

## Article

# Social Learning Resulting from Three Consecutive Flood Events in Yorkton, Saskatchewan, Canada

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**Abstract:** This paper explores the social learning, and its drivers and outcomes, in Yorkton, Saskatchewan, Canada, following flooding events that occurred in 2010, 2014, and 2016. The data for this study came from 15 semi-structured interviews and 110 newspaper articles concerning the flood events and infrastructure upgrades. Research demonstrates that the flood experience and the interactions and communications between the City, Council, and the public have produced social learning. However, this learning has been single- and double-loop learning. While the data revealed no explicit barriers to social learning, the perception that the public cannot contribute to stormwater management issues may have inhibited the degree of social learning that was achieved. As a result of social learning, Yorkton is now more prepared to deal with future flood events, both in terms of prevention and emergency response. However, social learning is diminishing as a result of the passage of time and the false sense of safety that the infrastructure upgrades create. Diminishing social learning has policy implications for Yorkton as the city has not yet implemented all the proposed flood upgrades.

**Keywords:** social learning; flood; climate change; flood risk management



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## 1. Introduction

In the domain of flood risk management, traditional approaches focus on controlling floods using measures such as embankments, dykes, levees, dams, canals, and others [1]. This kind of human intervention disrupts the natural hydrological flow and increases the frequency and intensity of flood events [1,2]. Due to the failure of these traditional methods and the increased uncertainty caused by climate change, a shift in flood water management has occurred, calling for more adaptive strategies [3]. As the changing climate brings more intense and heavy rainfall, and the incidence of flooding is anticipated to increase in some areas (including the study area in Saskatchewan, Canada) [4], new adaptive responses to flood management and governance are increasingly important. Hence, this approach focuses on improving communities' adaptive capacity and preparing them to deal with and recover from floods [3], which requires widespread changes in behaviours and institutions, or social learning [2]. This kind of learning can generate the change in understanding required to produce changes in a social system, improving adaptive capacity.

Social learning is central to adaptive flood management and its governance as it makes governance actors more proactive and capable of anticipating and responding to future conditions [5,6]. Social learning enhances the relationships among stakeholders, promotes collaboration and trust [7], reduces stakeholder conflict, enhances the ability to deal with uncertainty, and leads to more just decisions, ultimately improving adaptive capacity [8,9].

Although social learning is an important component of adaptation to climate change, the concept is still vague. There is no consensus among researchers on whether social learning happens on a societal level only [7,10–15] or on individual level as well [9,16–19]. There are also differences among researchers on whether social learning is a process [11,14], an outcome [18–20], or both [7,9,13,15–17,21]. Furthermore, there is disagreement among researchers on whether social

learning is a shared meaning among individuals developed over time [10,12,14] or a change in perspective that can happen in a short period of time [7,9,13,15–17,19]. There is even disagreement on whether the ambiguity of the concept is harmful [16] or helpful [22] for conducting research in this domain.

In this study, social learning is defined as “a change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks” [16]. This definition invokes both the process of disseminating social learning beyond the individual, as well as the necessary change in outcome (a specific practice, worldview, or perhaps policy). In order for social learning to be captured in policy, and attain the status of ‘enduring’ social learning, flexible policy processes are required to support the agreements and outcomes of the social learning process [23].

Identifying the outcomes of social learning is important for policymakers and researchers in this domain. However, this task is particularly challenging because many of the outcomes are intangible [10], such as the change in behaviour or the change in decisions made by an individual after participating in a social learning process. Furthermore, it is difficult to track down the outcomes and determine that they are the result of a social learning process, not any other process [10]. There is also the challenge of deciding the appropriate time to conduct the research [24]. Conducting surveys/interviews shortly after the social learning process occurs makes it easier to connect between the outcomes of social learning and the process. However, some social learning outcomes require a longer time to materialize; hence, they will not be captured in a study that is conducted directly after the social learning process [14]. This raises the question of how social learning occurs over time, and whether it is retained.

Despite the challenges, many empirical studies have aimed to determine the outcomes of social learning. The literature shows that social learning leads to cognitive change in the form of knowledge acquisition. Albert et al. [17] found that social learning contributed to improving the level of knowledge about climate change, the risks and opportunities associated with it, and how communities can adapt to its impact. Social learning allows the stakeholders to have a better understanding of the environmental problems that they are facing and the ways to mitigate these problems [10,23,25,26]. On a broader level, it has been found that social learning leads to knowledge acquisition through policy change as well as the creation of new organizations that are responsible for the development and implementation of new policies or advances in governance [23,25].

