A Watershed Bioeconomy Approach in Manitoba

Dimple Roy

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Ontario Climate Consortium: Sustainable Energy in the Agri-Food Supply Chain

IISD
International Institute for Sustainable Development

A Decade of Innovation

For the last decade IISD and partners from Industry, Academia, and Government have pursued innovative strategies to better manage land, water, and energy within the Lake Winnipeg Watershed

Harvesting Cattail (*Typha*) and other emergent plants to capture phosphorus, and using their abundant biomass for energy and other bioproducts

The International Institute for Sustainable Development (IISD)

- Independent, non-profit organization focussed mostly (but not only) on policy analysis for that promote equity and a healthy planet
- Based in Canada with over 200 staff and associates, and offices in Winnipeg, Ottawa, Geneva and New York
- Areas of focus: resilience, economic law and policy, energy, water (and ELA) and knowledge for integrated decisions

The Lake Winnipeg Watershed

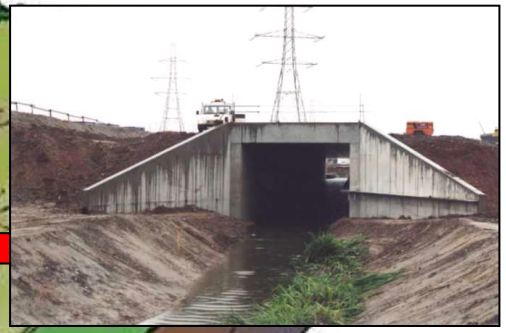
- Serious issues with algae blooms in the lake
- Caused by too much phosphorus
- Known as “eutrophication”

The Lake Winnipeg Watershed

- Flooding – higher frequency in last decade
- Spring runoff
- Summer storms
- Carries phosphorus and other contaminants downstream to lake

Functional Watershed

Modified Watershed



Ecosystems provide critical Environmental benefits (EGS)

- Flood storage
- Drought resilience
- Nutrient capture
- Wildlife habitat
- Biomass

