Solid waste management in Canadian First Nations communities

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Abstract Historically, the management of solid waste in First Nations communities in Canada had gained limited attention in terms of scientific research and governmental policies. Open-site dumping and open-air burning are commonly implemented in many First Nations communities and barriers towards environmentally sound and friendly solid waste management techniques including the remoteness, year-round inaccessibility of roads, lack of funding, and unclear jurisdictions. This improper practice could lead to environmental issues because of the generation of leachate and the emission of toxic compounds from the garbage dumpsite, and thus exposing the residents to pollutants such as heavy metals, persistent organic pollutant (POPs), volatile organic compounds, dioxins, and furans. This is particularly the case with the increasing consumption of industrial products and improper disposal of hazardous waste like scrap tires, used batteries, and end-of-life vehicles. It is true that the Canadian government publicly and financially made certain efforts and contributions towards the elimination of environmental issues in First Nations; however, more attention is required for some remote and isolated small-scale communities. This paper examines the existing challenges faced by the First Nations communities, particularly the environmental hazards from improper practices of solid waste disposal, and the current policy as well as funding aimed to improve the situation.

Keywords: First Nations; Solid waste management; Open dumping; Open-air burning; Government policy and funding

1. Introduction

First Nations is a term put forward in the 1970s to replace the word “Indian” that is considered offensive by some aboriginal people (Aboriginal Affair and Northern Development Canada, AANDC). “First Nations people” refers to status and non-status “Indian” people in Canada. According to the 2011 National Household Survey, more than 1.4 million people in Canada identified themselves as Aboriginal persons, which was 4% of the population, and 50% of these were registered as Indians, 30% as Metis, 15% as non-status Indians, and 4% were Inuit. Currently, there are 618 First Nations communities in Canada, which represent more than 50 nations or cultural groups that speak 50 different Aboriginal languages. The Aboriginal population increased from 312, 800 to 1,836,000 during 1901 and 2011, while the increase for the rest of the Canadian population was only 52%. Based on the population size of First Nation reserves, 125 reserves had a population between 250 and 499, and 70% of the reserves had less than 500 inhabitants. The explosion of the population changed the pattern of consumption and also the generation of garbage, which adds up the burden on waste management.

In Manitoba, there are 63 First Nations communities and 148,455 registered members as of July 2014. A total number of 88,076 (59.3%) of those members lived on reserves, which is second only to Ontario in terms of total on-reserve population and in total First Nations population (AANDC).

Although more than 50% of the First Nations people live in urban areas, many of them still live in remote and isolated places where the all-weather road is not even available. For example, Manitoba has twenty-three First Nations communities that are not accessible by an all-weather road. This accounts for more than half of all Manitoba First Nations people who live on reserve (AADNC).

In 1701 (Pre-Confederation of Canada), the British Crown entered into solemn treaties to encourage peaceful relations between First Nations and non-Aboriginal people. Subsequently, treaties were signed to define, among other things, the respective rights of Aboriginal people and governments to use and enjoy lands that Aboriginal people traditionally occupied. There is a total of 5 treaties in Manitoba and under these numbered Treaties, the First Nations people who occupied these territories gave up large areas of land to the Crown. As an exchange, the Treaties provided reserve lands and other benefits like farm equipment, animals, annual payments, ammunition, clothing, and certain rights to hunt and fish (Treaty No. 1, 3, 4, 5, 6, and 10). Since historically, first nation communities have gained support and benefits from the treaties in olden times from the government assistance; however, there are still a lot of areas not covered and left on the margins such as poor infrastructure and environmental issues.

Solid waste constitute of discarded material other than liquid. Based on the sources and types, solid waste can be divided into residential, industrial, commercial, institutional, construction, demolition, municipal services, process, and agriculture waste. Municipal solid waste is commonly referred to as trash, garbage or refuse, and rubbish. Although it is deemed waste and thus unwanted; however, some items are valuable for recycling and others are reused for industrial production or energy generation. Solid waste generation, collection, transportation, separation, treatment, and disposal make up an entire solid waste management system. An environmentally sound solid waste management system requires all these processes that collectively meet the appropriate regulations. However, the poor solid waste management in Canada's First Nations communities is a fact and has always been a long-standing concern. Because of the remoteness, non-all-weather roads, and insufficient funding, many First Nations communities do not have access to modern solid waste management facilities as well as the services, and as a result, open-site dumping and open-air burning are commonly employed practices

