The Cost of Soil Erosion and Sedimentation to Canadians
And
The Impact on Water Bodies Across Canada

An overview prepared for the Soil Conservation Council of Canada

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SUMMARY

Soil erosion—the movement of soil from one area to another—occurs through three main processes: wind, water and tillage. It occurs naturally on cropland through the erosive action of wind and water, processes that can be accelerated by some farming activities (e.g. summerfallow or annual cropping). It is also caused directly by tillage, which results in the progressive downslope movement of soil from hilltops to accumulate at the base of hills.

Healthy soils are fundamental to the sustainability of agriculture in Canada. Soil degradation results in lost biological activity and organic matter and contributes to the breakdown of and loss of soil aggregates and soil structure and ultimately a loss of soil stability and water infiltration. This contributes to wind and water erosion. Eroded soil has reduced fertility, water and air availability, crop yields and profitability. Yields from severely eroded soils may be substantially lower than those from non-eroded soils in the same field. Erosion can also have significant adverse environmental and economic impacts off-farm, through the physical transport and deposition of soil particles leading to the release of agricultural pollutants. Management of the combined effects of wind, water and tillage erosion is required to maintain soil health. The Soil Erosion Risk Indicator[i] assesses the state and trend of the risk of soil erosion from water, wind and tillage in the Canadian agricultural landscape.

THE ISSUE AND WHY IT MATTERS

Soil erosion can be a significant threat to the sustainability of agriculture in Canada. Since erosion impacts the organic-rich, topmost layers of soil, soil erosion typically results in decreased soil fertility, inefficient use of cropping inputs, as well as productivity and profitability losses due to reduced crop yields and quality. In extreme cases, severe degradation can result in land being permanently lost from agriculture.

Water runoff and soil erosion are the primary transport mechanisms for agricultural pollutants reaching surface waters. Therefore an understanding of soil erosion is essential to understanding agricultural risks to water. Soil erosion occurs through three main processes: wind, water and tillage erosion (see text box on types of erosion).

TYPES OF EROSION

WATER EROSION
Rainfall and runoff are the driving forces behind water erosion. In addition to the degradation caused by the loss of topsoil, eroded soil is carried in runoff to agricultural drains, ditches and other waterways where suspended soil particles increase the turbidity (cloudiness) of the water, add to sediment build-up in the waterways and reservoirs, and add agricultural pollutants (nutrients, etc.) that are carried with the eroded soil into the water.

WIND EROSION
Wind erosion is a concern in many areas of Canada, from the sandy soils along the Fraser River in British Columbia to the coastal areas of the Atlantic Provinces, but it is in the Prairie region that the potential for wind erosion is the greatest. This stems from the region's dry climate and vast expanses of cultivated land with little protection from the wind.

TILLAGE EROSION

Many farm implements move soil, and on sloping land this movement is influenced by gravity which causes more soil to be moved when soil is tilled downslope than when tilled upslope. Even when tilling is done across a slope, more soil will be moved downslope than upslope. The resulting progressive downslope movement of soil from hilltops and soil accumulation at the base of hills is called tillage erosion. Evidence of tillage erosion is found on hilly land across Canada. This form of erosion is most severe on land that has many short, steep slopes and in areas where intensive cropping and tillage practices are used. Although distinct from wind and water erosion, tillage erosion influences wind and water erosion by destroying soil aggregates and exposing the subsoil that is often more sensitive to these erosion processes, and by delivering soil to the areas of the landscape where water erosion is most intense. As such, tillage erosion also contributes to the off-site environmental impacts of soil erosion by wind and water.

The combined effects of wind, water and tillage erosion pose a more serious threat than individual erosion processes, and prudent management of the wind, water and tillage erosion is imperative, yet complex. Practices to control one type of erosion may exacerbate another, and the level of erosion risk is affected by multiple variables including cropping systems, climate and topography. Recognizing which landscapes and factors pose the greatest risks can help to target and develop localized management approaches where they are most needed, in order to maintain soil health and reduce environmental degradation and economic losses. This will allow Canada to maintain sustainable agricultural lands and be a competitive global supplier of agriculture and food products.

THE IMPORTANCE OF LAND AND WATER RESOURCES – AND THE COST OF DEGRADATION

Soil erosion and sedimentation have adversely impacted water bodies across Canada. The direct and indirect costs to the Canadian public and the communities and businesses who depend on these water resources is estimated to be in the 10s of millions of dollars per year.

