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# Building a national reactive N budget for Canada: a work in progress

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# Object of presentation

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- To produce an outline of nitrogen flows and amounts in Canada



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# Object of presentation

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- To produce an outline of nitrogen flows and amounts in Canada
- **To identify major information shortcomings or uncertainties in the mass balance model**



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- To produce an outline of nitrogen flows and amounts in Canada
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- **To discuss the path forward in improving the budgets**



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- To identify major information shortcomings or uncertainties in the mass balance model
- To discuss the path forward in improving the budgets
- **To develop a dynamic model which could be used to determine how management/societal changes could affect reactive N (and its by-products O<sub>3</sub> and PM<sub>2.5</sub>)**



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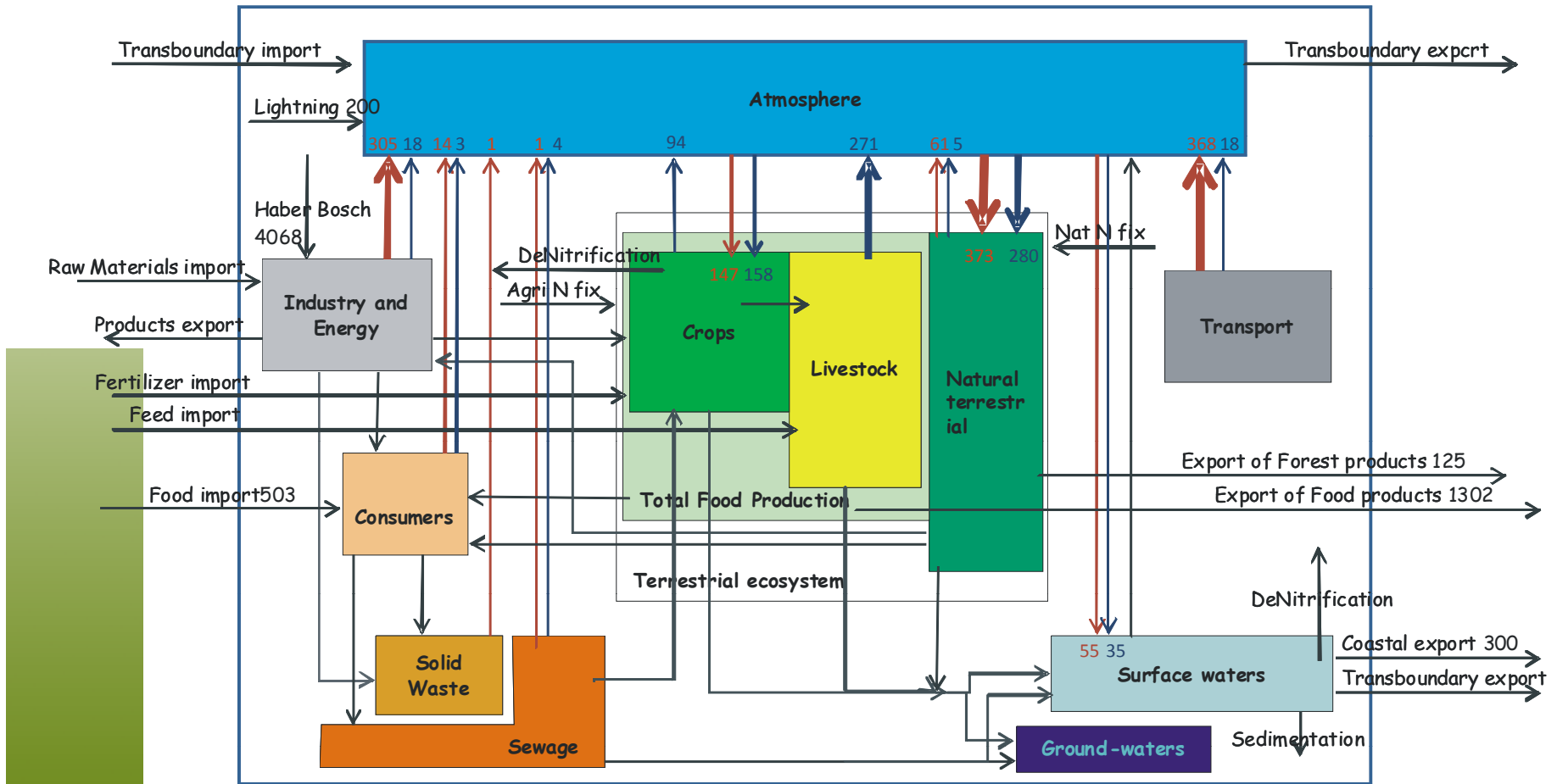
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# Preliminary N budget for Canada

