Institute for Management & Innovation
UNIVERSITY OF TORONTO
MISSISSAUGA

MScSM
Master of Science in Sustainability Management UofT

A Comparative Analysis of Lake Ontario, Canada and Lake Garda, Italy: Effects of Microplastic Pollution and Policy Analysis of Each Region

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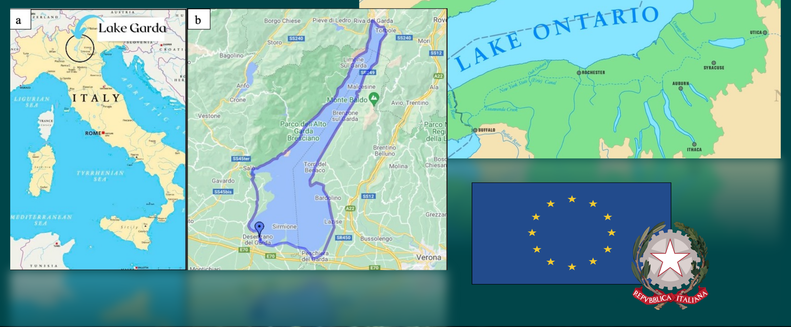
SSM1100Y: Research Paper Course

INTRODUCTION & BACKGROUND

- Ubiquitous nature of plastics has resulted in one of the most complex environmental problems to solve globally; plastics are persistent organic pollutants (POPs), incapable of biodegrading naturally, leading to microplastic (MP) pollution
- Although freshwater MP pollution is a fairly novel area of study compared to marine environments, it is equally important to study freshwater sources
- Freshwater systems are especially valuable to humans as a source of drinking water, given that there is only 1% of usable freshwater and about 21% of the global freshwater resides in the Great Lakes
- Conducting a comparative analysis between Lake Ontario and Lake Garda, could aid in determining further causes of MP pollution, trophic implications, and cumulative impacts on ecosystem services

RESEARCH OBJECTIVE & QUESTIONS

- Lake Ontario and Garda were selected because they both have significant MP pollution, are both situated in urban areas, and both were formed by glacial action after the last Ice Age
- **Objective** is to see how MP impact **varies**, depending on the characteristics of the two lakes which differ in their residence times, drainage basin, transport mechanisms, overall geomorphological characteristics and jurisdictions with different regulatory regimes:
  1. **What are the sources, transport mechanisms, and chemical composition of MPs in Lake Ontario and Garda ?**
  2. **In what ways have MPs impacted aquatic organisms in each region?**
  3. **How do the impacts of MPs differ or are similar to each other based on each study area?**
  4. **What are the similarities and differences with MP policy and management within the two regions at all levels of government and have the management solutions in each region worked or not worked? What are some other possible solutions?**



METHODOLOGY

- Consists of a comprehensive literature review of nearly **136** published studies and scholarly journals in the last **5-10 years**, containing scientific publications, case studies, web pages, policy briefs, and policy reports.
- **Keywords** used to search for articles include: 'MPs in Lake Garda & Ontario', 'policies to manage MPs in Lake Garda & Ontario', law and policy of MPs in Italy', 'law and policy of MPs in Canada', 'European policies of MP pollution',

LITERATURE REVIEW FINDINGS

PART 1: MICROPLASTIC POLLUTION IN LAKE ONTARIO AND GARDA

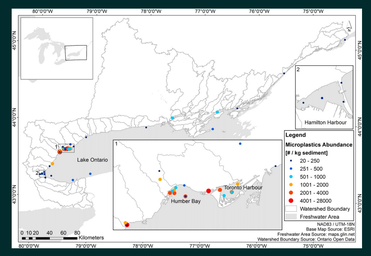


Figure 1: MPs abundance in Lake Ontario for 50 study sites. The inset shows the Greater Toronto Area in detail (source: A. Ballent et al., 2016).

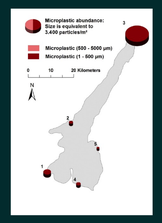


Figure 2: MP abundance in 5 studied beached of Lake Garda (source: Imhof et al., 2018)

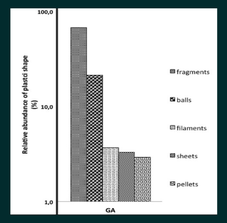


Figure 3: Composition of MPs by shape collected in Lake Garda (source: Sighicelli et al., 2018)

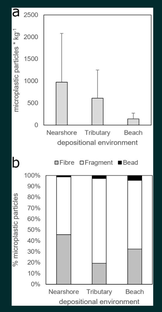


Figure 4:
a) Abundance of MP for beach, tributary and nearshore sediments of Lake Ontario with error bars.
b) Relative abundance of fibers, fragments, and beads (source: A. Ballent et al., 2016).

