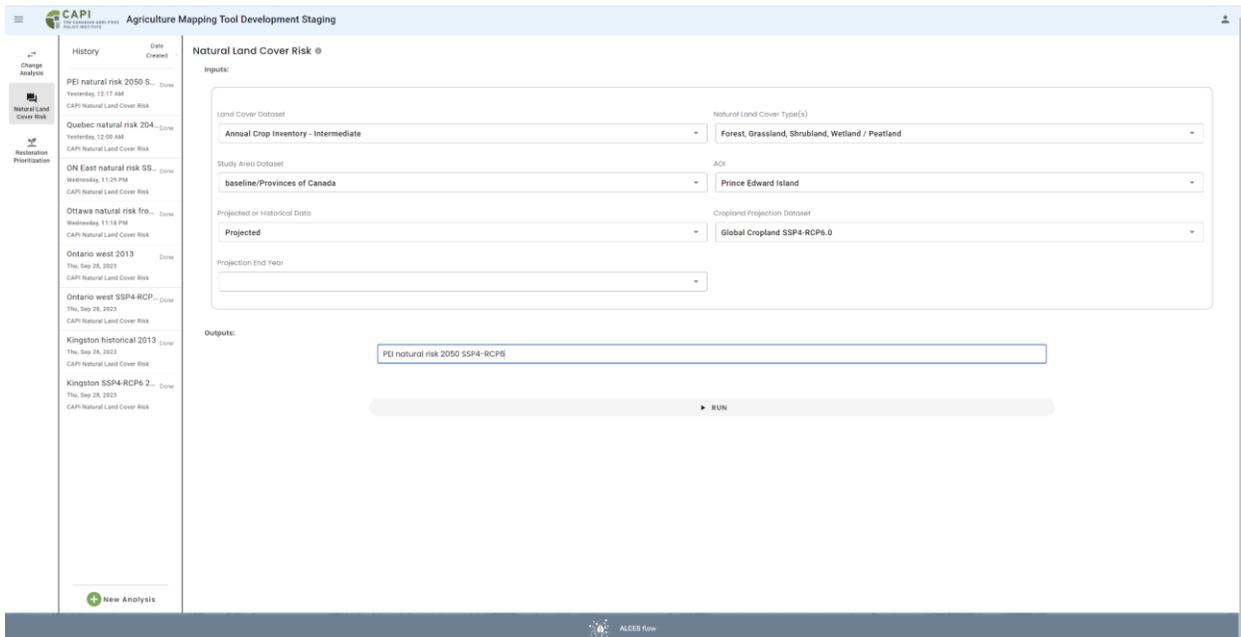
The example natural land cover risk analysis applies a 0 to 1 risk index to forest, grassland, and wetland based on the rate of growth in cropland, pasture, and built up footprint within 10 km since the year 2000. Risk is identified to be highest to the south and west of Ottawa.



Map the relative risk of conversion based on projected cropland expansion
 Natural land cover occurring in areas where cropland is projected to exhibit higher rates of growth is likely to be at greater risk of conversion.

The **Natural Land Cover Risk** tool can be used to map the relative risk of natural land cover conversion across a study area based on the projected cropland growth over a user-defined time period according to a SSP/RCP scenario.

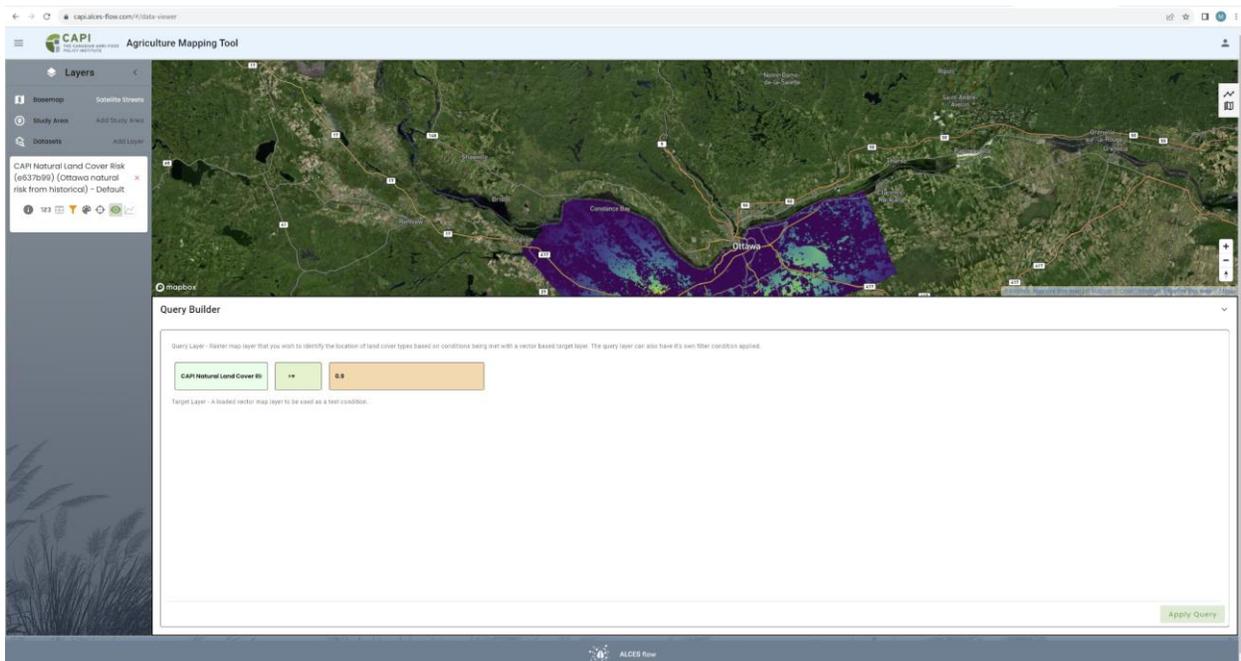
The example natural land cover risk analysis applies a 0 to 1 risk index to forest, grassland, shrubland, and wetland in Prince Edward Island based on the location of projected cropland growth under the SSP4-RCP6 scenario by the year 2050. Higher risk areas are in western and eastern portions of the province as opposed to the central portion where risk is low.



Identify areas with the highest conversion risk
 Identifying areas with the highest conversion risk can focus conservation attention on natural land cover where conversion may be most likely to occur.