2. Solid waste management in First Nations communities

2.1. Open-site dumping and open-air burning

The Minister of Indian and Northern Affairs Canada (INAC) assumes the responsibility for operation of waste dumps and landfills in First Nations communities and although the INAC has a fiduciary responsibility for waste disposal, most waste sites operated in First Nations Communities remain unregulated (Lalita *et al*., 2006). Waste dumpsites on most FN reserves have been reported as lacking environmental protection measures such as cover materials, engineered liners, or a leachate collection system, and are usually installed without geological considerations (Rebecca *et al*., 2011). Direct discharge of waste into the environment can pose threat to surrounding soil and groundwater, making it one of the serious concerns.

According to the First Nations on-reserve source water protection plan (guide and template), point source pollution originates from a landfill where leachate contaminates groundwater and subsequently contaminates the downstream source water. Furthermore, according to the on-reserve source water risk assessment results, landfill leachate was one of the most potential sources of water contamination (Table 1). Ashraf *et al*. (2013) conducted a research on contaminant transport at an open-tipping waste disposal site and found that contaminants including heavy metals; namely, Fe, Mn, Cu, Cr, Ni, Zn, Pb, and Co were shown to migrate vertically and/or horizontally from the source point (i.e., the disposed garbage) to soil and groundwater. Ajah *et al*. (2015) systematically established forty sampling nodes around the dumpsite in Ugwuaji, Nigeria and their research found that the status of soil in the dumpsite and the environs had been heavily compromised due to indiscriminate disposal of untreated waste. The order of abundance of the monitored heavy metals was Pb>Fe>As>Zn>Cu>Co>Ni>Cd>Cr>Mn. Another research conducted by Hafeez *et al*. (2016) revealed the existence of persistent organic pollutants (POPs) including polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs) and dechloran plus (DP) in air, dust, soil, and water samples from a waste dump site in Lahore, Pakistan. It showed baseline data on PBDEs, DP, and PCBs in environmental matrices emitted from waste into the dumping site and health risk assessment of studied POPs in soil and dust through different pathways that presented potential risk due to the carcinogenicity of PCBs. Oketola and Akpotu (2015) also found the concentrations of polyaromatic hydrocarbons (PAHs) and PCBs ranging from 0.85 to 1.47 mg/L and 0.01 to 0.08 mg/L, respectively. However, the values for PCH and PCB in the topsoil were 0.94-2.79 mg/Kg and 10.0-412 ug/Kg, respectively. The authors also revealed that if the dumpsite is not properly managed, the leachate can seep into the groundwater and surface water via runoff, and thus have adverse effects on human health and the entire ecosystem. Improper solid waste management like uncontrolled dumpsites can also lead to the emission of volatile organic compounds (VOCs), which are hazardous to human health. Majumdar and Srivastava (2012) analyzed the sampled air from the dumpsite in Mumbai, India, using gas chromatography-mass spectrometry (GC-MS) in

Table 1. First Nations on-reserve source water risk assessment

Contamination Source	Likelihood	Impact	Risk ranking (likelihood × Impact)
Agriculture	5	4	20
Landfill leachate	4	5	20
Private septic systems	4	4	16
Arsenic groundwater	3	5	15
Streambank erosion	2	4	8
Summer recreation	1	3	3
Winter recreation	1	2	2

Source: First Nations on-reserve source water protection plan (2014) accordance with U.S. Environmental Protection Agency (EPA) TO-17 compendium method for the toxic compounds, and as many as 64 VOCs were qualitatively identified, among which 13 are listed under Hazardous Air Pollutants (HAPs). Their assessment of total carcinogenic risk for the workers in the dumpsite considering all target HAPs was calculated to be 275 persons in 1 million.