Ecosystems impacted – reduced EGS

- Natural buffers gone or severely degraded

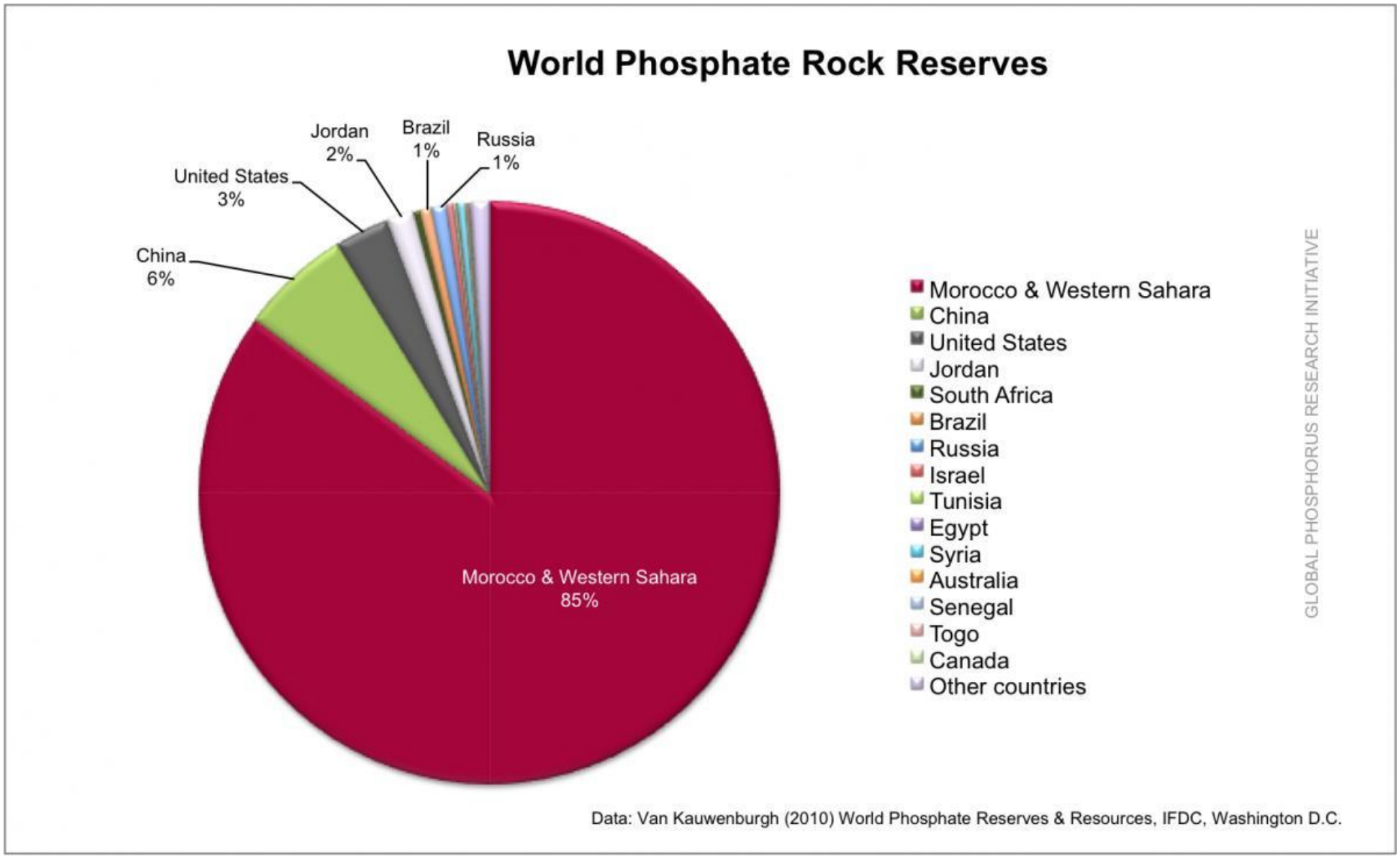
The Beginning: reasons why

- **Lake Winnipeg –** issues with algae blooms from too much phosphorus
- Explored innovative ways to reduce P loading using natural systems

  passive ecological engineering
- **Certain plants are very good at absorbing nutrients and pollutants**– cattails, but also reeds and grasses can contribute.
