Bioeconomies at a Watershed Scale

"Developing bioeconomies on a watershed basis creates synergies between natural systems (such as hydrology) and socioeconomic ones (such as agriculture). It puts sustainability and locally appropriate development at the forefront."

- Dimple Roy
Director, Water Program, IISD

iisd International Institute for Sustainable Development / Institut international du développement durable

What is a Bioeconomy?

A bioeconomy is an economy where the basic building blocks for industry and the raw materials for energy and high-value bioproducts are derived from plant- and crop-based (renewable) sources. The resulting bioproducts have many uses for such things as bioenergy, liquid fuels, plastics, textiles, chemicals and pharmaceuticals.

What is IISD's Approach to the Bioeconomy?

The International Institute for Sustainable Development (IISD) applies the bioeconomy concept at a **watershed scale**, using plant materials that are either naturally occurring (e.g., wetland plants) or are by-products of existing activities (e.g., agriculture crop residues). Our perspective is that **nutrients, energy and water** are all concentrated by watershed management. We are developing a holistic, watershed-based approach that increases sustainable development benefits and can be adapted for watersheds throughout the world.

A **distinguishing feature** of IISD's approach is that we identify and **bundle the many different benefits** of the bioeconomy. We look not only at the tangible end-products of using plant materials, but also see high value in the environmental, social and economic benefits that are overlooked in many bioeconomy processes and methods. These benefits can include:

- **Water quality improvements**
- **Decreased nutrient (phosphorus and nitrogen) loading to lakes and rivers; reduced algal blooms**
- **Carbon credits**
- **Methane credits**
- **Nutrient recovery and recycling for use (such as in fertilizer)**
- **Water quality credits**
- **Habitat improvement**
- **Flood and drought protection**
- **Strengthening of rural economies**

In addition, we are pursuing **innovative uses** for by-products of the bioeconomy. For example, we are exploring **recycling phosphorus** from harvested plant material in order to **protect waterways** from nutrient loading and decrease reliance on mined rock phosphates.

Why the Bioeconomy?

Many resources on which our society has grown dependent are becoming depleted or have negative consequences. A bioeconomy is based on renewable sources and can balance the environmental, social and economic elements of human progress. For example:

- Coal and other fossil fuels can be replaced with solid and liquid fuels from plants, such as grasses, cattails, reeds and agricultural residues.
- Petroleum-based plastics can be replaced by bioplastics that may be compostable.
- Mined rock phosphate, commonly used in fertilizers, can be replaced with phosphorus recovered from plants burned for bioenergy, from liquid fuel processing or biosolids.

Opportunities for Watershed-based Bioeconomies

Numerous examples can be found around the world where benefits are gained through a bioeconomy in the context of watershed management. IISD is pursuing watershed-based bioeconomy concepts in countries around the world to combine the multiple environmental, economic, and social benefits that help create profitable bioeconomies that are also resilient, renewable, and sustainable.

"The exciting thing about IISD's approach to the bioeconomy is that it creates viable business and investment opportunities that also contribute to sustainability and improved water quality."

- Glenn Crook
Vice-president, Commercial Financial Services at RBC Royal Bank

Lake Winnipeg Bioeconomy (Canada)

In recent decades, Lake Winnipeg, the 10th largest freshwater lake in the world, was faced with a significant challenge: excessive **nutrient loading** (i.e., phosphorus, nitrogen) causing **algal blooms**.

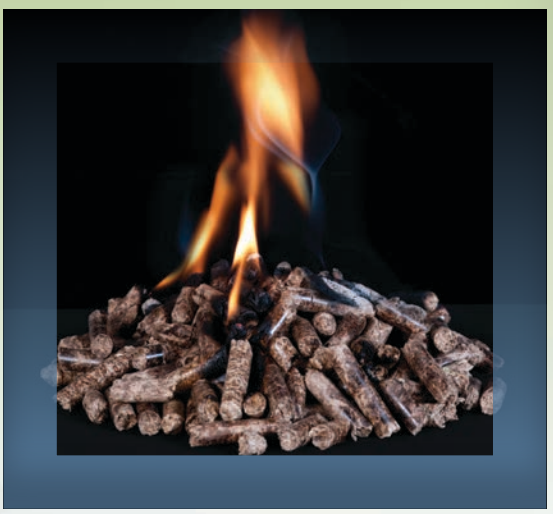
As one possible solution, IISD researched how **harvesting novel plant species**, such as the common wetland plant, cattail (*Typha spp.*), can capture nutrients throughout the watershed before they reach the lake. Cattails absorb large amounts of nitrogen and phosphorus when they grow.

