



**Growing Forward 2**  
A federal-provincial-territorial initiative

# Development of a Province-Wide, Source-Specific, Spatially-Resolved Agricultural Air Emissions Inventory

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# Purpose of Work



- Leverage highly spatially resolved activity data to quantify air emissions from agricultural in B.C.
- Develop knowledge and tools needed to assess Best Management Practices (BMPs) aimed at reducing air emissions from agricultural activities.

# Purpose of Work



- Distinguishing features:
  - Sector-based
  - B.C. focused Emission Factors (EFs)
  - high resolution (sub-parcel) GIS activity data
  - Includes sources not typically inventoried or are lumped into “other agricultural”

# Emission Sources Assessed



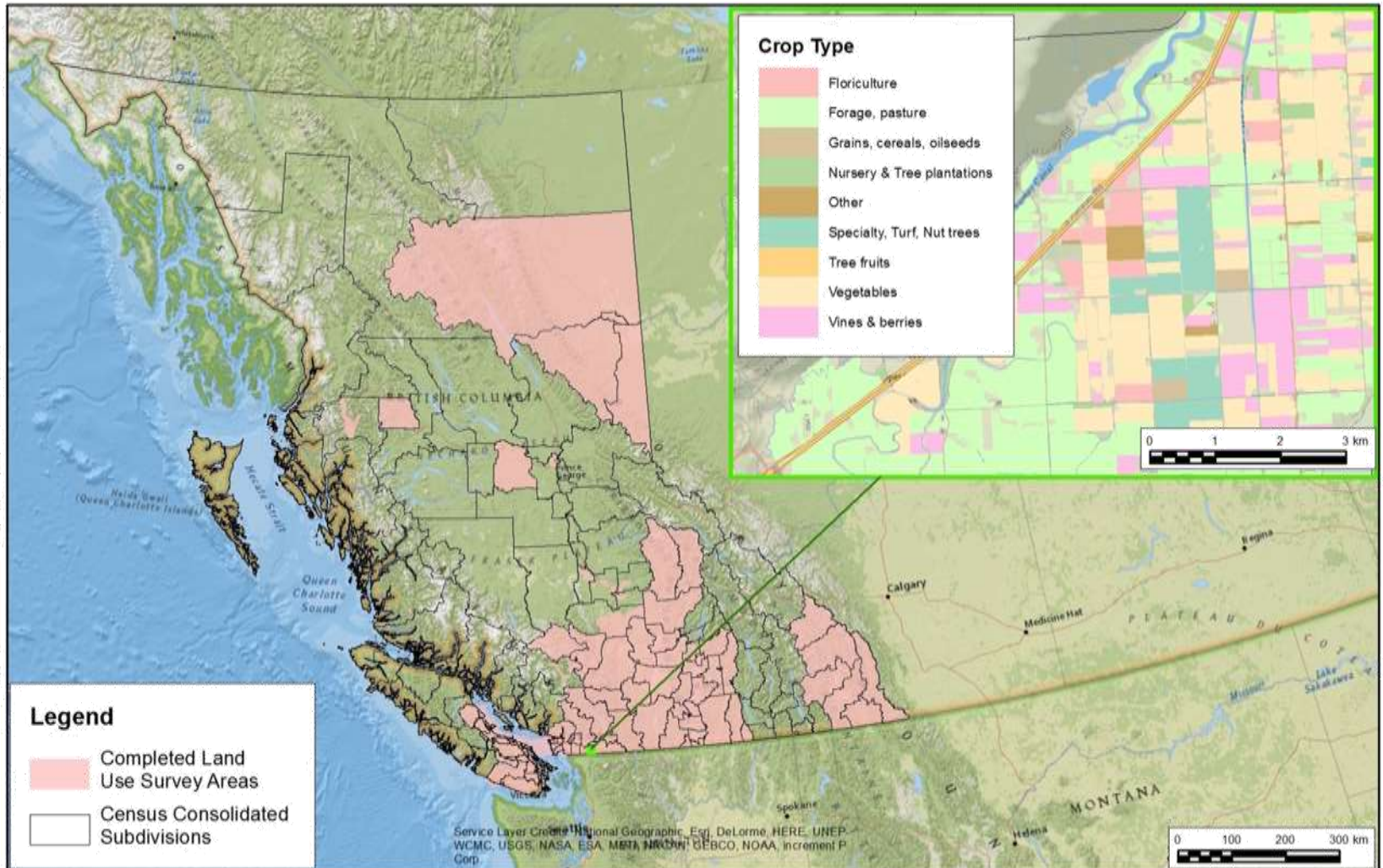
✓ Emission methodology researched and developed

✗ Emission methodology researched but not developed (insufficient data, EFs, etc.)