- **Could we harvest plants** (i.e. cattail, reeds) to capture and remove P?
- **Use of biomass**? For low carbon energy?
- Can we use biomass in place of coal/fossil fuels to reduce carbon emissions?
- Markets?
- Incentives to make this work?
- Reduce carbon emissions = **carbon offset credits**
- **Combine with water retention (flood protection)**

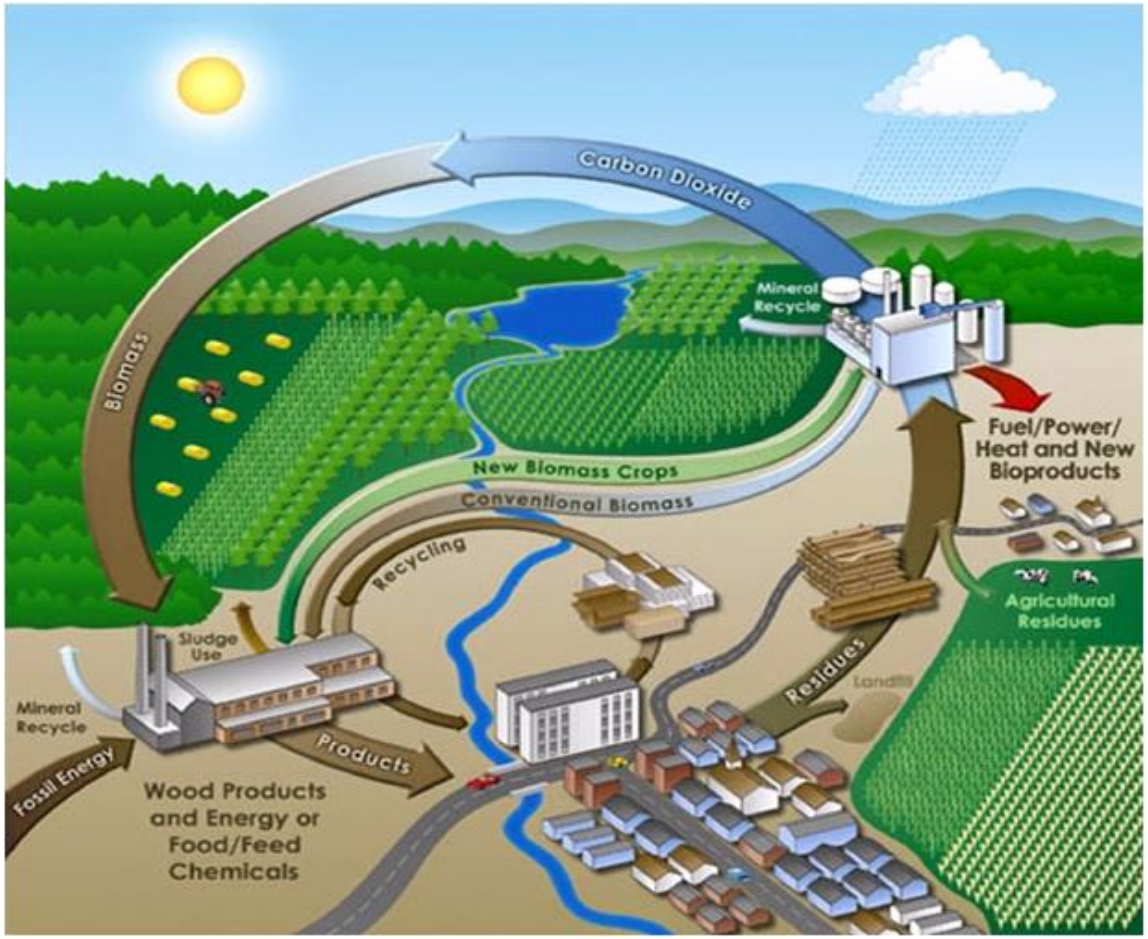
  holding water on the land also holds nutrients