As described above, the **Natural Land Cover Risk** tool can be used to map the relative risk of natural land conversion based either on the intensity of recent development or the location of projected cropland expansion. Output from the Natural Land Cover Risk tool is a 0 to 1 index that is proportional to risk, with the location at highest risk receiving a value of 1. For example, a location with a value of 0.9 is assessed as having a conversion risk that is 90% of the maximum. The **Query Builder** can be applied to the natural land cover risk output dataset to map locations that area assessed as having a conversion risk that is within a user-defined percentage of the maximum risk. This is done by selecting the natural land cover risk output dataset as the query layer and setting the condition to being greater than the user-defined percentage of maximum risk (e.g., >0.9).

In the example below, output from the natural land cover risk analysis for Ottawa is queried to identify areas where the risk index is at least 0.9 (i.e., 90% of the highest risk index value for municipality of Ottawa). The area at the junction of highways 7 and 417 to the west of Ottawa is identified as having a risk index value of 0.9 or greater.





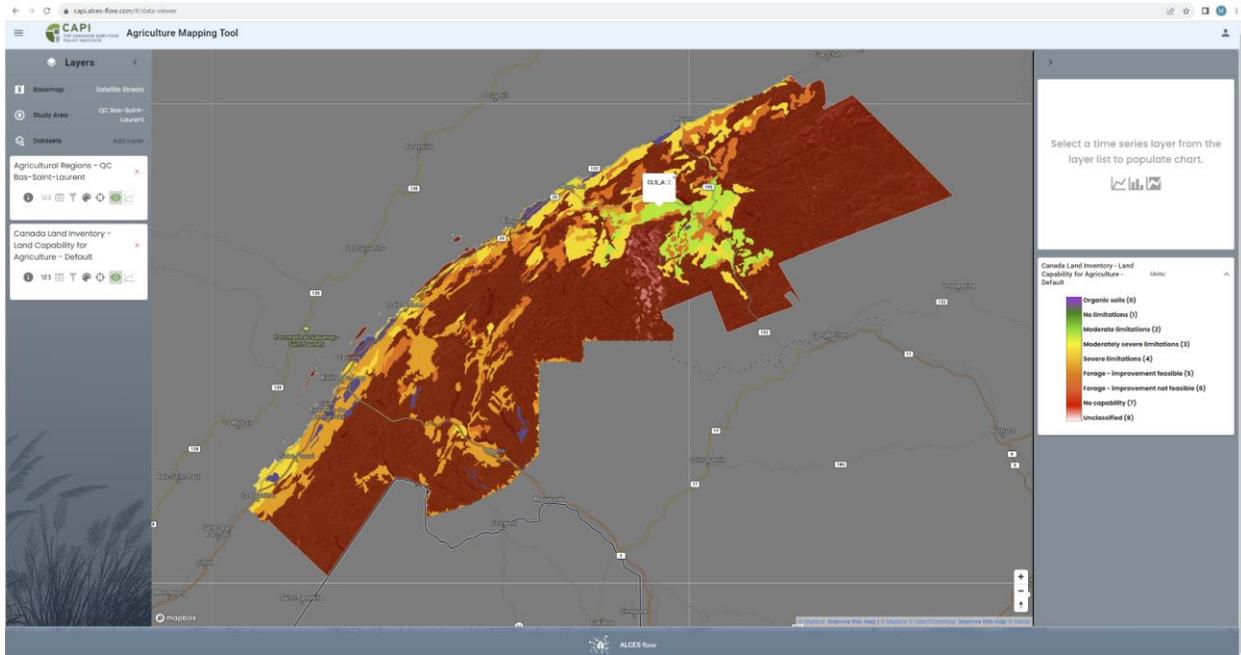
Objective 4 – Identify marginal agricultural land to be restored

Agricultural capability can be mapped for a wide range of study areas to explore the availability of marginal agricultural land, and marginal agricultural land can be prioritized for restoration based on the abundance of natural land cover in the surrounding area. Examples of analyses that can be completed in support of objective 4 are listed below.

Map agricultural capability

Mapping agricultural capability is useful when identifying the general location of marginal agricultural land to be considered candidates for restoration.

The Canada Land Inventory – Land Capability for Agriculture dataset can be accessed in the **Data Viewer** to prepare a maps of agricultural capability for a study area. Agricultural capability ranges from 1 (no limitations) to 7 (no capability). Capability is mapped by soil polygons; the capability rating of a polygon can be identified by clicking its location on the map.