□ Emission methodology not developed (source does not emit significant quantities of the contaminant listed)

Source Category	Specific Source	PM	NH <sub>3</sub>	SO <sub>x</sub>	NO <sub>x</sub>	CO	VOC
Organic Material	Manure Composting	✗	✓	□	□	□	✗
	Poultry Mortality Composting	✗	✓	□	□	□	✗
	Dairy Silage Fermentation	✗	✗	□	□	□	✓
	Mushroom facilities	✗	✓	□	□	□	✗
Fuel Consumption and Storage	Non-road Vehicles and Equipment	✓	□	✓	✓	✓	✗
	Boilers and Heaters	✓	□	✓	✓	✓	✓
	Fuel storage	✓	□	□	□	□	✓
Energy Use	Building energy use	✓	□	✓	✓	✓	✓
Burning	Resource Management Open Burning	✓	✓	✓	✓	✓	✓
	Category 3 Open Burning	✓	✓	✓	✓	✓	✓
	Municipal Open Burning	✓	✓	✓	✓	✓	✓
Farm Field Inputs	Pesticide application & sprays	✗	□	□	□	□	✓
	Fertilizer use	✓	✓	□	□	□	✗
Soils and Cropping	Dry field tillage	✓	✗	□	□	□	□
	Wind erosion	✓	✗	□	□	□	□
	Crop harvesting	✓	□	□	□	□	□

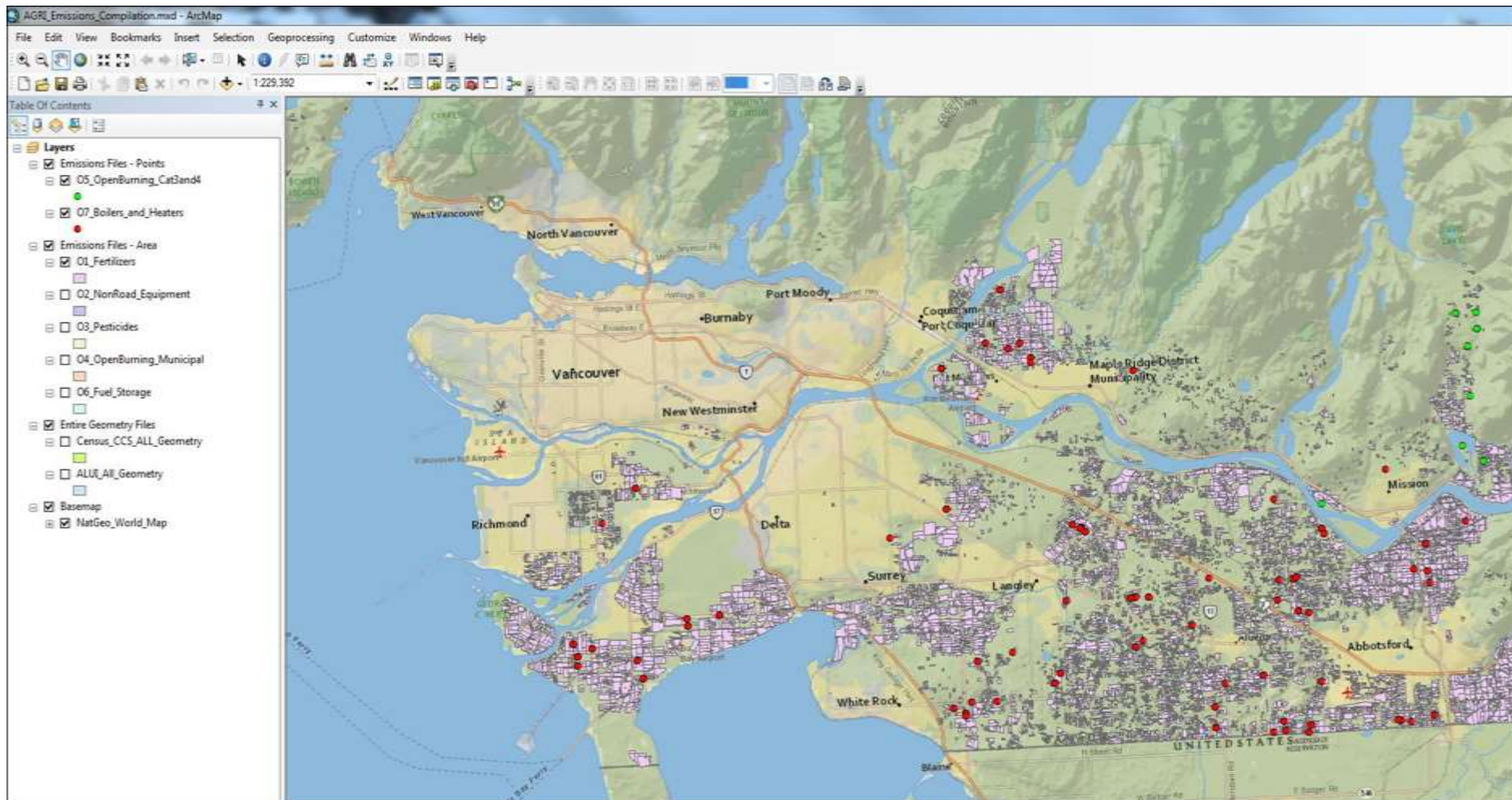
# Activity Data: Agricultural Land Use Inventory (ALUI)