Because of the lack of environmentally sound solid waste management systems, open-air burning of solid waste is also a common practice although it had been banned by regulations and laws. However, based on the principle of "out of sight out of mind", First Nations people tend to burn the piles of solid waste as to significantly reduce the volume of waste. This open-air burning of waste leads to the toxic emissions, especially with the changing pattern of consumption, and the increasing use and disposal of anthropogenic products, which has quietly emerged as a serious environmental concern. Of particular concern are several families of organochlorine compounds, dioxins, and furans, formed as PICs when plastics are incompletely oxidized in the low-temperature environment of burn barrels (Lighthall and Kopecky, 2000). In Canada, the open burning of garbage produces more dioxins and furans than all industrial activities combined (Environmental and Climate Change Canada, 2015). The biggest source of dioxins and furans in Canada is the large-scale burning of municipal and medical waste. Human's exposure to dioxins can cause certain health effects including skin disorders, liver problems, impairment of the immune system, the endocrine system, and reproductive functions, effects on the developing nervous system, other developing events, and certain types of cancers (Health Canada, 2006). Open burning of solid waste is also an important source of particulate matter (PM) emissions, which are associated with various health effects, including respiratory and cardiovascular disease, adverse birth outcomes, and cancer (Ramaswami *et al*., 2016)

2.2. Household hazardous waste

Household hazardous materials possess any or all of the following characteristics: toxic, corrosive, flammable, and reactive. Several common products used in households possess items: such as solvents, antifreeze, pesticides, oil-based paints, batteries, medication, e-products, and etc. (Vassilis *et al*., 2015). High disposal costs, lack of disposal facilities, along with increasing stringency of laws and regulations, and declining or limited natural resources have been cited as some of the problems associated with the poor management of household hazardous waste (Ephraim *et al*., 2014). According to the claim from Environmental and Climate Change Canada (2016), there are three levels of government contribution to environmental protection and the management of hazardous waste in Canada. Municipal governments are responsible for the establishment of the collection, recycling, composting, and disposal programs within their jurisdictions, and the provincial and territorial governments establish measures and criteria for licensing hazardous-waste generators, carriers, and treatment facilities, in addition to controlling movements of waste within their jurisdictions. The federal government regulates transboundary movement of hazardous waste and hazardous recyclable material, in addition to negotiating international agreements related to chemicals and waste (Environmental and Climate Change Canada, 2016).

In Canada, under the Canadian Environmental Protection Act of 1999 (CEPA, 1991), regulations are released toward the management of hazardous waste. Also, there are a lot of organizations in Canada and Province of Manitoba that assume the operations of management, recycling, and disposal of hazardous waste such as Canadian Association of Tire Recycling Agencies (CATRA), Tire Stewardship Manitoba (TSM), Canadian Plastics Industry Association (CPIA), Medications Return Program (MRP), Manitoba Electronic Products Recycling Association (EPRA), and Used Oil Management Association of Canada (UOMA). All of the aforementioned disposal agencies and also other related organizations have improved the recycling and safe handling of household hazardous waste; however, when it comes to the activities in remote and isolated First Nations communities, there is little work been done.

Without proper collection and treatment of household hazardous waste, it is likely that the First Nations people dispose of the waste items such as electronic products, used oil, scrap tires, old batteries, etc. in the open dumpsites. This household waste is being collectively called e-waste. Uncontrolled disposal of e-waste is an emerging issue elevated by the rapidly increasing quantities of complex end-of-life electronic products; informal e-waste recycling has introduced large amounts of toxic substances in which poses health risks to exposed population (Zeng and *et al*., 2016). Polychlorinated biphenyls, polychlorinated diphenyl ethers, and heavy metals are a major health concern for workers engaged in waste disposal and processing, residents living near these facilities, and are also a detriment to the natural environment (Awasthi *et al*., 2016). The penetration of e-waste related materials into the subsurface layer of the earth can also contaminate soil and groundwater. Anna *et al*. (2013) found that the highest average total PAH concentration in combusted residues of wires, cables, and other computer components located at two e-waste open dumping and open burning areas were 195- and 113-fold higher than the PAH concentration of soil at the control site. The establishment of a comprehensive system for the management of healthcare waste is also essential for environment protection. However, improper waste disposal, insufficient financial resources, lacking awareness of health hazards, and lack of data on healthcare waste generation and disposal are some of the main issues impeding the development of waste management (Issam *et al*., 2010).