The critical importance of land and water resources to Canadians was underscored in May 2014 when Prime Minister Stephen Harper launched the National Conservation Plan (NCP), which provides a more coordinated approach to conservation efforts across the country. The NCP, which was a commitment made in the 2013 Speech from the Throne, includes significant investments over five years to secure ecologically sensitive lands, support conservation and restoration actions, including the restoration of wetlands, and strengthen marine and coastal conservation. This is the latest in a long history of conservation programs to protect land and water resources in Canada.

Benefits to Canadians

The sustained use of our natural land and water resources are under threat from soil erosion and sedimentation. The loss of soil degrades soil quality, diminishing the utility and value of land resources by reducing its capacity to produce food, fuel and fibre. It is estimated that crop production in Canada has been reduced by between 5 and 10 percent from the loss of soil; this represents a loss of about $2 billion per year to Canadian agriculture and the Canadian economy (30 million hectares in field crops valued at $29 billion in 2012, AAFC 2013)[ii] . For a typical farm, this translates into an annual loss of about $35,000. From the most recent national assessments, it is not clear that soil conservation measures have stabilized these losses; in some regions these losses continue to increase in severity and extent (Lobb et al. 2014)[iii] ; in all regions land resources continue to suffer from past soil losses. Furthermore, it is not known how badly these soil losses have affected the land's ability to support stable crop production

(robustness and resiliency) in a changing climate with more severe and frequent extreme weather events.

Canadians spend over $100 billion in food each year, about 9 percent of their personal income (AAFC 2013)[i]. Over the next 20 years, this soil degradation will contribute to a food availability and price crisis worldwide, and Canadians can expect to pay more for food as a result. The current food price inflation is about 1-3 percent per year (AAFC 2013)[ii] , and this value could easily double within 20 years as our land resources lose their ability to provide high and stable levels of crop production. For a typical household this would mean an increase of about $250 in spending of annual household income on food.

The delivery of sediments to waterways degrades water quality, diminishing the utility and value of water resources for consumption, recreation, fishing, and wildlife. Soil erosion and sedimentation have adversely impacted water bodies across Canada, most notably the eutrophication of wetlands (prairie potholes), small lakes (e.g. Killarney Lake and Lake Simcoe) and large lakes (e.g. Lake Winnipeg and The Great Lakes). They also have the potential to adversely impact coastal waters (e.g. Hudson Bay) through siltation and loading of contaminants. The direct and indirect costs to the communities and businesses that depend on these water resources and the Canadian public are estimated to be in the $100s of millions per year. Each year, Canadian governments spend well in excess of $100 million cleaning roadside ditches for drainage and flood control and dredging rivers and estuaries for navigation.

Over the past 100 years, major efforts have gone into controlling soil erosion, particularly on agricultural land. In Canada, it is estimated that hundreds of millions of dollars in government and industry funds have been spent on developing and promoting conservation tillage, permanent cover, riparian buffers, windbreaks, streambank stabilization and shoreline protection. As of 2011, the extent of adequate soil conservation practices on cropland is estimated to be only about one half of the total cropped land area. Estimates do not exist for soil and water conservation practices associated with other land uses. Given what has been learned about soil erosion and sedimentation in the past 20 years through the innovative techniques used by researchers, it is clear that there is potential to spend future funds more effectively on soil and water conservation practices or on other public interests.

The greatest impediment to taking new and more effective action on soil and water conservation is the high degree of uncertainty regarding the extent, degree and impact of the problems and the efficacy of the potential solutions. Over the next 20 years, the research currently underway should be able to decrease these uncertainties considerably, providing for reasonably accurate assessments of the economic and environmental impacts of soil erosion and sedimentation. This will be achieved through the expanded number of research sites across Canada. At these lower levels of uncertainty, there will be sufficient confidence to advance the development of more effective policies and programs, leading to more widespread use of effective soil and water conservation practices.

References

[i] Eilers, W., R. MacKay, L. Graham, and A. Lefebvre (eds.), 2010. *Environmental sustainability of Canadian agriculture: Agri-Environmental Indicators Report Series – Report #3*. Agriculture and Agri-Food Canada, Ottawa, ON.

[ii] Agriculture and Agri-Food Canada, 2013. *An overview of the Canadian agriculture and agri-food system*. Ottawa, ON.

[iii] Lobb, DA, et al. 2016. Soil Erosion. Pages 77-89 in Clearwater, R. L., T. Martin and T. Hoppe (eds.) 2016. *Environmental sustainability of Canadian agriculture: Agri-environmental indicator report series – Report #4.* Ottawa, ON: Agriculture and Agri-Food Canada.