That “pollutant,” phosphorus, is actually a scarce and strategic resource!



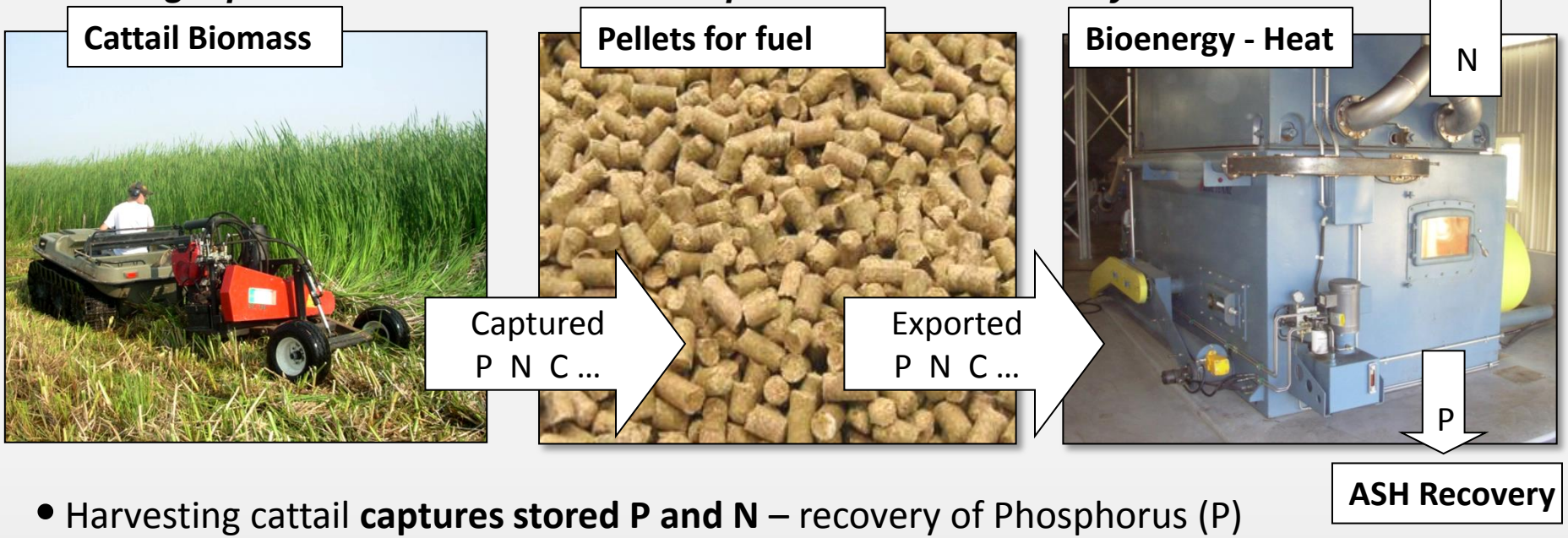
What is the Bioeconomy?