# Activity Data: Agricultural Land Use Inventory (ALUI)



# Activity Data: Boilers & Heaters, Open Burning



# Sample Emission Calculation



$\text{NH}_3$  Emissions (kg) from fertilizer application

= Area of land per crop (hectare)

\* Amount of Fertilizer applied per crop (kg N / ha)

\* Fraction of applied N emitted to atmosphere (%)

\* Conversion of N to  $\text{NH}_3$  (= 1.21 kg  $\text{NH}_3$  / kg N)



# Sample Emission Calculation

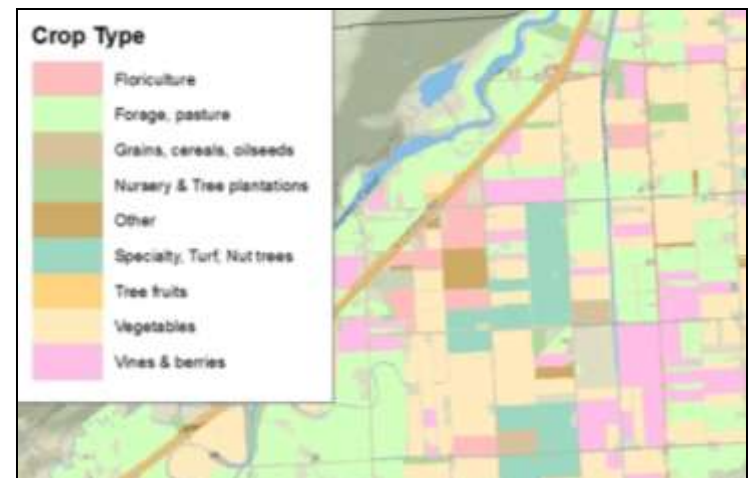


$\text{NH}_3$  Emissions (kg) from fertilizer application

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Area of land per crop from GIS-based ALUI data where available, and Census of Agriculture data where ALUI is incomplete.



# Sample Emission Calculation



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- \* Fraction of applied N emitted to atmosphere (%)
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Adapted from Sheppard *et al.* (2009): fertilizer sales data used in conjunction with farmer and agronomist surveys to assign type of fertilizer and application rates to 37 crop types in B.C.

# Sample Emission Calculation



$\text{NH}_3$  Emissions (kg) from fertilizer application

= Area of land per crop (hectare)

\* Amount of Fertilizer applied per crop (kg N / ha)

\* Fraction of applied N emitted to atmosphere (%)

\* Conversion of N to  $\text{NH}_3$  (= 1.21 kg  $\text{NH}_3$  / kg N)

Adapted from Sheppard *et al.* (2009): monthly fractions for arable and grass-type crops and different types of fertilizers based on eco-regions of B.C.