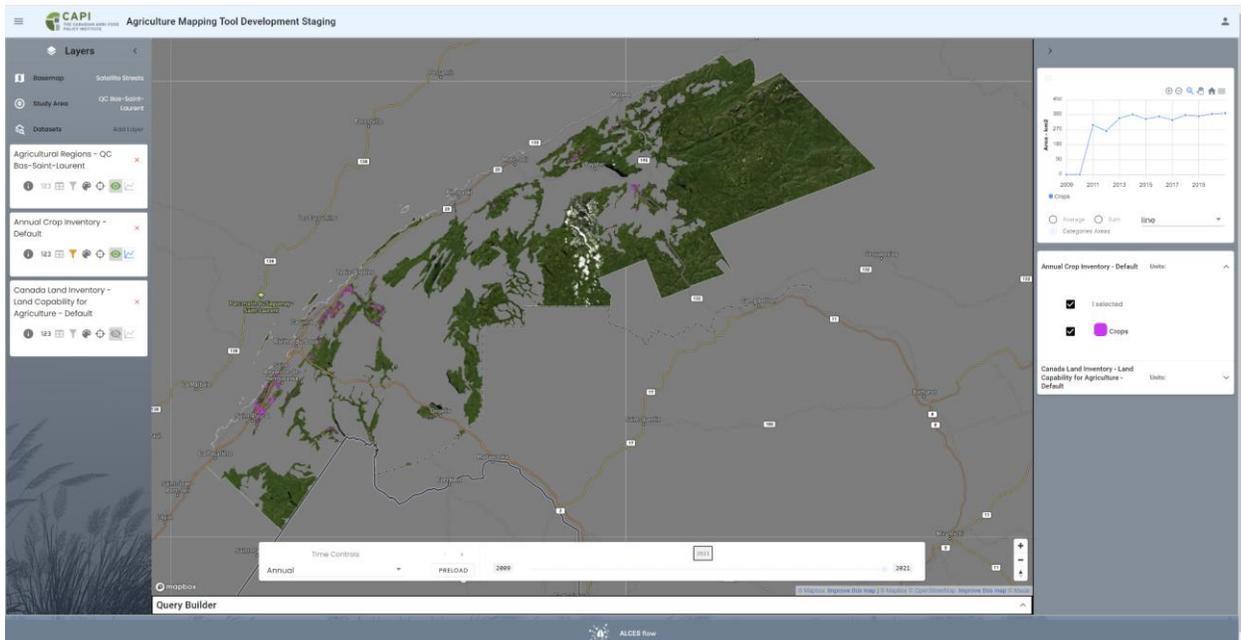
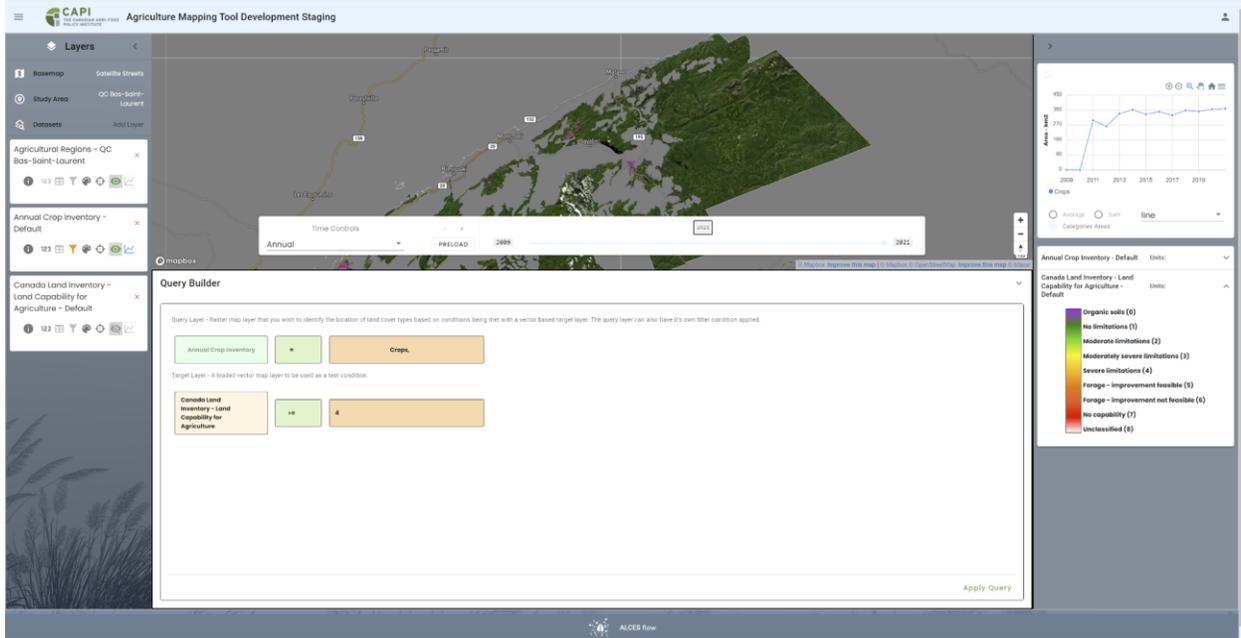


Identify marginal agricultural land

If the user has identified a capability threshold beyond which agriculture is considered marginal, mapping the location of marginal agricultural land can focus attention on candidate sites for restoration.

The **Query Builder** can be used to identify agricultural land cover where the agricultural capability exceeds a user-defined threshold. Selecting one or more agricultural land use types (e.g., wheat or cereals) as the query layer and then applying a condition to agricultural capability layer (e.g., >4) will generate a map identifying locations of agricultural land use that are marginal. The statistics table can be viewed to understand the total area of marginal agricultural land in the study area.

The example query below maps crop occurring in the portion of the Quebec Bas-Saint-Laurent agricultural region with severe (5) or greater limitations to agricultural capability. The chart presents change in marginal agricultural land over time according to the queries definition of capability. Note that the first two years in the chart are 0 because the first 2 years of the annual crop inventory did not have coverage in Quebec.