A sustainable economy that uses biological renewable resources (e.g. plants, algae, fish) as raw materials to bioproducts: *bioenergy, liquid fuels, plastics, textiles, chemicals, pharmaceuticals*



From Research to Commercialization

turning a problem into a sustainable input for the Bioeconomy



- Harvesting cattail **captures stored P and N** – recovery of Phosphorus (P)
- **Sustainable renewable biomass** feedstock for bioenergy (displace fossil fuels, i.e. coal) or higher value bioproducts
- **Carbon credits** - production of "low carbon" bioenergy, while reaping benefits of P capture from Lake Winnipeg – **"Lake Friendly" biomass**
- Opening wetland site for wildlife habitat renewal
- **Bioremediation + habitat renewal + GHG reductions + + +**

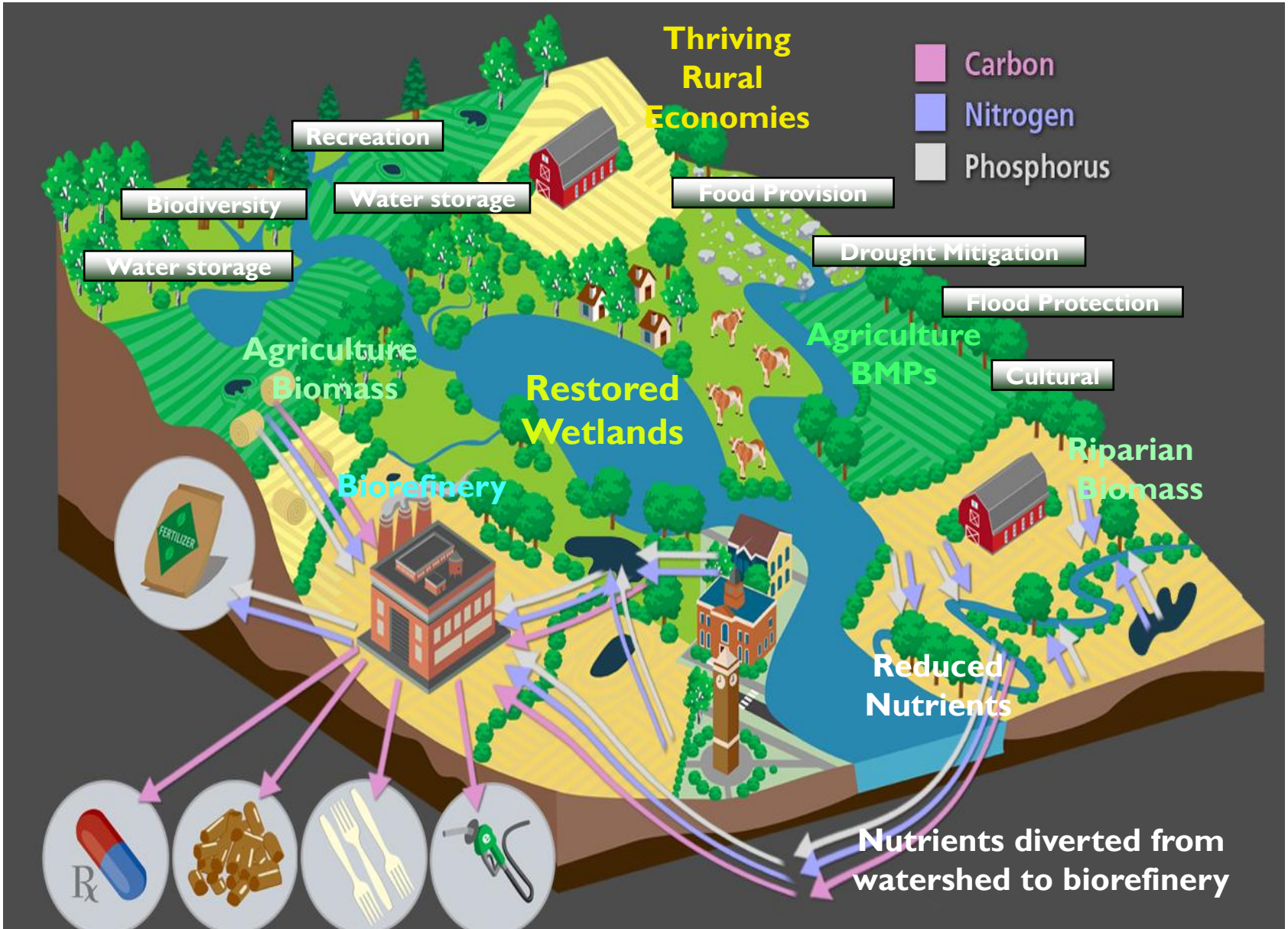
88% Phosphorus Recovery

Lake Winnipeg and the Manitoba Bioeconomy

- **Flooding and nutrient management issues** provide economic opportunity through innovative solutions
  - Surface water management
  - Emergent Plants – take up nutrients
  - Harvest to remove nutrients

- Opportunity: **Biomass harvest** = Bioenergy, biofuels, Bioproducts
- **Phosphorus capture** & recycling
- **Manitoba Coal Ban** - creates market and demand for solid biomass fuel (*fuel pellets*)

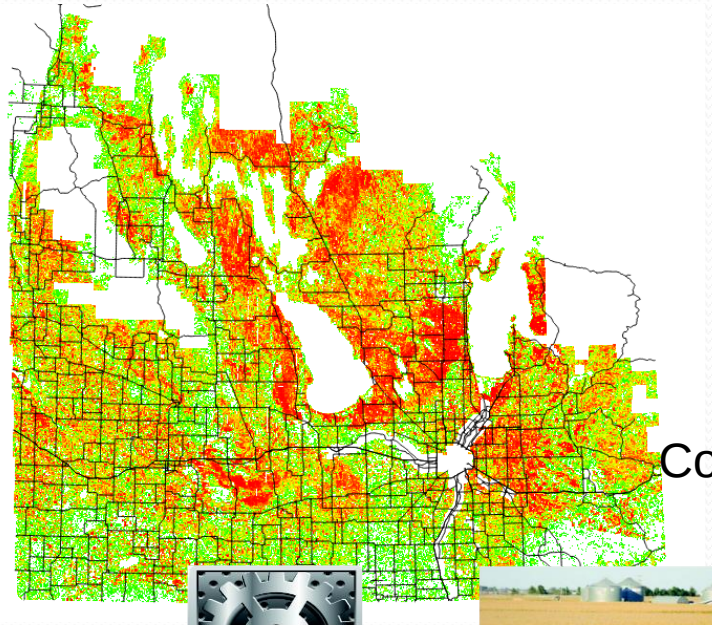
Watershed of the Future



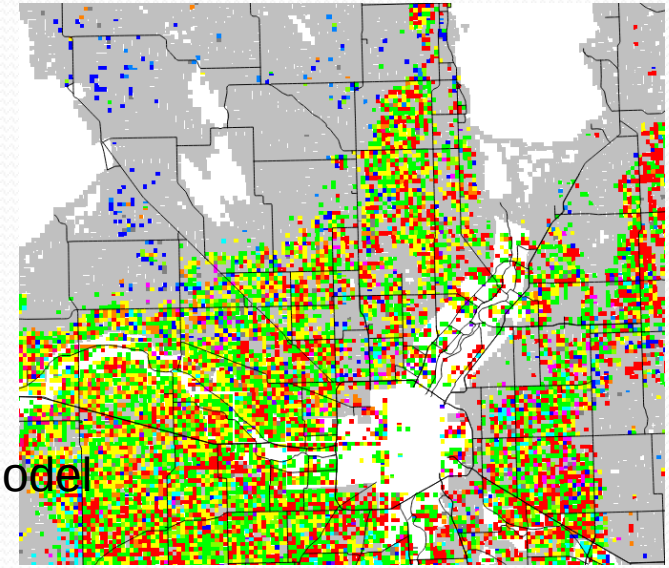
Overview of the Manitoba BioEconomy Atlas