# Sample Emission Calculation



$\text{NH}_3$  Emissions (kg) from fertilizer application

= Area of land per crop (hectare)

\* Amount of Fertilizer applied per crop (kg N / ha)

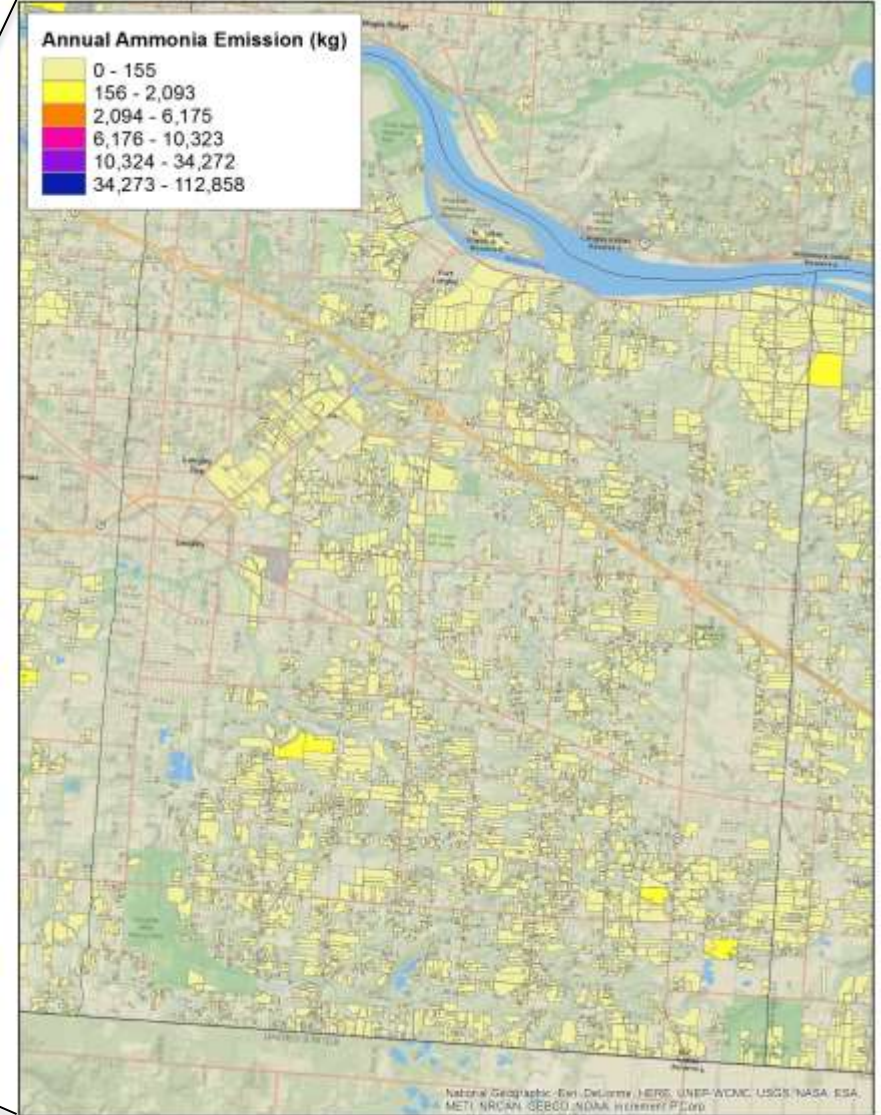
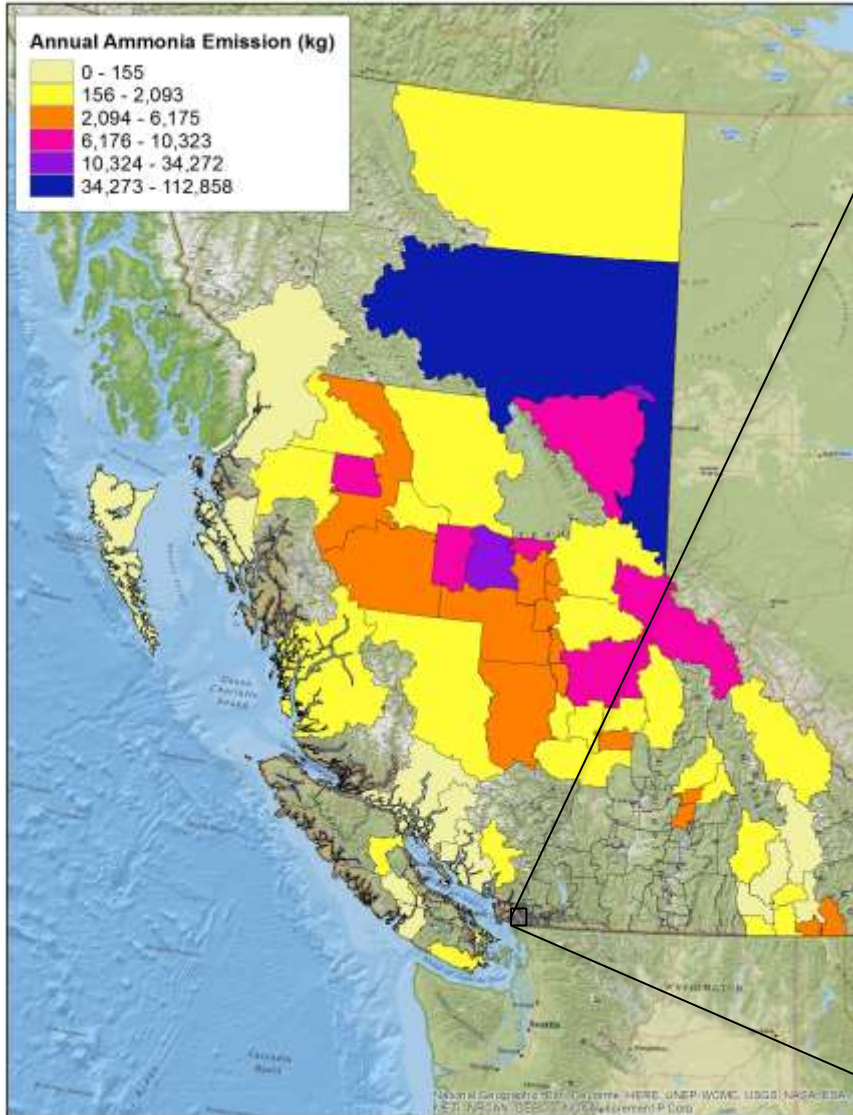
\* Fraction of applied N emitted to atmosphere (%)