All values in ktons/yr

↑ NO<sub>3</sub>  
↑ NH<sub>3</sub>



# Issues with the model:

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- It's very complicated
- It's difficult to show the inter-relations between the different model components
- The complexity can be simplified in order to extract the large-scale picture of reactive N flows in Canada



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# Natural imports and exports

Ktons N/yr	imports	exports	Reference
Lightning	200		Galloway
Forest N fixation	423		Arp
Forest denitrification		328	Arp
River exports		300	Clair/Galloway
Total Natural	623	628	



# N from the atmosphere to the landscape

(from AURAMS)

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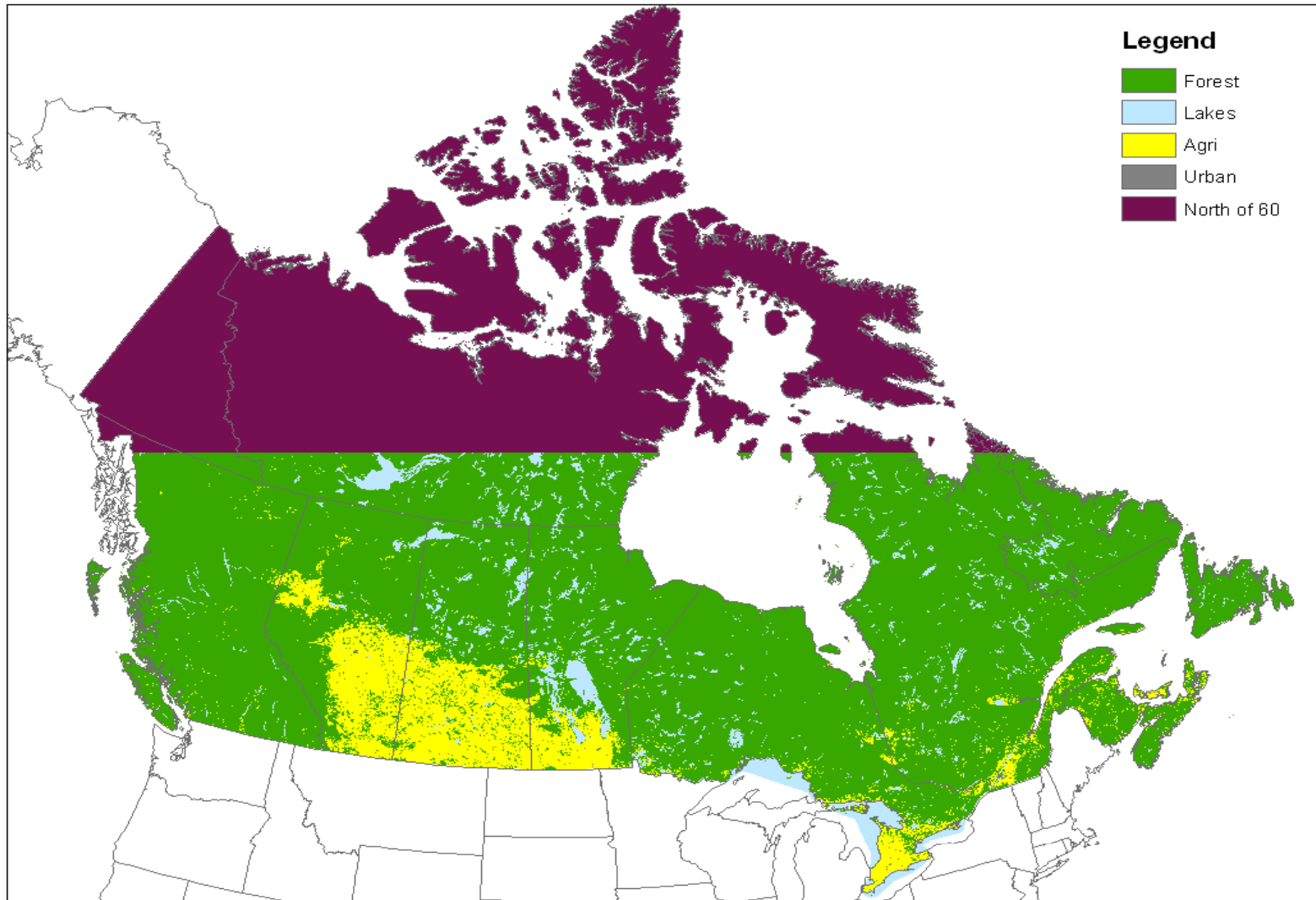