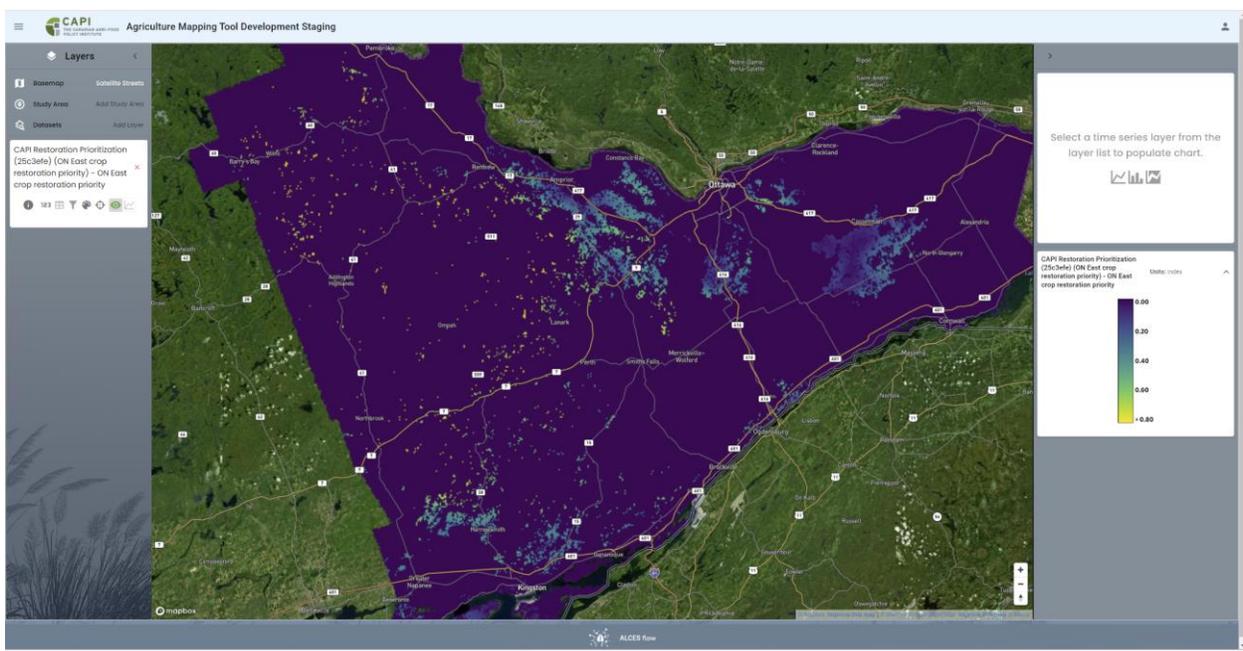
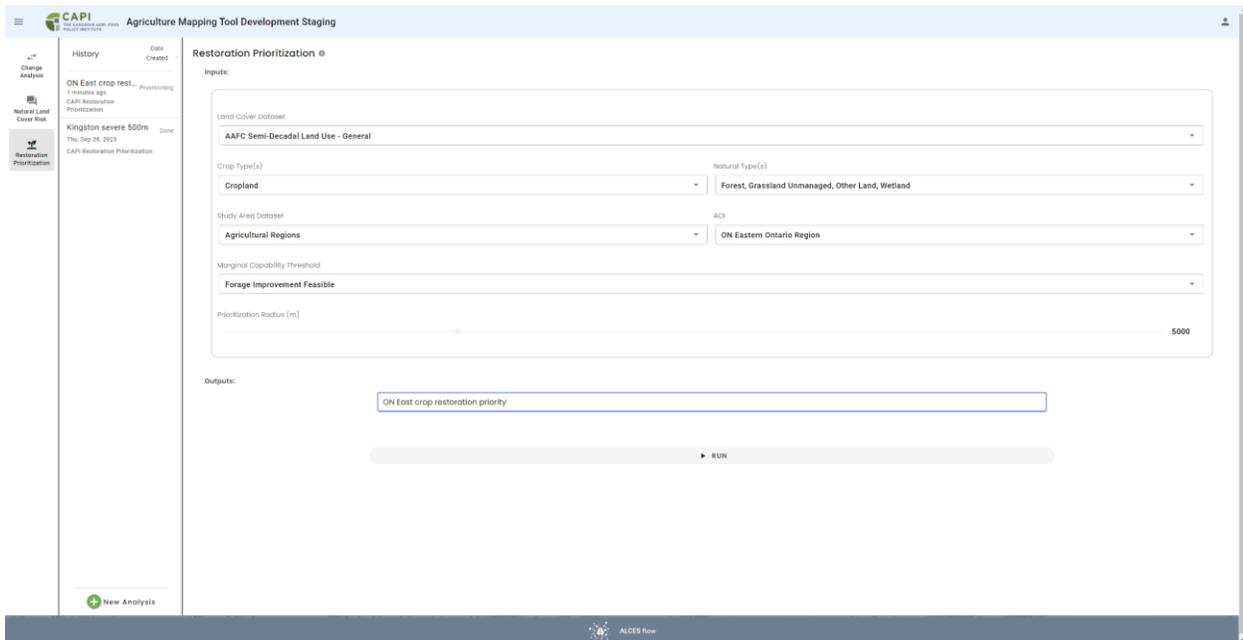


Prioritize marginal agricultural land for restoration based on surrounding natural land cover

One approach for prioritizing marginal agricultural land for restoration is to focus on areas where natural land cover is more abundant. Surrounding natural land cover can contribute native colonizers and reduce edge effects from developed land. Furthermore, focusing restoration on areas with surrounding natural land cover acts to build larger natural landscapes with the capacity to support a wider range of species.

The **Restoration Prioritization** tool can be used to be used to map relative restoration priority of marginal agricultural land based on the abundance of surrounding natural land cover. The level of agricultural capability that is deemed to be marginal is user defined, as is the maximum distance to be considered when assessing he abundance of surrounding natural land cover.

Is the example below, a restoration priority index is applied to cropland in eastern Ontario with a capability of “Forage Improvement Feasible” or less, based on the abundance of natural land cover types within the surrounding 5 km. Marginal cropland with the highest restoration priority is located in the western part of the study area where natural land cover is abundant and agricultural capability is low.