\* Conversion of N to  $\text{NH}_3$  (= 1.21 kg  $\text{NH}_3$  / kg N)

Conversion of N to  $\text{NH}_3$  based again on eco-regions of B.C. and a constant value of 1.21 kg  $\text{NH}_3$  per kg of nitrogen.

# Sample Emission Calculation:

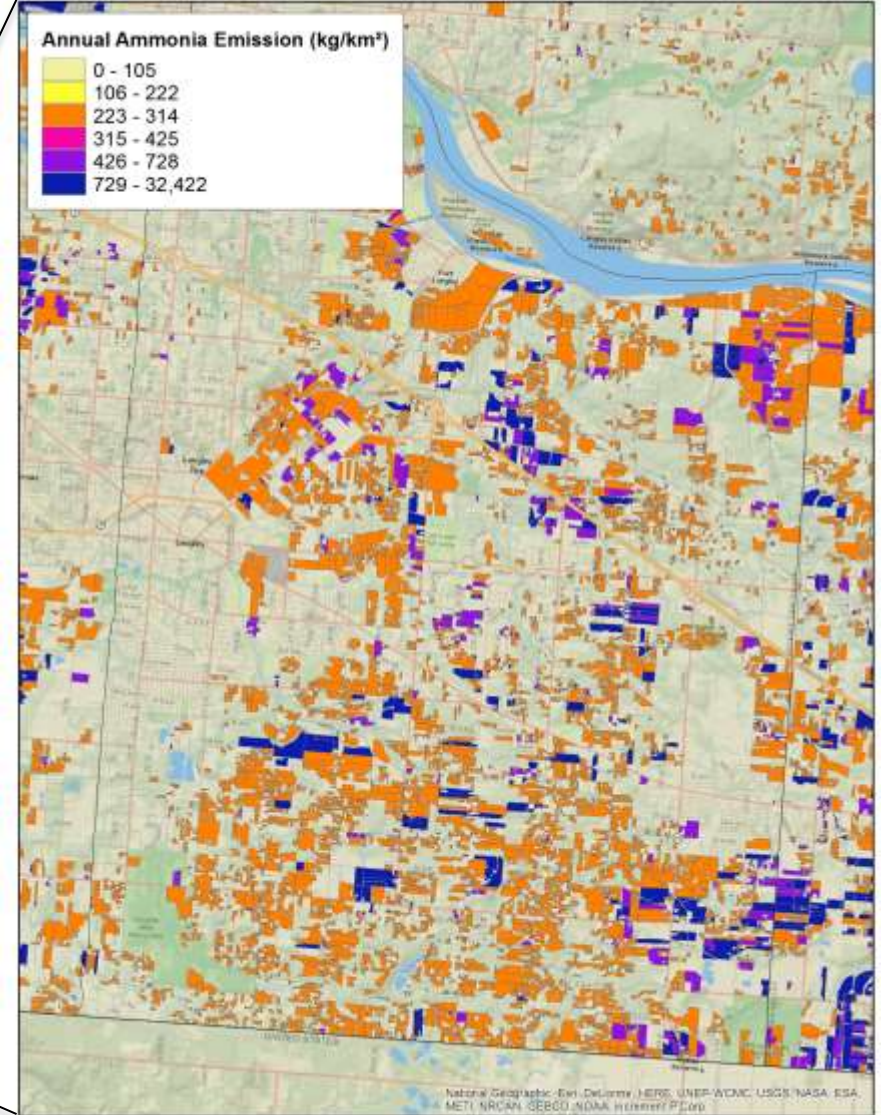
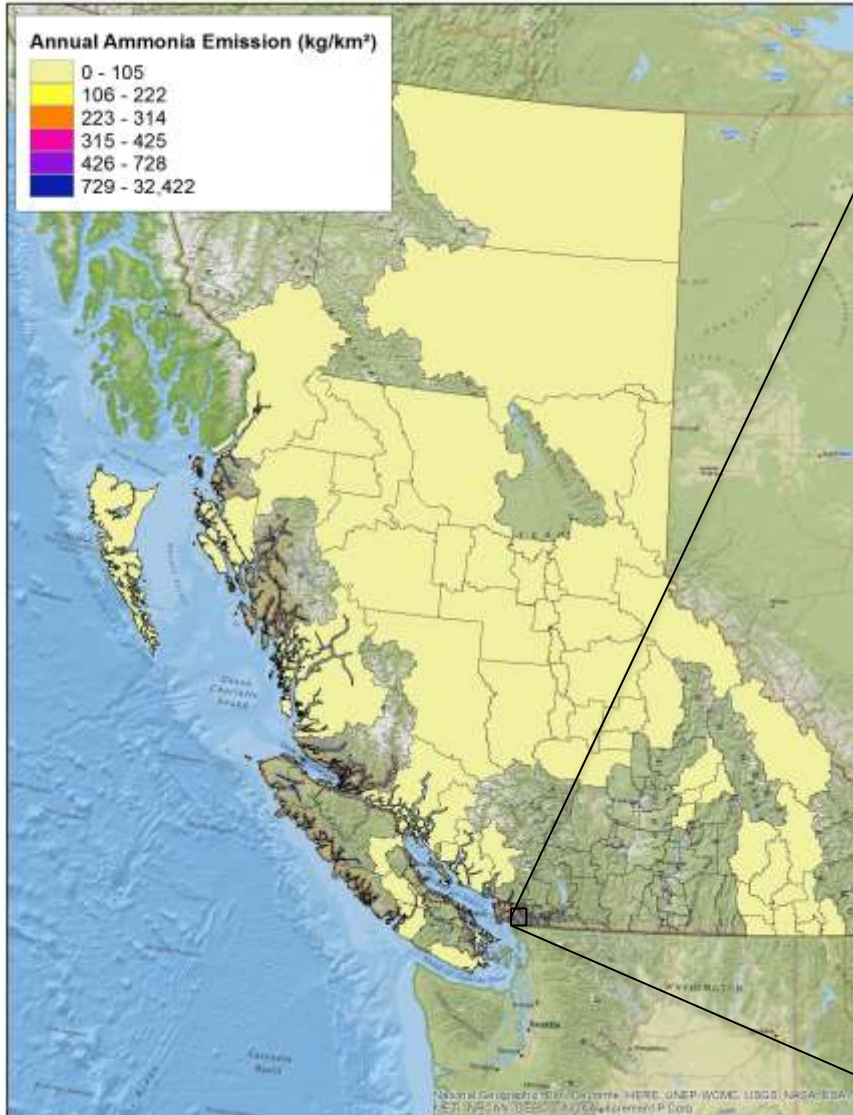
## Annual Ammonia Emissions from Fertilizer (kg)





# Sample Emission Calculation:

## Annual Ammonia Emissions from Fertilizer ( $\text{kg}\cdot\text{km}^{-2}$ )



# Best Management Practices (BMPs)



- Mitigate negative environmental impacts
- Interest in assessing / modelling:
  - changes to farming practices (e.g., shading fuel tanks to reduce evaporative losses)
  - changes in farm activities (alternate or replace crops, etc.)
  - cumulative affects (replace commercial fertilizer with manure = changes to emissions from AND manure storage piles)