Bioeconomy Atlas: Supply-side analysis

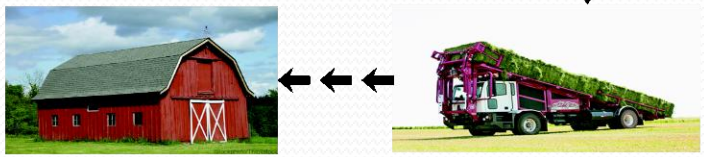
Typha Remote Sensing



MASC Crop data



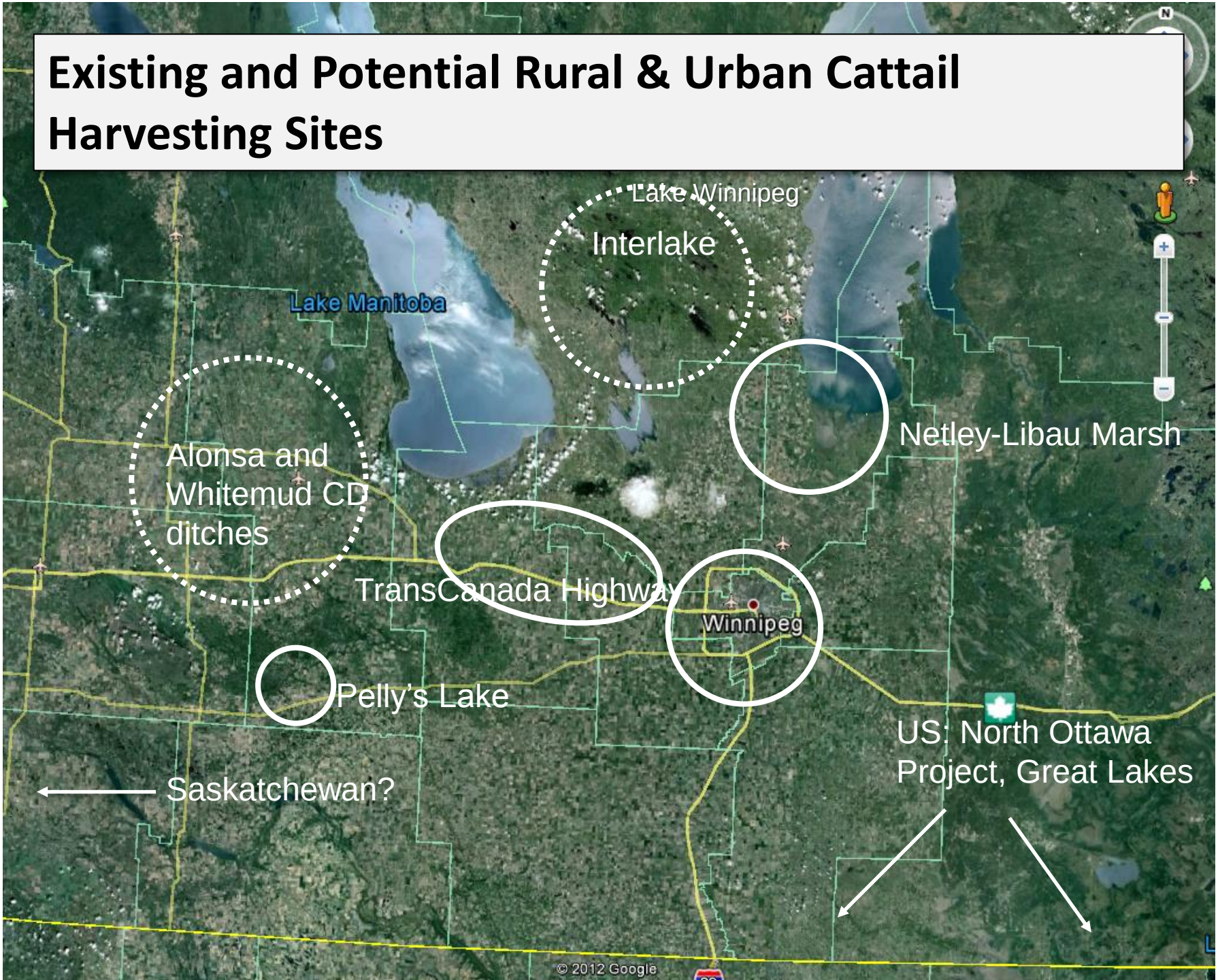
Components of Model



The Manitoba Market Demand: Solid Fuel

- Replace coal and other fossil fuels with biomass = fuel pellets
- Manitoba Government Banned use of coal for heating in 2014 – enforced 2017
- Many coal users switching to biomass – increased demand for processed biomass fuel