3. Policy & legislation framework and government funding: from very beginning

Solid waste management including source separation, collection, transportation, recycle, reduce, treatment, and disposal has developed a lot in the past 150 years, and most of the Western Nations have policies and regulations for the continuous monitoring and evaluation of the social and environmental effects (Lalita *et al*., 2016). This is also true for many Canadian cities and regions. Although several agencies and policies have been developed to protect people from environmental hazards in Canada, no equivalent mechanisms exist at present within the terms of self-government agreements that enable First Nations people to control environmental impacts on their lands. Historically, First Nations communities have been left at the margins in policy development, and the revenues for their participation in federal, provincial, and territorial review processes are still unclear or unsatisfactory (Bharadwaj *et al*, 2006). Under the 1978 Indian Reserve Waste Disposal Regulations, no person shall operate a garbage dump or use any land to dispose of, burn, or store waste without a permit. However, based on the information from INAC, there are 365 First Nations communities in British Columbia, Saskatchewan, and Ontario whose land is managed by the Indian Act, but only 14 of those communities have been issued the permit. Therefore, the other communities without a permit are prone to using the site-specific waste management techniques such as open burning and open-air dumping.

3.1. Federal aspect

While the provision of solid waste management is a municipally led function, the regulations of relative practices are supposed to be set up by the provincial governments under their justifications

3.1.1. The Canadian Environmental Assessment Act

In 1992, the Canadian Environmental Assessment Act (CEAA) was enacted by the Government of Canada to achieve sustainable development by evaluating and mitigating adverse environmental effects resulting from projects under the federal jurisdiction. Therefore, this legislation supports planning and decision-making for designated projects at a federal level and it also delineates distinct roles and responsibilities to reduce the potential for overlap between the jurisdictions of the Federal and Provincial governments. However, in 2012, the Government of Canada repealed this legislation and substituted for a new CEAA 2012, which significantly narrows the nature and scope of the federal environmental assessment obligations. Consequently, the Canadian Environmental Law Association (CELA) views this new CEAA 2012 as an unjustified and ill-conceived rollback of the federal environmental law.

3.1.2. The Canadian Environmental Protection Act

Assented to 14th September 1999, the Canadian Environmental Protection Act (CEPA) declared that the protection of the environment is essential to the well-being of Canadians and that is the primary purpose of this Act, which is to contribute to the sustainable development through pollution prevention. Also, CEPA is the primary legislation that gives the Federal government jurisdictional authority for involvement in solid waste related matters.

3.1.3. Canadian Council of Ministers of the Environment

The Canadian Council of Ministers of the Environment (CCME) serves as a forum for Federal and Provincial Environmental Ministers to collaborate in developing overarching tools that jointly undertake initiatives to address major environmental issues. Through CCME they have developed a variety of Canada-wide policies and a wide range of supporting technical products. For management of solid waste, it has issued the policies and guidelines for bio-solids, compost quality, extended producer responsibility, hazardous waste, packaging, PCBs, along with other waste management. Particularly, the Solid Waste Management Task Group of the CCME commissioned UMA Environmental to study and evaluate small-scale waste management models (SSMs), which are appropriate for implementation in rural, remote, and isolated Canadian communities and regions. In this case, the methods for managing solid waste were identified through an investigation of existing small-scale waste management models in a variety of Northern American and European jurisdictions (EMA Environment, 1995).

a. Governmental funding

3.2.1. Infrastructure Canada

In 1999, the Government of Canada outlined a new vision, which provided measures to improve the quality of life for Canadians and make a long-term contribution towards a dynamic economy through the building of infrastructure for the 21st century. Infrastructure Canada was created as a separate organization in 2002 under the Financial Administration Act and it delivers a broad range of infrastructure programs along with providing flexible and effective funding support to provincial, territorial, municipal, the private sector, and not-for-profit infrastructure projects.

In the Budget 2000, the Government of Canada reiterated its commitment to supporting the country's physical infrastructure by allocating $2.05 billion over six years to improving urban and rural municipal infrastructure across Canada through the Physical Infrastructure Project (PIP) (Infrastructure Canada, 2010). Of this, a total number of $31.13 million was allocated towards the First Nations component to improve the quality of life in First Nations communities. The First Nations component of the Infrastructure Canada Program (ICP-FN) operated from 2001-2007 within the ICP. The INAC was solely responsible for the program delivery of ICP-FN, and it was operated within INAC's Capital Facilities Program. The ICP-FN was a multi-year collaborative initiative amongst the Government of Canada, First Nations communities, and their partners like the neighboring municipalities. Through ICP-FN, 37 new green infrastructures along with 9 cultural and recreational facilities, 3 local transportation infrastructure, 3 affordable housing and 3 other projects were funded. However, only 17 of the 37 green infrastructures went to solid waste components, which were mainly new landfill site construction. Moreover, not all the provinces or regions received the funding for the upgrade. Financially, around $2.5 million was distributed to solid waste management facilities, which merely accounted for 8% of the total funding of ICP-FN.