# Best Management Practices (BMPs)



## Examples for Fertilizer Application

Best Management Practice	Potential NH <sub>3</sub> Reduction (%)
Maintaining records of all fertilizers	5 to 10
Switching formulations (e.g., urea to ammonium nitrate, or ammonium phosphate to calcium nitrate)	90 to 95
Irrigation following fertilizer application	40 to 70%
Urease inhibitors	40 to 70%
Using improved fertilizer formulations (e.g., slow release fertilizer)	30%
Improved methods of fertilizer application (e.g., incorporation into the soil)	50 to 80%



# Ongoing Developments



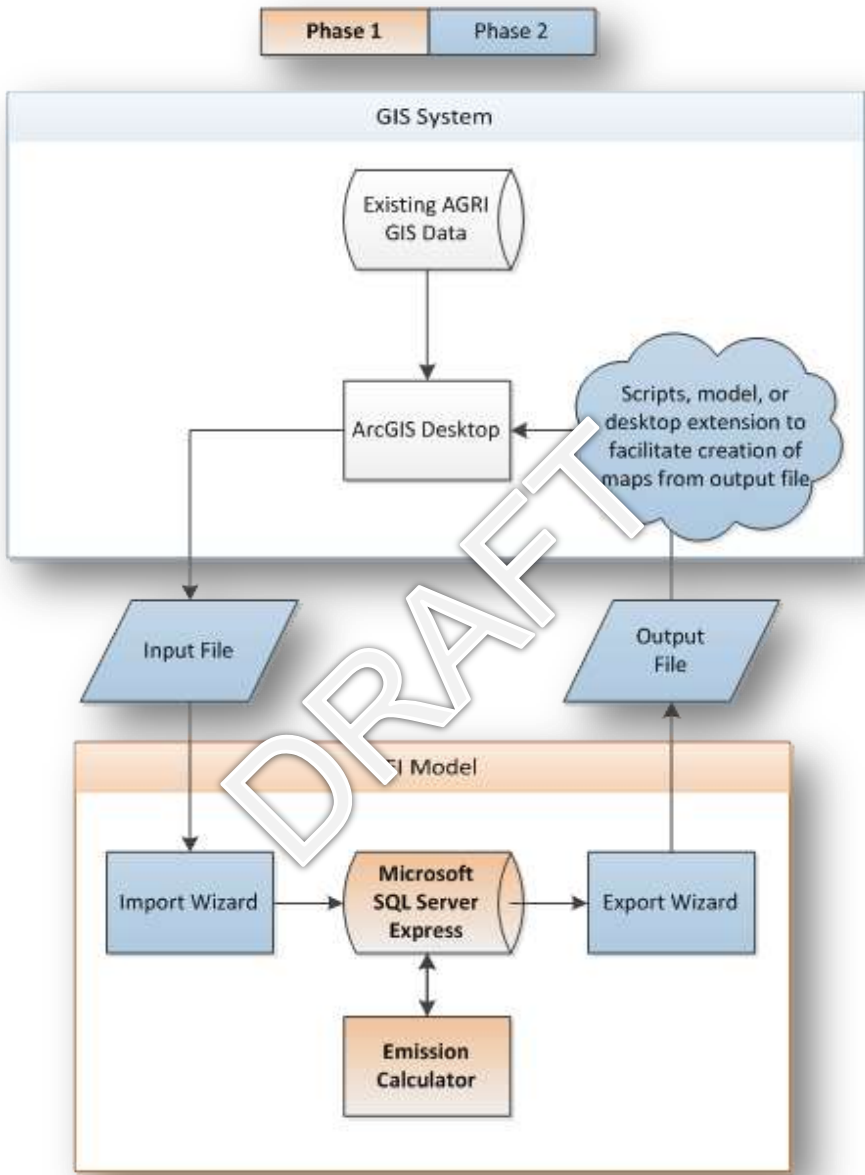
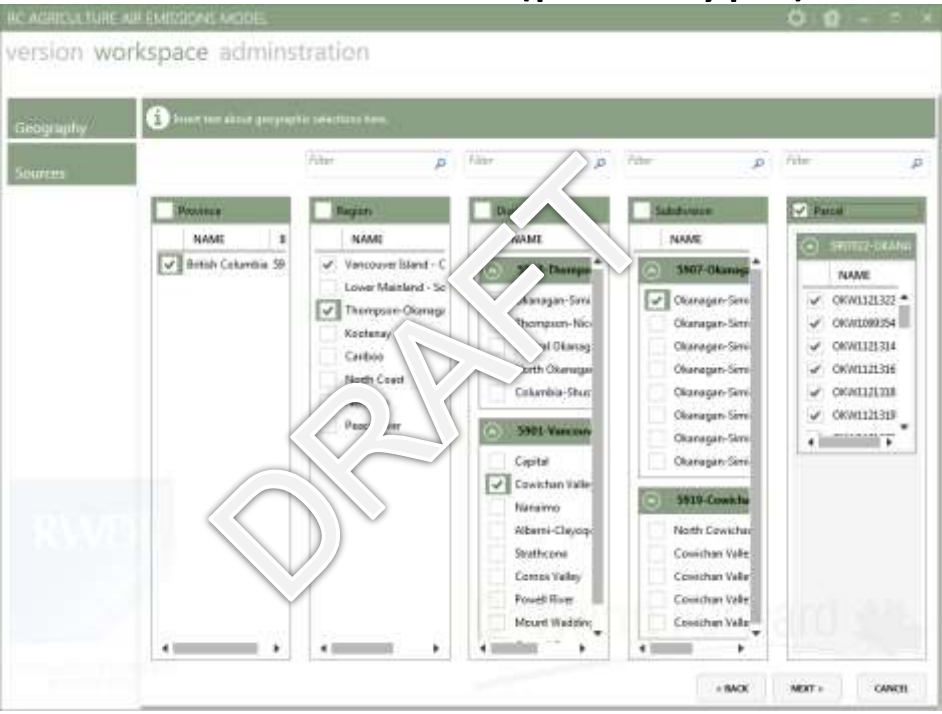
- Development of a database model and GUI to allow for automated emission calculations, BMP scenarios, and activity changes
- Loose coupling with ArcGIS for activity data and mapping / analysis to align with departmental computing environment
- Ongoing improvement of EFs and BMPs based on new studies, research and latest data available