Existing and Potential Rural & Urban Cattail Harvesting Sites



Pelly's Lake Cattail Harvesting 2012-2015

- Water retention site - reduces downstream flooding, captures nutrients
- Excellent conditions for growing cattail
- Dries up in the fall suitable for harvesting

Commercial harvesting, baling, pelletizing, use 2012-2015

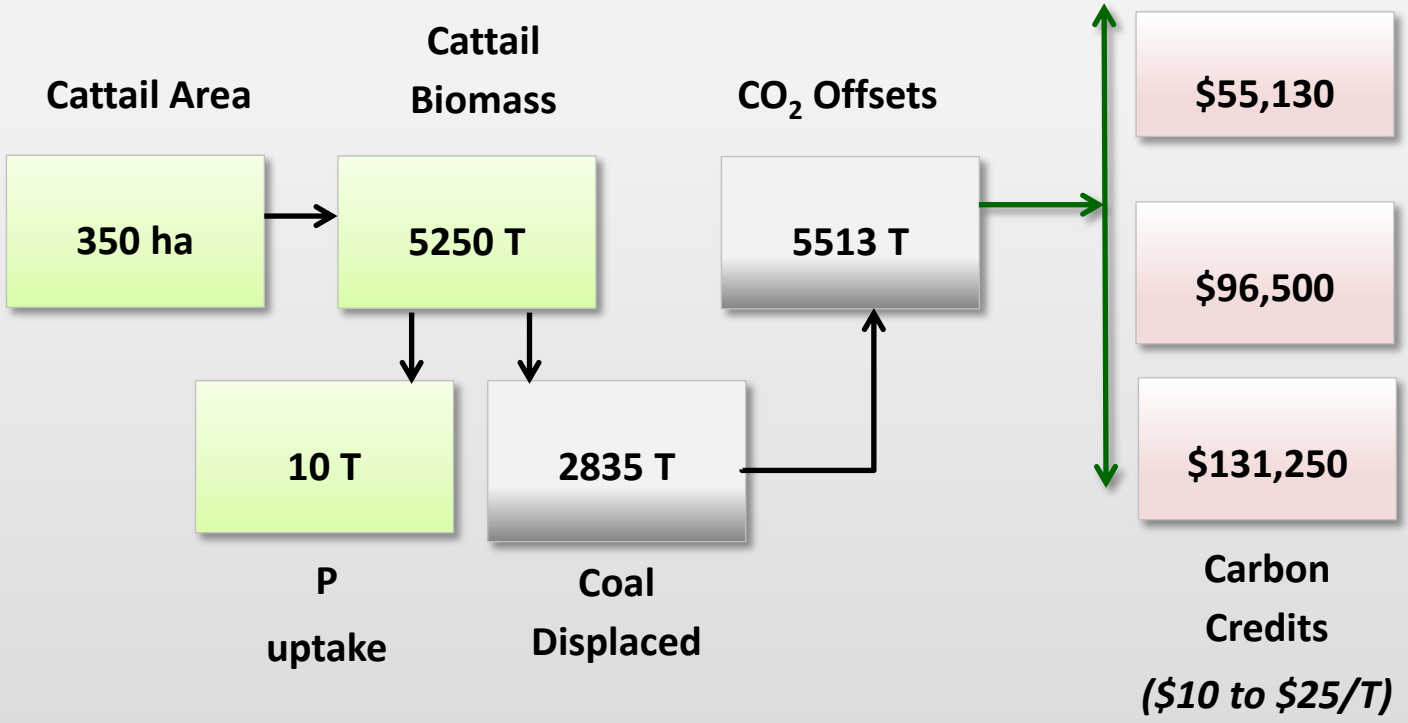
Biomass and Phosphorus captured (2012-2015)

(1 tonne = 1000 kg)

TOTALS	**Cattail Biomass** (tonnes)	**P** (tonnes)	**N** (tonnes)
2012	330	0.3	4.3
2013	150	0.2	1.4
2014	120	0.07	0.5
2015	600	0.96	7.8
TOTAL	1,200	1.5	14.1