Under the management of infrastructure Canada, $120 billion funds were planned over next 10 years for public transit, social infrastructure, and green infrastructure (2016).

3.2.2. Capital Facilities and Maintenance Program

The Capital Facilities and Maintenance (CFM) program within Aboriginal Affairs and Northern Development Canada (AANDC) is the main pillar of the Government of Canada's effort to support community infrastructure for First Nations on reserve (INAC, 2015). The objective of the CFM program is to provide financial support to First Nations and other eligible recipients to invest in physical assets (or services) that mitigate health and safety risks in their communities, establishment of codes and standards for the aforesaid assets, management of those assets in a cost-effective and efficient manner that protects, maintains and maximizes asset lifecycle, and ensure that the above activities are undertaken in an environmentally sound and sustainable manner. The expected result of the Capital Facilities and Maintenance Program (CFMP) is that First Nations communities have a base of infrastructure that ensures health and safety and enables engagement in the economy.

3.2.3. First Nations Infrastructure Funds (FNIF) Program

The FNIF program was created as a complementary source of funding to the Capital Facilities and Maintenance Program for six eligible categories of infrastructures projects:

- planning and skills development
- solid waste management
- roads and bridges
- energy systems
- connectivity

The objective of the FNIF program is to improve the quality of life and the environment for First Nations communities by improving and increasing public infrastructure on reserves. Other goals include increased access to the Crown Land, which is land set aside for the use and benefit of a First Nations community, or access to an off-reserve in the case of a cost-shared project with non-First Nations partners such as neighboring municipalities. The expected result of the FNIF includes improving health and safety of the First Nations communities; contributing to a cleaner and healthier environment; enhancing collaboration between the Government of Canada, First Nations communities, municipalities, provinces, and the private sector; and leveraging other sources of funds for infrastructure projects in First Nation communities.

In Budget 2007, the FNIF was announced as part of the Canada’s Infrastructure Plan and $127 million funding was pooled from three existing federal sources, namely Infrastructure Canada’s Municipal Rural Infrastructure Fund (MRIF), Gas Tax Fund (GTF), and the Capital Facilities and Maintenance Program (CFMP). In 2009, AANDC accessed an additional $107.6 million to increase the total FNIF funding envelope to $234.9 million. However, the funding contributed to solid waste management only account for 11 % of the total funding among other projects, namely connectivity, energy system, planning and skill, roads and bridge development (FNIF activity report, 2007-2012).

In 2014-2015, the Government of Canada announced $155 million over ten years from the New Building Canada Fund and $139 million over five years from the Gas Tax Fund for the FNIF. Starting in 2016-2017, Budget 2016 proposed an additional $255 million over two years to the First Nation Infrastructure Fund.

4. Conclusion and recommendation

The environmentally sound management of waste and used materials through a hierarchy of actions or the 5Rs regarding waste, namely reduce, reuse, recycle, recover, and retain. The goal of the 5Rs is to divert solid waste materials out of the waste disposal stream. However, because of the remoteness, insufficient funding, unclear jurisdiction, and lacking enforcement, the situation in First Nations communities is a long-standing concern. Historically, First Nations also had limited involvement in research concerning environmental contamination and policies with respect to solid waste management, which definitely needs to be improved.

For remote and isolated First Nations communities, the unique or innovative components for a long run should include 1) waste and household hazardous waste reduction including reuse, recycle and proper disposal supported through public education program; 2) segregated waste management programs, and 3) reuse of waste within the community that is supported and encouraged through public. A feasible and suitable scenario to improvement should get better involvement of the government, tribal council, band office, and also other stakeholders. The involvement of stakeholders such as retailers, taking the electronic products retailers as an example, could be a decent solution for short-term plans. Properly designed and mandatory take-back programs through retailers can significantly increase users’ involvement and convenience in waste recycling and management compared to voluntary collection programs.

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