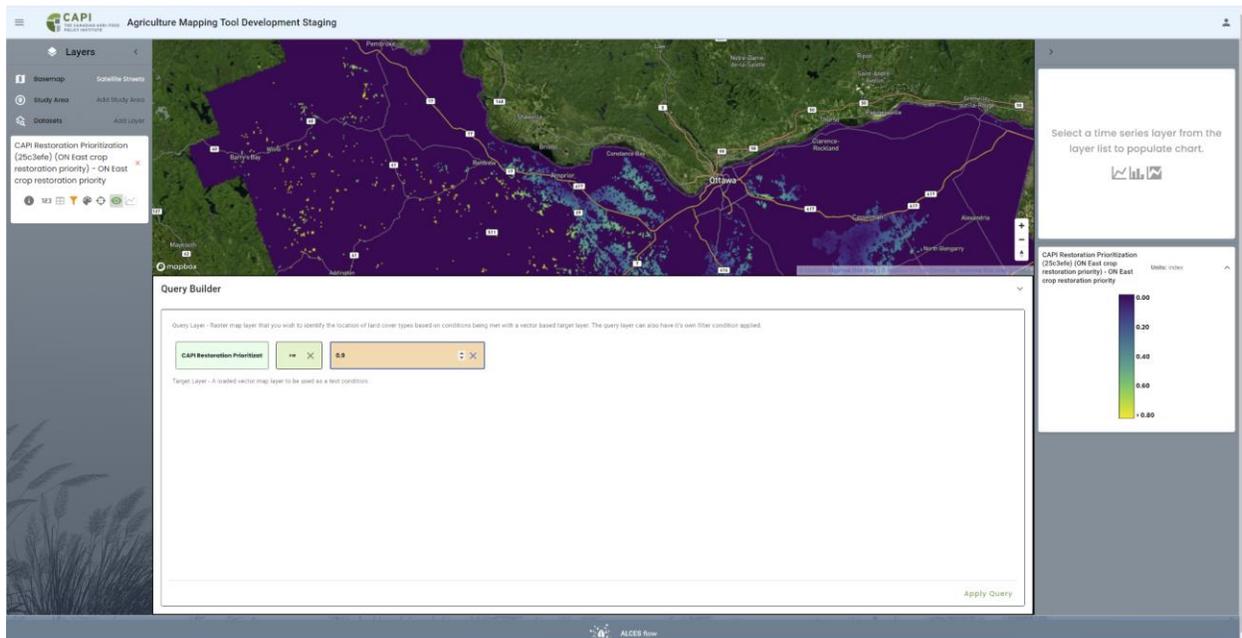


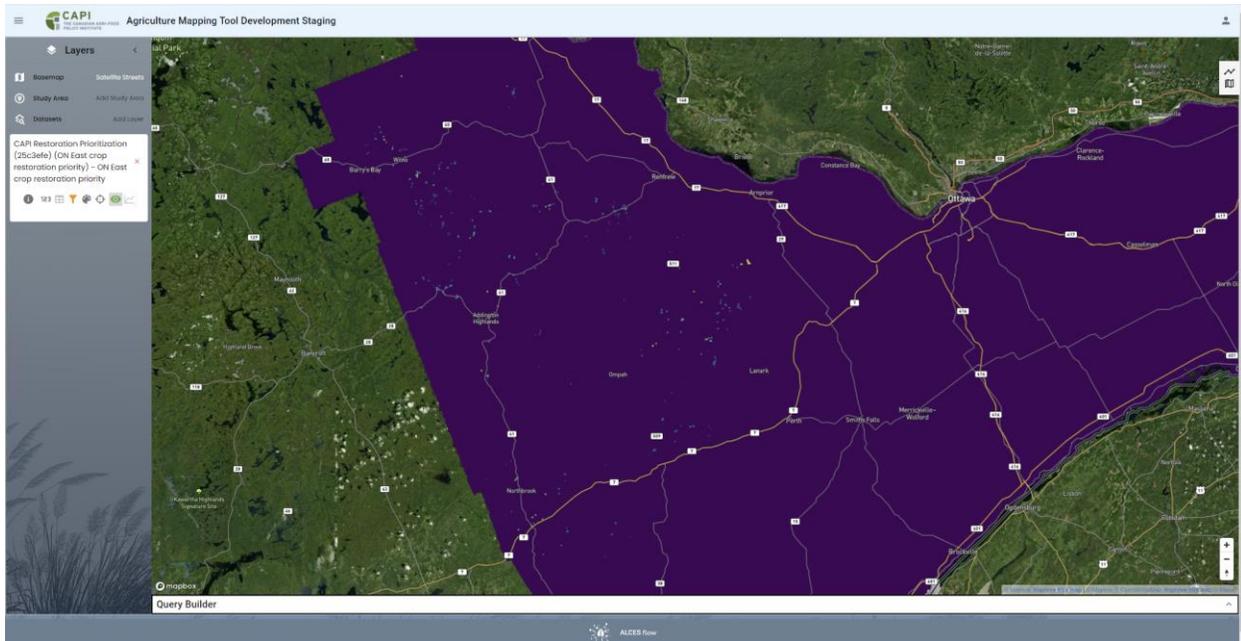
Identify areas satisfying a restoration priority threshold

Identifying areas with the highest restoration priority can focus attention on marginal agricultural land where restoration is best able to contribute to larger patches of natural land cover.

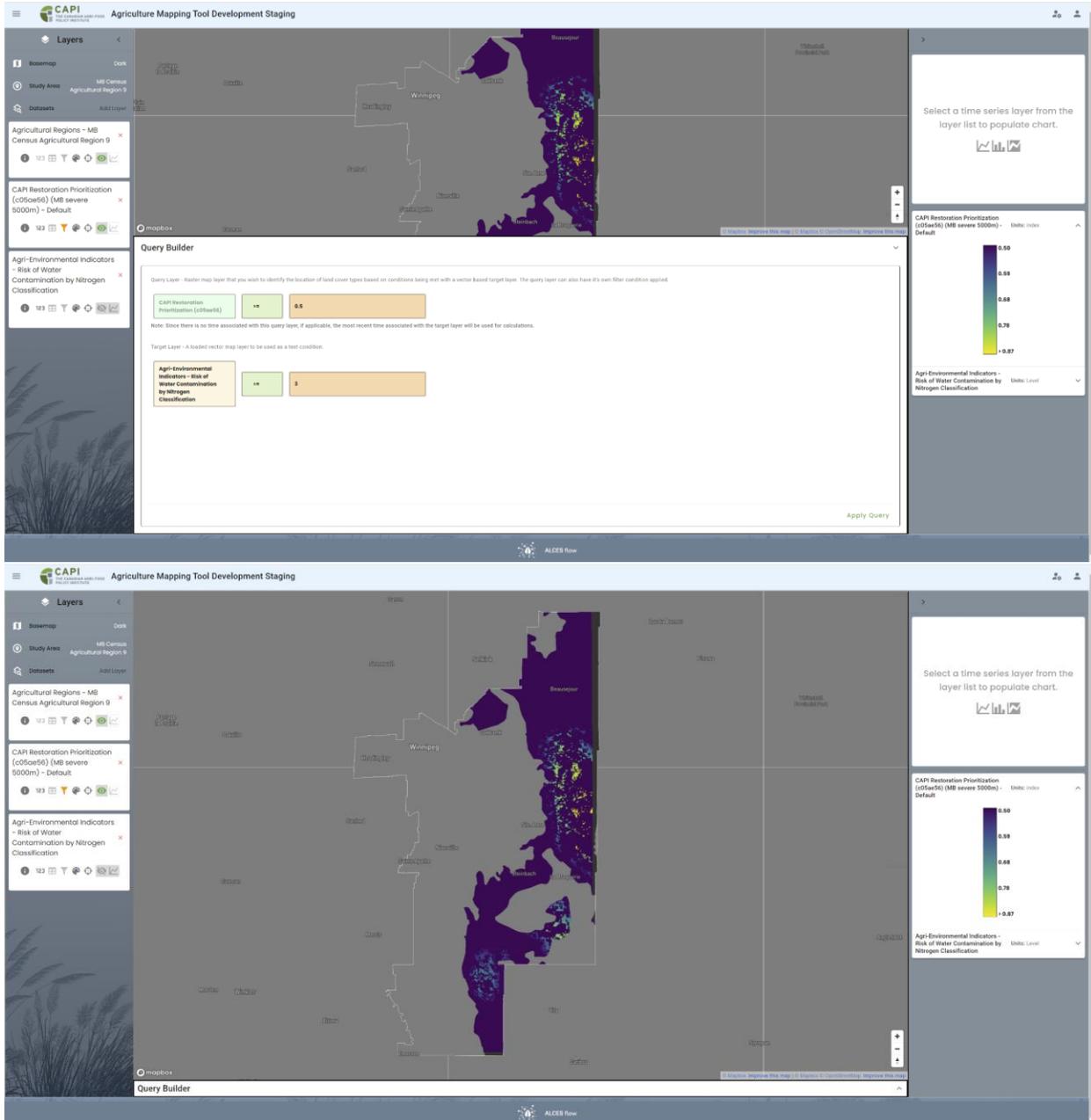
As described above, the **Restoration Prioritization** tool can be used to map the relative restoration priority of marginal agricultural land based on the abundance of surrounding natural land cover. Output from the tool is a 0 to 1 index that is proportional to the abundance of surrounding natural land cover, with the location with the most surrounding natural land cover receiving a value of 1. For example, marginal agricultural land with a value of 0.9 is assessed as having 90% of the maximum amount of natural land cover in its vicinity. The **Query Builder** can be applied to the restoration prioritization output dataset to map locations that are assessed as having an abundance of surrounding natural land cover that is within a user-defined percentage of the maximum. This is done by selecting the restoration prioritization output dataset as the query layer and setting the condition to being greater than the user-defined percentage of the maximum (e.g., >0.9).