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# Canadian land classification

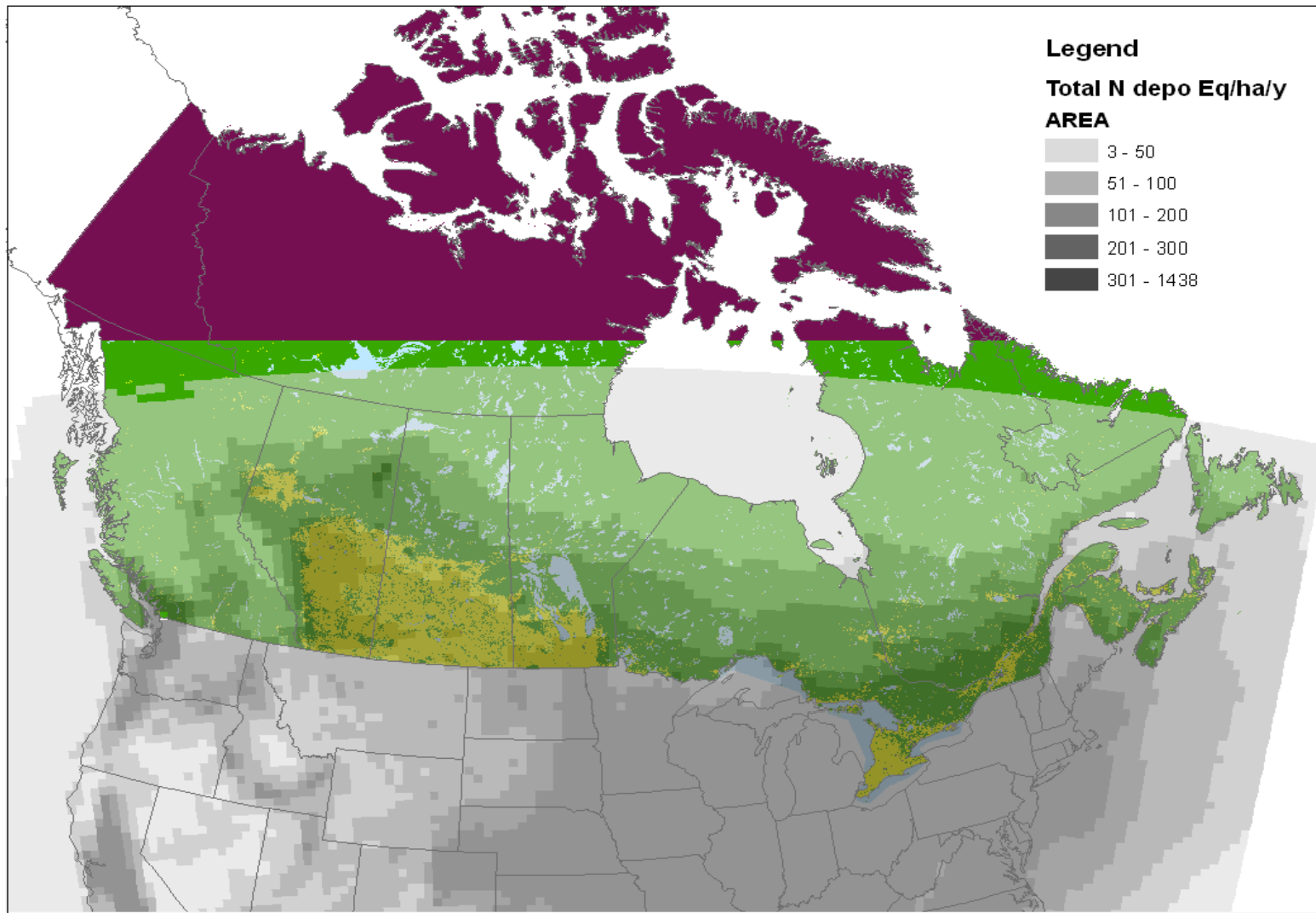


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# Total atmospheric N