PEAK PHOSPHORUS: A NEW DIMENSION FOR FOOD SECURITY AND WATER QUALITY IN THE LAKE WINNIPEG BASIN

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Abstract

Evidence is emerging that global supplies of rock phosphate used for production of phosphorus (P) fertilizers are declining. The term *peak phosphorus* has been applied to the situation that phosphorus, the first non-renewable, non-substitutable life-supporting element, will become scarce in the foreseeable future. As a result, management of phosphorus on the land and the prevention of nutrient pollution in aquatic ecosystems are aligned by the common goal of keeping phosphorus on the land for crops. The objective of the study was to investigate the confluence of intensive management of phosphorus in agriculture with the goals of securing food productivity and water pollution prevention as symbolized by Lake Winnipeg, visibly the most eutrophic Great Lake in the world. The method was an action research approach designed to disseminate and gather information on existing and future challenges related to P management and social process of change. Based upon review of science, analysis of the basin and dialogue with 40 stakeholders, action recommendations for best management practices, P recycling and stewardship were formulated. The results demonstrate the urgency and importance of establishing an integrated watershed management approach including all aspects of Lake Winnipeg-related water security, phosphorus recycling, traditional knowledge and governance.

Keywords: peak phosphorus; food security; water quality; social change; eutrophication; Lake Winnipeg

Introduction

The prospect of depleting the world's easily minable mineral rock phosphate reserves, predicted to be as early as 20 years (Cordell, Drangert & White, 2009) is of great concern and is being increasingly compared to 'peak oil' (Déry & Anderson, 2007). Unlike irreversible impacts such as the consumption of fossil fuels, phosphorus can neither be created nor destroyed, but is endlessly recycled through the natural processes of the Earth. While we can never 'run out' of phosphorus, when washed from the land to the oceans it is not returned to mineral forms that can be mined for tens of millions of years. Yet, phosphorus stores within agricultural soils, crops, food, composts, biomasses, and wastewater can be controlled, managed, and recycled rather than being lost to the oceans.

The objective of our study was to investigate the confluence of intensive management of phosphorus in agriculture with the goals of securing food productivity and water pollution prevention as symbolized by Lake Winnipeg, visibly the most eutrophic great lake in the world (Fig. 1).

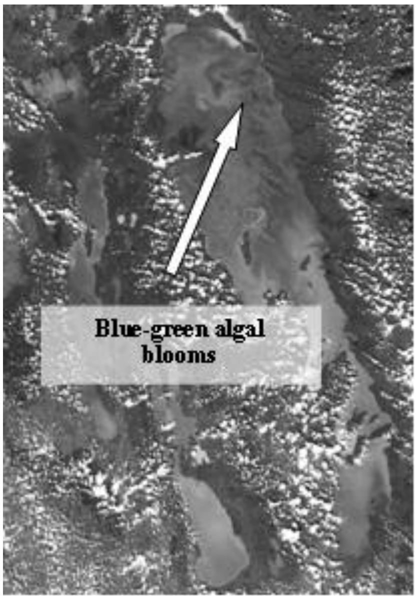

Figure 1: Satellite view of Lake Winnipeg in 2009 showing the large expanse of surface blooms in the North Basin, covering 13.000km^2 in 2005 (Supplied by Greg McCullough).

Home to 6 million people, 17 million livestock, the basin (Fig. 2) covers nearly 1 million km^2, including 55 million hectares of agricultural land. Lake Winnipeg serves multiple purposes, including recreation, commercial fisheries, and is the world's largest hydro-electric power generation reservoir. These functions affect or are being affected by high phosphorus levels.

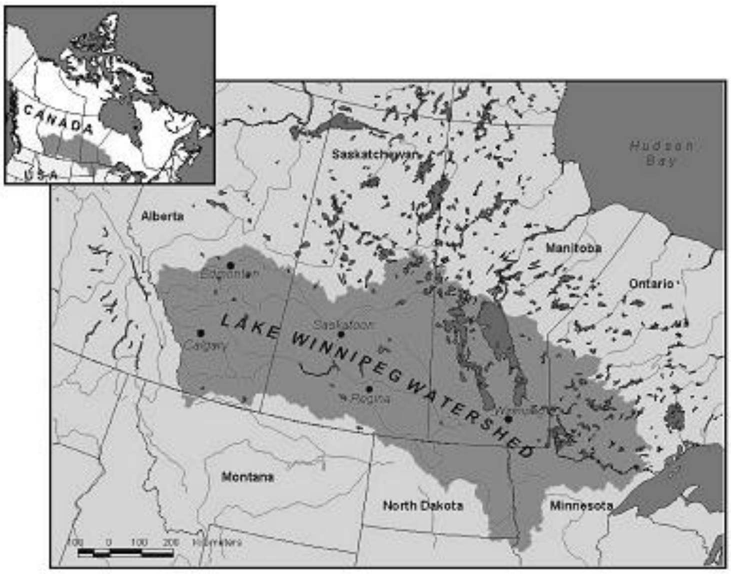

Figure 2: The Lake Winnipeg basin (in orange) is the second largest watershed in North America. It is nearly 40 times greater in area than Lake Winnipeg, the largest ration for any large lake in the world (Source: Manitoba Water Stewardship,

Fig.3 shows the phosphorus cycle consisting of natural processes and human influences. In this interdisciplinary work, while we consider all pools as important, we see agricultural operations (Fig. 4), consumption, social change, life-cycle assessments as well as wastewater treatment as central.