- Lake Ontario MP > Garda MP
- MP abundance in nearshore and beach regions due to proximity of river outlets in both
- Lake Ontario population > Garda
- Lake Ontario residence time < Garda
- Lake Garda drainage basin < Ontario
- Fibers more abundant in Lake Ontario, compared to Lake Garda (fragments)
- Polyethylene most abundant type of plastic in both
- Brown bullhead and white sucker from Lake Ontario ingested greater amounts of MPs; salmon and birds have also been affected by MP pollution through litter or trophic transfer
- Fluorescent debris found in California blackworms in Lake Garda

PART 2: POLICY ANALYSIS OF LAKE ONTARIO AND GARDA

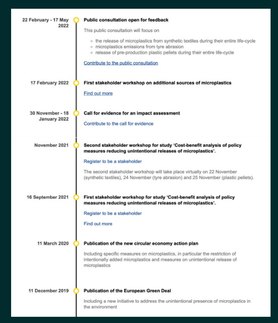


Figure 5: Timeline for upcoming EU directive on MPs (source: European Commission, n.d.-d)

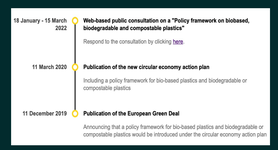


Figure 6: Timeline for upcoming policy framework on bio-based, biodegradable, and compostable plastics (source: European Commission, n.d.-a)

Table 1: Characteristics of SUPs (source: Government of Canada, 2021a)

Categories of single-use plastics	Criteria
Environmentally problematic	• the SUP is prevalent in natural or urban environments, according to citizen science, civil society data, or municipal litter audit data • the SUP is known or suspected to cause environmental harm (e.g. risk of ingestion or entanglement by wildlife)
Value-recovery problematic	• the SUP hampers recycling systems or wastewater treatment systems • the SUP has a low or very low recycling rate (i.e. lower than the average recycling rate for plastic packaging, from 0–22%) • barriers exist to increasing the recycling rate

Table 2: Cost-benefit analysis of the 6 categories of SUPs (source; Government of Canada, 2021a).

Policy design and activities	Costs	Benefits
Prohibition on six categories of SUPs, resulting in • **Decreased quantity (and tonnage) of plastic waste from SUPs entering waste stream or becoming plastic pollution in the environment** • **Associated increased quantity (and tonnage) of waste from substitutes to SUPs entering waste stream and the environment**	Economic costs: • Substitution cost • Secondary-use cost • Waste management cost Environmental and social impacts: • Life cycle assessment • Potential perceived utility loss (from consumer preferences)	• Reduced risk of injury or death to wildlife and improved habitat quality • Increased enjoyment of ecological goods and services • Avoided terrestrial litter clean-up cost • Avoided marine pollution cost
Record keeping	Administrative costs	N/A
Compliance promotion	Government costs	N/A
Enforcement activities	Government costs	N/A

- Canada in the process of banning single-use plastics (SUP)
- Cost-benefit of plastics; the benefit of reusables outweighs the cost due to their longevity and durability
- Italy as EU member has policies in place amending: Packaging and Packaging Waste Directive 1994, SUP Directive 2019, the Plastic Bags Directive 2015, and Marine Strategy Framework Directive
- Upcoming EU policy on MPs and biodegradables

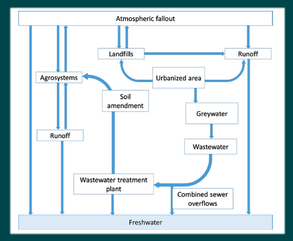
DISCUSSION: COMPARATIVE ANALYSIS

PART 1: MICROPLASTIC POLLUTION

- MP sources: Anthropogenic littering, urban runoff, and wastewater treatment plants
- Higher concentrations of MPs in Toronto Harbour (Ontario) and Riva-Torbole (Garda) near wastewater plants

PART 2: POLICY ANALYSIS

- Both Italy and Canada have banned microbeads in 2020 and 2018 respectively
- Canada's SUPs Prohibition Regulation under CEPA 1999 intending to take force in late 2022
- Italy banned lightweight plastic bags and implemented a plastic tax in 2018
- Italy implemented Save the Sea (Salva Mare) directive to amend EUs Marine Strategy Framework Directive and Italy's Green economy law, Law No. 221, 2015
- Implemented Canada-wide Strategy on Zero Plastic Waste in 2018 to divert 75% of plastic waste by 2030 and have 50% of recyclable content
- Italy requires grocery bags be made of 30% recycled material with EU's directive on Packaging and Packaging Waste
- The City of Toronto, Hamilton, and TRCA offers educational programs on the 3Rs while Italy educates citizens through the Italian Marine Strategy Framework Directive Programme and Ocean Literacy program



CONCLUSION & KEY TAKEAWAYS

- Both countries are committed to Ocean Plastic Charter 2018, MARPOL 1973, the Basel Convention 1989, and the Stockholm Convention on Persistent Organic Pollutants 2001
- Requirement to manage consumer habits, reduce cost for recycled plastics vs. virgin plastics, incentivize R&D, standardize and harmonize plastic content through an extended producer responsibility framework and model recycling systems
- Use comprehensive quantitative and qualitative details by harmonizing waste strategies, including specific national indicators, and monitoring and sampling freshwater sources
- Requires businesses and producers to include the chemical composition and correct disposal mechanisms of their plastic products in the form of a label or QR code
- Recommend research on substitutes to plastics as costly and poses sustainability issues such as greater carbon footprint, deforestation rates, and impacts on marginalized communities
- Having minimum requirements, certain % of recyclable content as implemented by Italy and Canada, as part of product design, can help with achieving higher circularity

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