In the example below, output from the restoration prioritization analysis for eastern Ontario is queried to identify areas where the priority index is at least 0.9 (i.e., 90% of the highest priority value for eastern Ontario). As expected, the high priority areas are exclusively in the western part of the study area where capability is low and natural land cover is abundant.





Identify areas satisfying a restoration priority threshold and an agri-environmental target
 As described above, the Restoration Prioritization tool can be used to map the relative restoration priority of marginal agricultural land based on the abundance of surrounding natural land cover. The Query Builder can be applied to the restoration prioritization output dataset to map priority restoration areas that also satisfy an agri-environmental threshold. For example, the risk of water contamination by nitrogen classification layer can be applied to limit the outcome of a priority restoration analysis to marginal cropland that poses a high risk of water contamination. This can be done by selecting a restoration prioritization output dataset as the query layer, setting the condition to being greater than the user-defined percentage of the maximum (e.g., >0.75, which is equivalent to being within 25% of the maximum priority), and applying risk of water contamination by nitrogen classification as the target layer with a threshold of 4 (high).



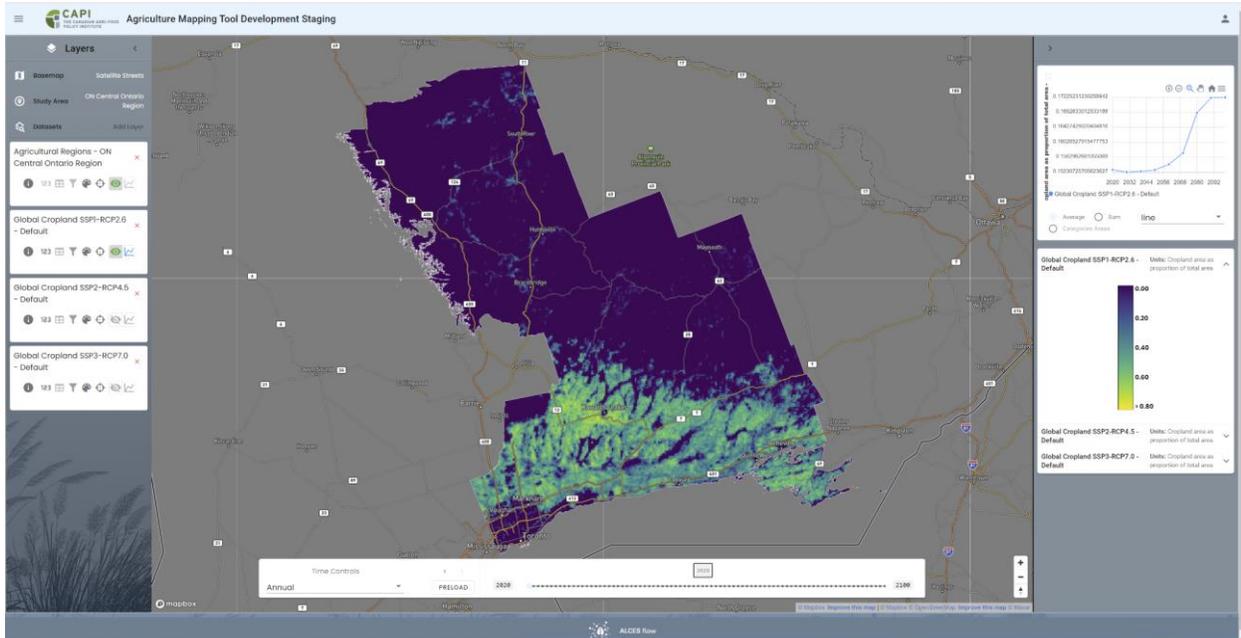
Objective 5 – View Maps Forecasting Agricultural Land Use

Cropland projections can be mapped for a wide range of study areas, compared across SSP and RCP scenarios, and compared between study areas. Examples of analyses that can be completed in support of objective 5 are listed below.

Map cropland projections under SSP scenarios

Mapping and charting cropland growth and contraction under a range of scenarios can provide insight into how agricultural activity may shift in the coming decades.