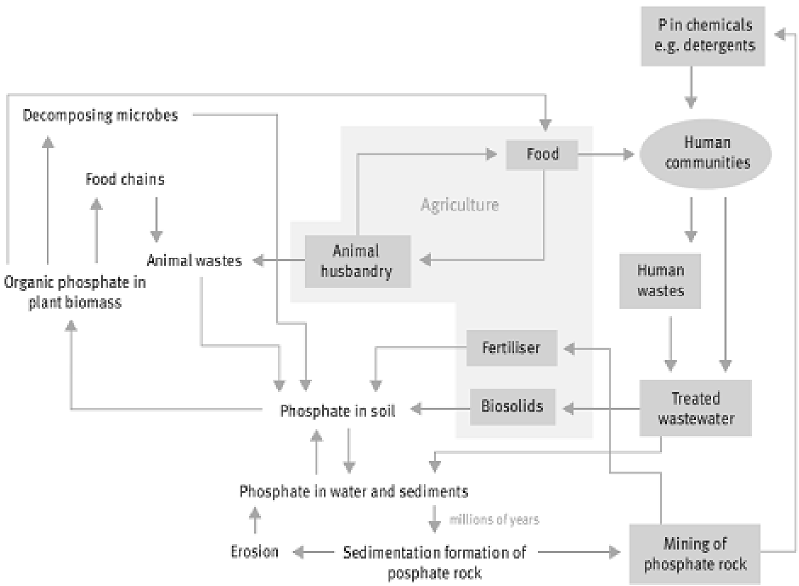

Figure 3: The natural phosphorus cycle and its human influences (shaded) (Source: Green Alliance, 2007)

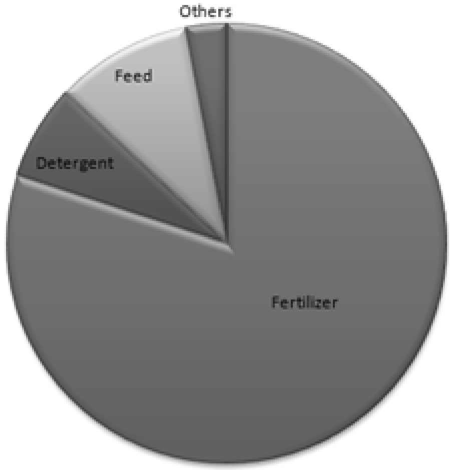

Figure 4: The most important commercial use of phosphorus is the production of fertilizers for food production (Source: International Fertilizer Industry Association, 2007).

The realization that there is a finite limit to easily accessible phosphorus must lead to a paradigm shift in its management: No longer can phosphorus be seen as pollutant, managed to protect the environment. Instead, it must be managed as a finite, life-supporting resource to secure regional and global food production.

Method

The method was an action research approach designed to disseminate and gather information on existing and future challenges related to declining phosphorus reserves, water and phosphorus resources management, governance and changing the level of awareness, attitudes and practices with regard to planning, wastage and disposal. Based upon review of science, literature, and websites of more than 40 organizations and agencies, analysis of the basin and dialogue with 40 stakeholders, action recommendations for best management practices, phosphorus recycling and stewardship were formulated.

Results

In general, the problem of declining phosphorus reserves is neither well-known nor widely acknowledged within the discourse of food security and nutrient management in respect to the prevention of eutrophication. Nevertheless, dialogue is emerging and opportunities to better use, recover, and recycle phosphorus are at hand. A successful process requires an integrated, systematic perspective and includes relevant ecological, geopolitical, social and technological factors affecting supply and demand. Such a multi-level, long-term strategy must aim at protecting, sustaining and improving water quality and phosphorus conservation. This agenda must be advocated and advanced basin-wide.

The following activities are recommended to pave the way to a food and water secure Lake Winnipeg Basin:

- municipalities, householders and the agricultural sector take immediate steps to promote the stewardship and recycling of P by
    - reducing and composting food waste
    - recovering P from wastewater (i.e. in form of struvite)
    - improving knowledge of dynamics of P in soil and on landscapes, including availability of P to plants
- establish an integrated watershed management approach to include all aspects of Lake Winnipeg-related water security, indigenous perspectives, and sustainable governance
- develop a comprehensive watershed communication plan among all stakeholders, commissions, boards and agencies
- First Nations traditional knowledge be integrated in the development of a healthy Lake Winnipeg basin vision
- establish funds for research and development in monitoring P flows in and between commodities, wastes, land, and water
- a comprehensive review of policies on phosphorus is initiated with all governance partners to design new multi-jurisdictional mandates for sustainability
- enhance science, social science, education and information with the goal of identifying roles for students, families and other individuals in a sustainable approach to peak P and food security related issues

Discussion

While declining supplies of rock phosphate are triggering concern about future limitation in the supply of phosphate fertilizers manufactured from rock phosphate for food production, it is more important to focus on that fact that phosphorus is indestructible. It is abundant on the earth. The urgency is to begin and maintain monitoring of the global flows of phosphorus in foods, feeds, and other products. It is crucial to put in place effective, global recycling activities to keep the phosphorus in these flows cycling via human and domestic animal waste management back to the land. Land and soils should become a greater focus of attention for better understanding of nutrient dynamics and availability to promote efficient reuse of the phosphorus by plants. As well, soils and agricultural lands can be a point of integration of nutrient dynamics, climate change, water management, and biodiversity for the provision of healthy land-based foods and fiber. In this way, peak phosphorus is transformed from a discussion of scarcity to a vision of sustainable abundance.

Conclusion

The Lake Winnipeg Basin is highly complex and its phosphorus monitoring, management and conservation strategies could provide models for peak phosphorus responses in other parts of the world. Engaging urban and rural communities, national, state and provincial jurisdictions and First Nations communities to endorse research, technological developments, and social change is a crucial endeavor for improving the health of Lake Winnipeg and maintaining the phosphorus supply to agricultural lands in the breadbasket of Canada.

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