Cattail carbon offsets - displacing coal

Biomass	Yield (T/ha)	Energy Content (MJ/T)	Energy Content (MJ/T) at 80% efficiency	Emissions (T CO_2/T biomass)	CO_2 offset per T
cattail	15	17500	14000	0.5	1.05
coal	-	25800	-	2.44	-

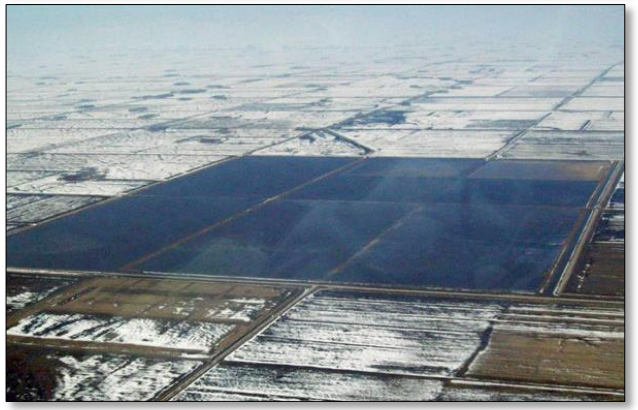


Multiple EGS benefits – High value Environmental and Economic benefits

Harvest Cattail =

1. **Biomass supply**
2. **Nutrient capture (P, N)**
3. **Carbon offsets**

+ **Surface Water Management** – hold water to reduce flood damages + irrigation in times of drought
+ **Biodiversity and habitat management** – improved wildlife habitat - payments provided in Europe
+ **Water quality trading credits** – payments for service of removing Phosphorus ($/kg)
+ **Higher value bioproducts** – biochar, fibres, composites, ethanol, bioplastics, biogas, fertilizer
+ **Methane and Nitrous Oxide reduction**



IISD Water Program - Bioeconomy

REPLICATION
National/ International

Cattail/Biomass Harvesting

COMMERCIALIZATION

- Nutrient Capture
- Water Retention
- Watershed Management
- Sustainable Renewable Biomass
- Sustainable Agriculture
- Policy

Reduce Phosphorus loading to Lake Winnipeg	Flood protection	**Habitat/ Biodiversity**	**Solid Fuel (fuel pellets, cubes)**	**Marginal Agr lands**	**Carbon Credits**
	Drought Protection	**Invasive species control**	Liquid Fuels	New markets	Water Quality credits
Reduce Algae blooms	**Wetland restoration**	Maintenance of municipal lands	Charcoal (biochar)	Additional revenue	Surface Water Management
Lake remediation technology	Erosion control	Drainage ditches	Composites	Custom equipment	Drainage Management
Bioremediation (toxins, contaminants)_			Absorbants	Custom services (harvest/bale)	Flood protection
Phosphorus reuse and recycling $$$			Biogas (methane)		Wetland protection

Floating Bioplatforms for Bioremediation

- Water treatment, habitat, bioremediation
- Research at ELA 2015

Regional Priority Policies and Programs

- Surface water management strategy (draft)
- No net loss of wetlands policy
- Manitoba coal ban
- Manitoba biomass strategy
- Municipal ditch maintenance
- Local carbon offsets
- Flood/drought management
- Rural economic development
- Municipal waste management and composting




Applying bioeconomy concepts in other regions

- **Applications of the Bioeconomy will differ**:
  - local issues
  - needs, demands, and current markets
  - Policies and incentives
- In Manitoba focus = Lake Winnipeg algae, phosphorus, flooding, and solid biomass fuel
- Europe = biodiversity, sustainable biomass, roof thatching, biogas
- China = water pollutants, pulp and paper, mats
- Africa = alternative energy (charcoal), water conservation, economic development
- Ontario = ??

Conclusions

- Cattail and other biomass is a **sustainable and renewable resource** with significant environmental and economic benefits
- Demonstration of the bioeconomy with quantifiable success in **achieving SD co-benefits**
- **Nutrient management + novel biomass production combined with surface water management** - applied to engineered wetlands, storm water basins, and ditches for greater economic gains
- **Mechanism to capture and recover phosphorus -** reduce watershed loading profitably, rather than at cost both environmentally and economically
- **Creating value for ecological biomass -** incentives for conservation and restoration of wetlands on marginal agricultural land
- **Alternative revenue for landowners -** otherwise unproductive land