deposition in Canada 2005 (from AURAMS, to get Kg/ha/yr divide by 14)



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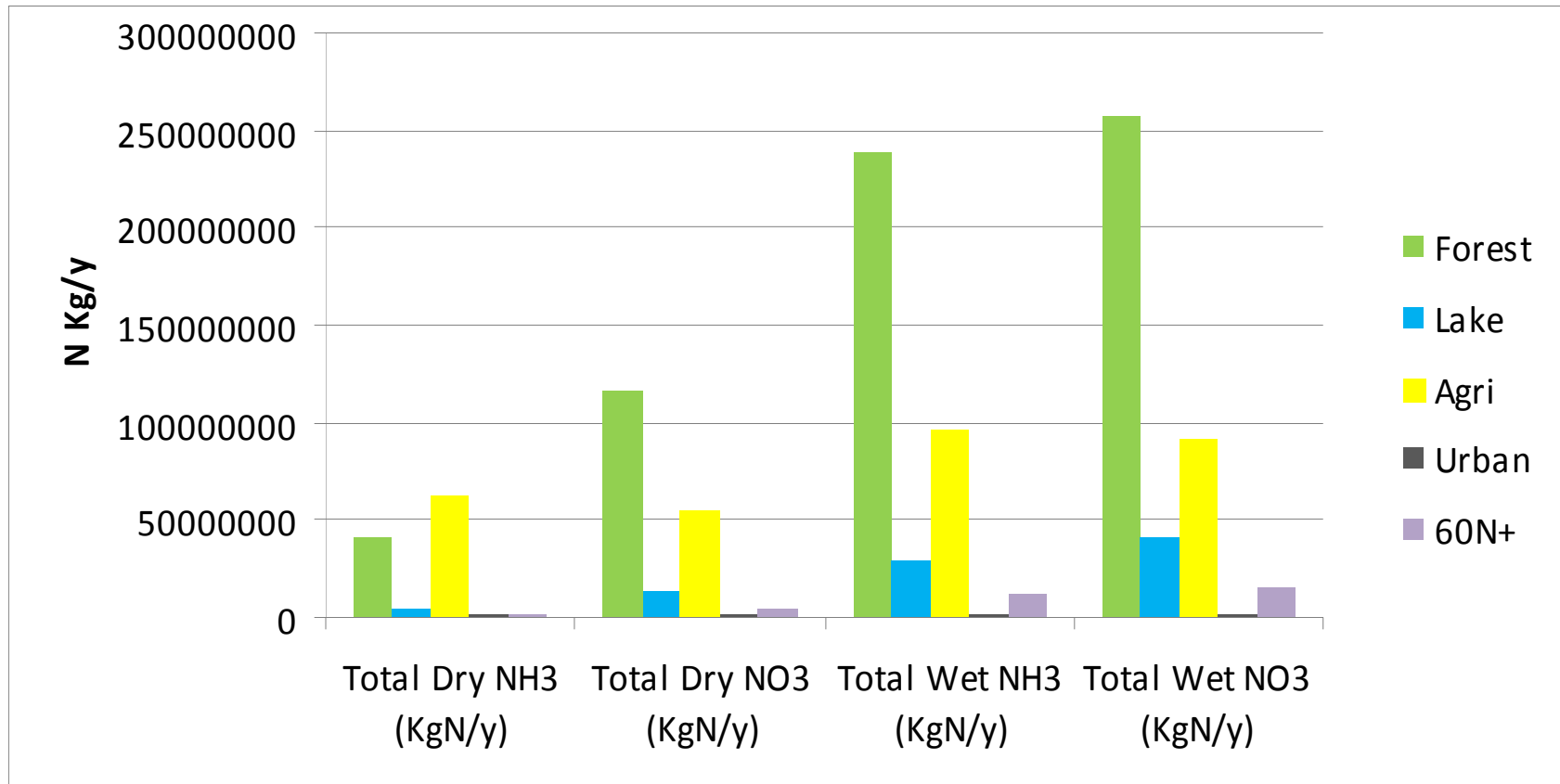
# N from the atmosphere to the landscape