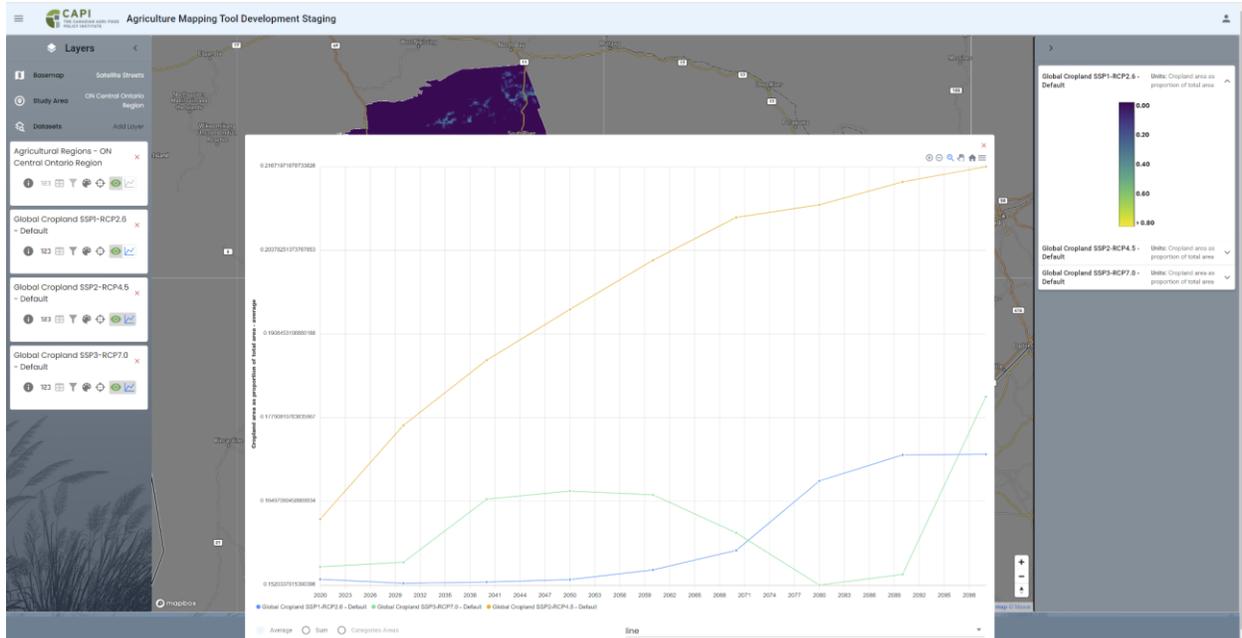
Cropland projections at decadal time steps from 2020 to 2100 are available for multiple shared socioeconomic pathway (SSP) scenarios (SSP1 =sustainability, SSP2=middle-of-the-road, SSP3=regional rivalry, SSP4=inequality) combined with representative concentration pathway (RCP) climate change scenarios (RCP 2.6 to RCP 7.0, with higher values indicating higher GHG emissions and therefore temperatures). These scenarios allow the user to explore potential change in agricultural activity in response to a range of potential climate and socio-economic futures. The **Data Viewer** can be used to map cropland projections for a study area and chart the projected change in cropland.



Compare cropland projections under different SSP scenarios

The future is uncertain and comparing cropland projection scenarios helps to bracket the uncertainty. Comparing projections under a range of scenarios helps to identify whether projected changes are supported by multiple potential futures or whether the projected changes differ substantially from one scenario to the next.

The **Data Viewer** can be used to view multiple cropland projections for a study area. By clicking the chart icon for each scenario, the user can request a chart that compares the cropland projections. The user can also toggle between map layers to compare the spatial distribution of cropland projections between scenarios.



Identify natural land cover overlapping with areas of projected cropland expansion
 Assessing the overlap of natural land cover with projected cropland expansion helps to identify areas where conversion of natural land cover is more likely under a future scenario.

As discussed under objective 3, the **Natural Land Cover Risk** tool can be used to map the relative risk of natural land cover conversion across a study area based on the projected cropland growth over a user-defined time period according to a SSP/RCP scenario.

Objective 6 – Assess agricultural land use change

Change in agricultural, urban, or natural land cover types between time periods can be mapped and summarized for a range of study areas. Examples of analyses that can be completed in support of objective 6 are listed below.

Map agricultural land use over time

Mapping the extent of agricultural land use over time provides insight into the spatial distribution of agricultural activity and how it is changing.

As described under objective 1, agricultural land use types can be selected from the Annual Crop Inventory or AAFC Semi-Decadal Land Use Change datasets using the **Data Viewer's** interactive legend to generate maps and a chart displaying agricultural land use over time.

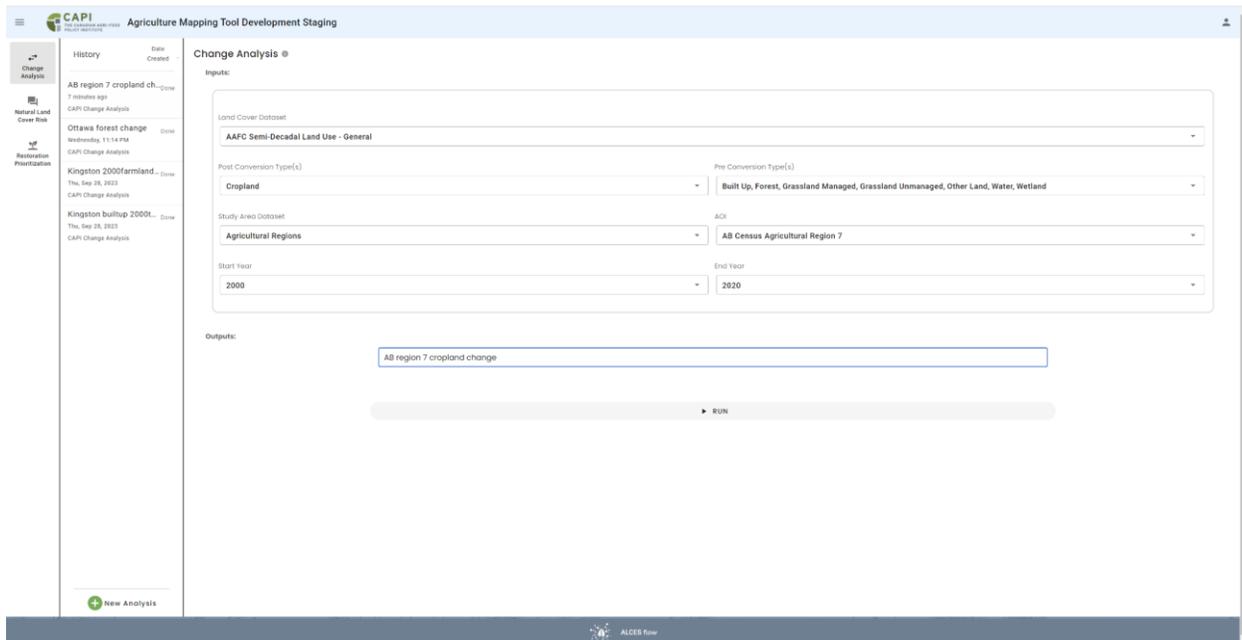
Identify areas of agricultural land use expansion or contraction