# Ongoing Developments



## Conceptual Model

Cascading geographic query and selection interface (prototype)



# Ongoing Developments



Source type, activity, and emission factor interface (prototype)

BC AGRICULTURE AIR EMISSIONS MODEL

version workspace administration

Geography: New Selection, British Columbia, 2 Agricultural Regions, 2 Census Divisions, Okanagan-Similkameen A, 2332 Parcels

Sources: Please select a Source

Grain: ADD REMOVE

SOURCES:

- FERTILIZER
  - NAME
  - Oats for grain
  - Barley for grain
  - Corn for grain
  - Mixed Grains
- FUNGICIDE
  - NAME
  - Cereal, Grains, Oilseeds
- HERBICIDE
  - NAME
  - Cereal, Grains, Oilseeds

EMISSION FACTORS:

GROUP	SOURCE	POLLUTANT	ACTIVITY	EMISSION FACTOR	UNIT
Fertilizer	Barley for grain	NH3		7.133617977	kg/he
Fertilizer	Barley for grain	PM10		1.09	kg/to
Fertilizer	Barley for grain	PM25		0.31	kg/to
Fertilizer	Barley for grain	PM		2.23	kg/to
Fertilizer	Corn for grain	NH3		9.031099518	kg/he
Fertilizer	Corn for grain	PM10		1.09	kg/to
Fertilizer	Corn for grain	PM25		0.31	kg/to
Fertilizer	Corn for grain	PM		2.23	kg/to
Fertilizer	Mixed Grains	NH3		5.855955056	kg/he
Fertilizer	Mixed Grains	PM10		1.09	kg/to
Fertilizer	Mixed Grains	PM25		0.31	kg/to
Fertilizer	Mixed Grains	PM		2.23	kg/to
Fungicide	Cereal, Grains, Oilseeds	PM10		0.82	kg/he
Fungicide	Cereal, Grains, Oilseeds	PM25		0.23	kg/he
Fungicide	Cereal, Grains, Oilseeds	PM		1.67	kg/he

BACK OK CANCEL

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Sources: Please select a Source

Grain: ADD EMISSION FACTOR

ADD EMISSION FACTOR dialog:

Source Group: Fertilizer

Source Name: Oats for grain

Pollutant: NH3

Activity:

Emission Factor:  Please Enter a Factor.

OK

EMISSION FACTORS:

GROUP	SOURCE	POLLUTANT	ACTIVITY	EMISSION FACTOR	UNIT
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Funding provided through:  
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**QUESTIONS ?**