( ktons/yr from AURAMS)

Ktons - N	NO <sub>x</sub>	NH <sub>3</sub>	Total
Deposition on crops	147	158	305
Deposition on forests	373	280	653
Deposition on freshwaters	55	35	90
Fixation by forests			423
Fixation by agric.			35
Total atmospheric N to the landscape	998	473	1506



# Total N deposition by land use type



# N to the atmosphere or ocean from the landscape from EC National Pollution Release Inventory)

Ktons - N	NO <sub>x</sub>	NH <sub>3</sub>	N <sub>2</sub> O or N <sub>2</sub>	Total
Industry	305	18		323
Consumers	14	3		17
Landfills (deponies)	1			1
Sewage	1	4		5
Transportation	368	18		386
Crops		94	35	129
Livestock		271		271
River export (DON + NO <sub>3</sub> )				300
Forest fires and denitrification	411		328	739
<b>Total</b>	<b>1100</b>	<b>408</b>	<b>70</b>	<b>2171</b>



# Total N exchanges between the landscape and atmosphere

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Ktons N/yr	Deposited or fixed	Emitted or exported
Total Natural	623	628
Total anthropogenic + natural	1506	2171
Atmospheric advection	In: ?	out: ?





# Anthropogenic imports and exports

(in Ktons/yr from Pelletier/Statistics Canada)

Ktons N/yr	imports	exports	Difference
Food Products	503	1303	+800
Wood Products	105	125	+20
Petroleum Prod	871	2136	+1265
Fertilizer	342	2025	+1683
Total	1821	5589	+3768