Cattail is also an excellent raw material for energy and bioproducts, and a building block for a regional bioeconomy.

IISD has collaborated with a variety of partners to develop a range of cattail-based products including:

- **Bioenergy** in various forms (pellets, cubes, biomethane, syngas – a type of synthetic gas, ethanol, biocoal).
- **Biochar** for improving soil conditions.
- **Biocomposites** and building materials.
- **Solid fertilizers** from ash after combustion and **liquid fertilizers** from the extraction of captured nutrients in harvested biomass.

These physical outputs have been combined with less tangible benefits, including carbon offset credits, potential water quality credits and floodwater storage to create a business case that has compelled decision-makers at all levels to support a regional Lake Winnipeg bioeconomy.



Comparison of cattail to traditional biomass plant species and coal

RAW PLANT MATERIAL	AVERAGE YIELD (tonnes/hectare)	HEATING VALUE (mj/kg)	TIME TO MATURITY	PHOSPHORUS CAPTURE (kg/hectare)
Cattail	14–20	17–20	90 days	10–40
Wheat straw	1–3	13–18	90–100 days	0.1–2
Switchgrass	9–14	17–19	3 years	-
Miscanthus	6–48	17–19	3–5 years	-
Willow	7–10	10–12	3 years	-
Poplar	7–10	10–12	6–12 years	-
Corn stover	5–6	17–18	110–120 days	-
Coal (anthracite)	n/a	30–35	n/a	-
Coal (lignite)	n/a	10–20	n/a	-

Wuliangsuhai Lake (China)

Common reed (*Phragmites australis*) is the foundation for a bioeconomy at Wuliangsuhai Lake in Inner Mongolia. Nearly half of the lake is covered in reeds, providing 100,000 tonnes of harvested plant material every year and directly and indirectly supporting 2,000 jobs.

The main use of the reeds currently is in paper production, as well as production of insulation panels, resulting in revenues of 32 million *yuan* (CAD$5 million) per year. However, the lake administration is also interested in researching higher-value uses for the reeds, including as construction materials and bioenergy (e.g., combustion).

Harvesting also removes nutrients from the watershed and lake, capturing 14 tonnes of phosphates and 362 tonnes of nitrogen in the harvested reeds per year. This nutrient removal helps ensure other ecosystem services continue to be supported at Wuliangsuhai Lake, such as habitat for migratory birds and recreation – valued at 7 million *yuan* (2003) or CAD$1.2 million.

The International Institute for Sustainable Development (IISD) contributes to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change and energy, and management of natural and social capital, as well as the enabling role of communication technologies in these areas. We report on international negotiations and disseminate knowledge gained through collaborative projects, resulting in more rigorous research, capacity building in developing countries, better networks spanning the North and the South, and better global connections among researchers, practitioners, citizens and policy-makers.

IISD's vision is better living for all—sustainably; its mission is to champion innovation, enabling societies to live sustainably. IISD is registered as a charitable organization in Canada and has 501(c)(3) status in the United States. IISD receives core operating support from the Government of Canada, provided through the International Development Research Centre (IDRC), from the Danish Ministry of Foreign Affairs and from the Province of Manitoba. The Institute receives project funding from numerous governments inside and outside Canada, United Nations agencies, foundations and the private sector.

For more information, please contact:

Dimple Roy
Director, Water
T: 1-204-958-7737 | F: 1-204-958-7710
E: Droy@iisd.ca

Dr. Richard Grosshans
Senior Research Scientist
T: 1-204-958-7718 | F: 1-204-958-7710
E: Rgrosshans@iisd.ca

International Institute for Sustainable Development (IISD)
161 Portage Avenue East, 6th Floor
Winnipeg, Manitoba, Canada
R3B 0Y4

iisd International Institute for Sustainable Development / Institut international du développement durable

www.iisd.org

"The real costs for agricultural production are currently not fully considered. Watershed bioeconomies that value externalities and co-benefits of land use such as in the case of nutrient uptake and carbon sequestration through paludiculture (harvesting wet peatland or wetland plants) pave the path for paying for and managing these important ecosystem services in the future."

- Dr. Wendelin Wichtmann
Scientific coordinator, Michael Succow Foundation for the Protection of Nature at the Greifswald Moor Centrum