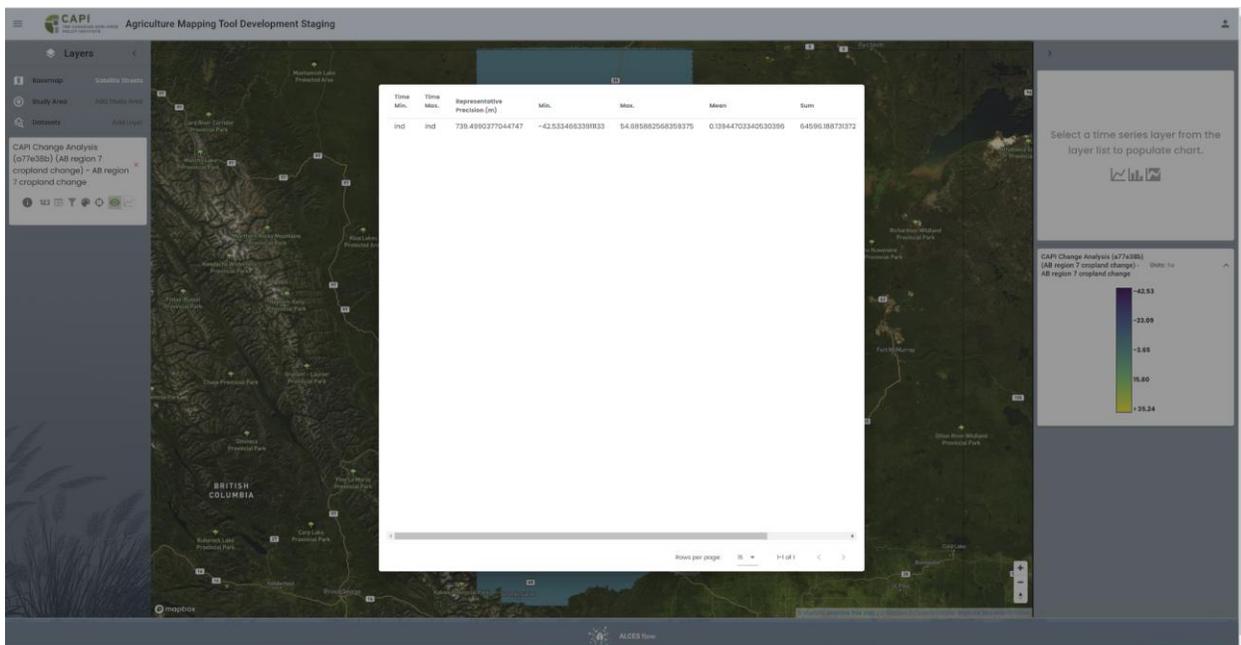
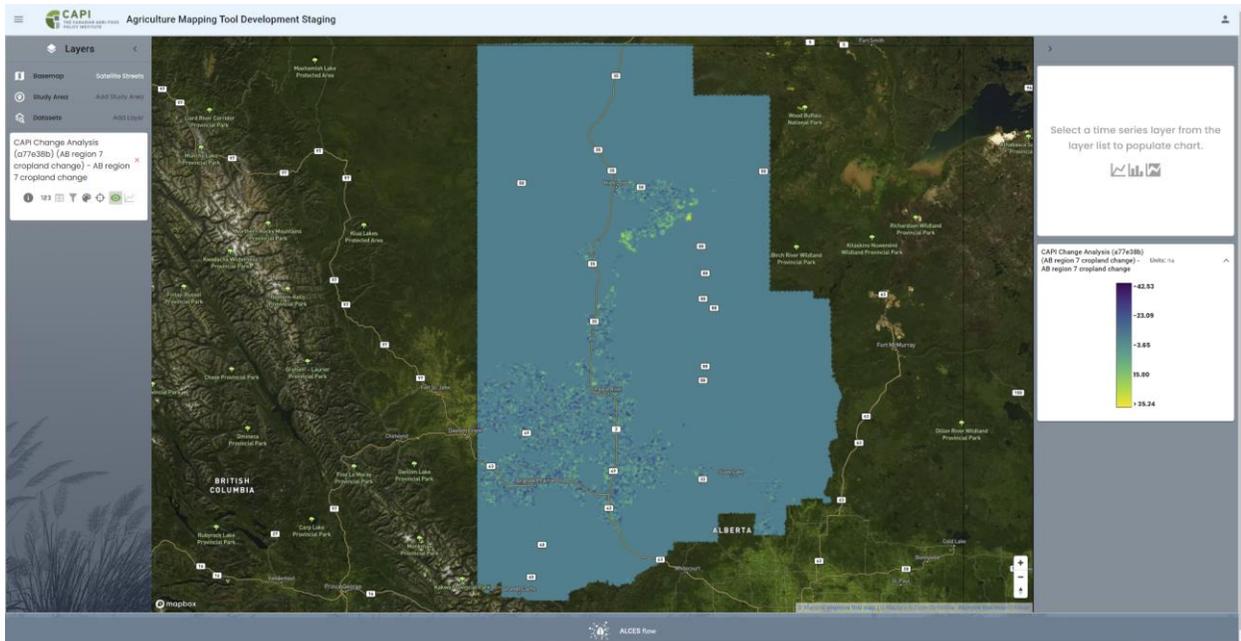
Mapping locations where agricultural land use has changed between time periods provides insight into shifts in agricultural land use and where agricultural land use may expand or decline in the future.

The **Change Analysis Tool** can be used to identify locations where an agricultural land use increased or decreased between time periods. The analysis can assess change in a single agricultural cover type (e.g., cereals) or multiple types (e.g., all agricultural land cover).

In the example below, the Change Analysis Tool is applied to map change in cropland from 2000 to 2020 in Alberta Agricultural Region 7 according to the AAFC Semi-Decadal Land Use dataset. Because change in cropland is of interest, it is selected as the Post Conversion Type. In this example, all other cover types are selected as Pre Conversion Types so that any change in Cropland is mapped (i.e., regardless of the other cover type before or after cropland change).

The first screenshot shows the Change Analysis settings. The second screenshot shows the output layer from the analysis, with green to yellow identifying cropland growth and blue to purple identifying cropland loss. Cropland growth is greatest in the north-central portion of the region. The third screenshot shows the output layer's statistics table. The sum in the table identifies the approximate total change in cropland area (64,596 ha growth in cropland).





Identify locations of specific types of change such as conversion of agriculture to urban Mapping where agricultural land cover has converted to urban footprint helps identify locations where urbanization is affecting agricultural activity.

By selecting urban footprint as the post conversion land cover type, the **Change Analysis Tool** can be used to map conversion of agricultural land to urban footprint.

In the example below, the Change Analysis Tool is applied to map conversion of cropland to built up (e.g., urban footprint) between 2000 and 2020 according to the AAFC Semi-Decadal Land Use dataset.

The first screenshot shows the Change Analysis settings. The second screenshot shows the output layer from the analysis, with green to yellow identifying conversion of cropland to built up. The third screenshot shows the output layer's statistics table. The sum in the table identifies the approximate total area of cropland conversion to built up (7,587 ha).