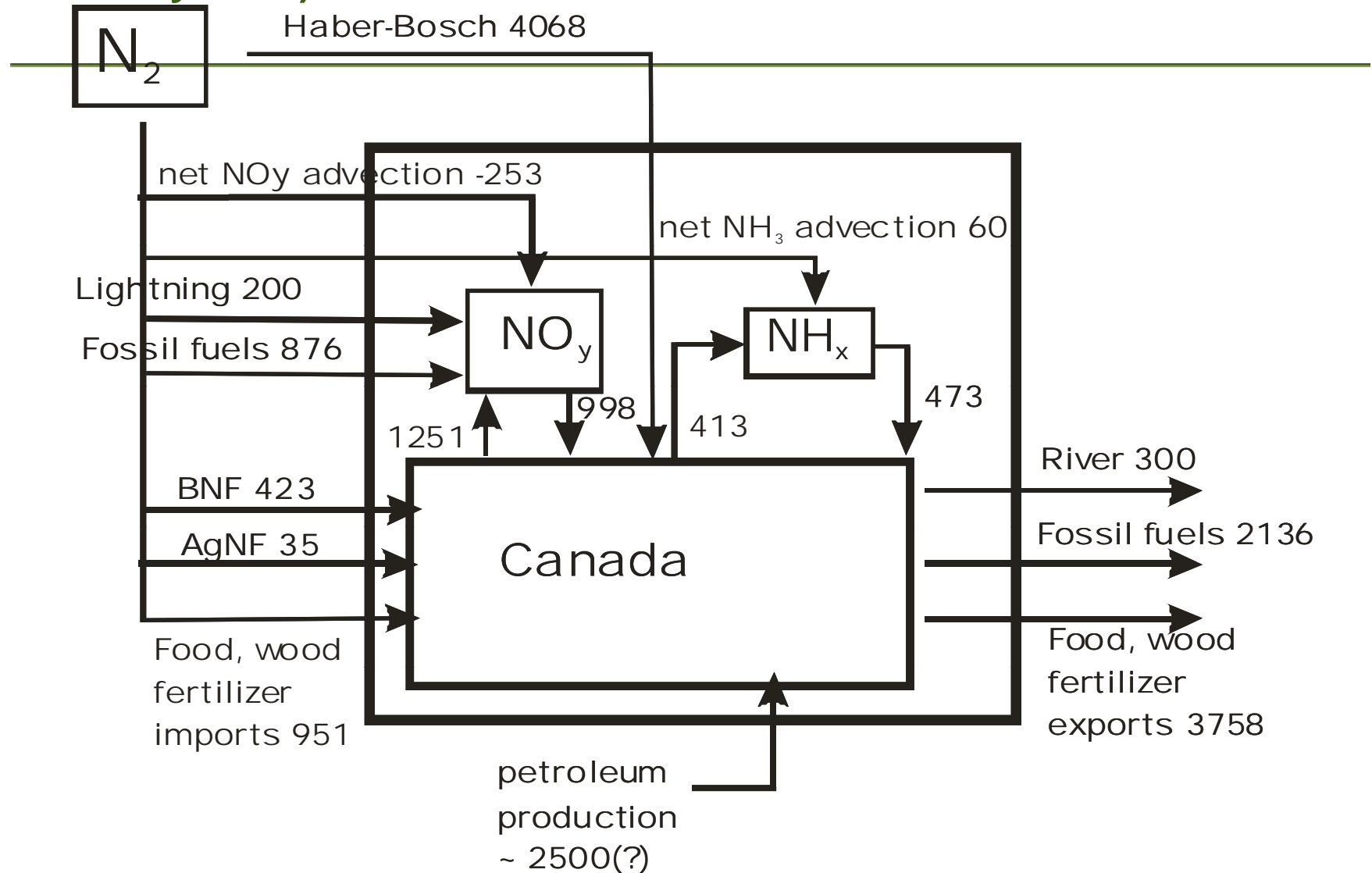


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# Simplified N budget for Canada (as per Galloway et al.)



# Summary

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- **The mass balance model is a good start and has been informative to identify how Canadian N flows occur**



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# Summary

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- The mass balance model is a good start and has been informative to identify how Canadian N flows occur
- **Canada is a large exporter of nitrogen in the form of food, fertilizer, and petroleum products**



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# Summary

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- The mass balance model is a good start and has been informative to identify how Canadian N flows occur
- Canada is a large exporter of nitrogen in the form of food, fertilizer, and petroleum products
- **There is still uncertainty with some of the key inputs or outputs – more work needs to be done with specialists to firm up the numbers**



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# Next modeling steps:

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- In order to better understand how the various model components interact, and to determine how management, dietary and societal changes may change air-landscape interactions we will be developing a model using STELLA software which will link the various components to each other and allow us to predict how different scenarios will affect air and water quality.



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- Canada is an agglomeration of 10 provinces which all have different industrial, population and agricultural intensities, specialties and legislative systems. The modeling effort will have to be able to deal with this level of complexity.



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