Gaining relational knowledge is another outcome of social learning. It allows stakeholders to have a better understanding of their own knowledge and potentials as well as the knowledge, potential, and perspectives of other stakeholders [10,13,21,26–28]. This type of knowledge changes the relationships between stakeholders [25,28] and facilitates trust building [17,28,29], collaboration, and conflict resolution [23,29].

Skill development has been highlighted by many researchers as an outcome of social learning [21,25]. Albert et al. [17] noted that the participants in a participatory social learning process have mentioned that this process had made them “more comfortable” (p. 353) dealing with uncertainty. They have also declared that their communication and collaboration skills have improved [17]. These three outcomes of social learning inform the methodology.

While there is a wealth of research on social learning, the vast majority of researchers explored social learning in the context of natural resource management. Articles that explored the occurrence of social learning following a natural disaster are extremely scarce. At the same time, most of the articles considered social learning in the context of participatory processes. Articles investigating how people learn from their experiences and disseminate this learning through organic social interaction (as opposed to interaction that happens during formally organized participatory social learning processes) are limited. Hence, the objectives of this case study research are to provide insights into the social learning that

occurred in Yorkton, Saskatchewan, Canada, following the floods of 2010, 2014, and 2016, to determine the factors that facilitated or hindered the occurrence of social learning.

## 2. Materials and Methods

This is a case study approach investigating the phenomenon of social learning in an urban community in Saskatchewan, Canada. Available documents and 110 articles of Yorkton's local newspaper surrounding the events of flood were reviewed and analyzed. *Yorkton This Week* is the local newspaper that has extensively covered the flood events and City's response and upgrades. To find as many related articles as possible, the following search terms were used: "flood", "Yorkton west storm drainage", "Dracup", "flood mitigation", "brodie avenue", "skate park", "retention pond", "Associated engineering", "Bullee", "Integrated", and "Whitesand drive". This search resulted in identifying 110 relevant articles covering the period 2010–2020.

In addition, 15 semi-structured qualitative interviews were conducted with policy stakeholders and residents of Yorkton. The participants were chosen based on their ability to inform the research. Some of them were identified through an Internet search (e.g., the *Yorkton This Week* journalists). Others were identified through the snowball sampling method, whereby each participant was asked to recommend another person for an interview. Four interviews with City of Yorkton officials were conducted between July and September 2019. Three of these individuals were interviewed again towards the end of the data collection process. The remainder of the interviews were conducted between September 2020 and February 2021. Most of the respondents lived in Yorkton their whole life. The two exceptions are CY2, who moved to Yorkton after the first flood, and a library employee, who lived in Yorkton during the 2010 flood but moved out shortly after the flood. A list of participants is provided in Appendix A.

The interview questions covered the background (of flooding), decision-making process surrounding the floods, proposed solutions, and change brought by the floods. Generally, all interviewees were asked similar questions within the four categories mentioned above. However, City officials and the Councillor were asked more questions about the decision-making process, given their positions and heavy involvement in response to flooding in Yorkton. The data collection process through interviews continued until saturation was reached and no new findings emerged. The interviews lasted between 25 and 90 min. Informed consent was obtained from all participants and all the interviews were conducted in English, over the phone, recorded, and transcribed. The collected data were coded deductively to identify the manifestations of social learning listed below; however, induction was also used to allow for new themes and ideas to emerge. New ideas included diminishing social learning and recurrence of flood events [30].

Manifestations of social learning (Table 1) include three components. The first one is acquisition of technical skills, such as community engagement, planning, and conflict resolution. The second one is relational knowledge, which refers to knowledge about other stakeholders' perspectives, and can lead to the development of new connections and/or enhancement of existing relationships. Finally, there is acquiring new knowledge about, for example, the science, economics, political feasibility, and policies related to climate change and flooding. Gaining this kind of knowledge through interaction allows the stakeholders to form a common understanding and, according to Leach et al. [31], can lead to belief change. That is why both common understanding and belief change are categorized under knowledge acquisition.

**Table 1.** Manifestations of Social Learning.

	Examples Include
<b>Acquisition of Technical skills</b>	<ul style="list-style-type: none"> <li>– Increased experience in community engagement</li> <li>– Improved ability to plan under uncertainty</li> <li>– Improved ability for conflict resolution</li> </ul>
<b>Relational Knowledge</b>	<ul style="list-style-type: none"> <li>– Understanding other stakeholders' values, beliefs, preferences and goals.</li> <li>– Increased trust and changes in power</li> <li>– Development of new connections and/or strengthening of existing ones</li> </ul>
<b>Knowledge Acquisition</b>	<ul style="list-style-type: none"> <li>– Knowledge about the science, economics, politics and policies related to: <ul style="list-style-type: none"> <li>• Climate change and its worldwide impact as well as its impact on Yorkton</li> <li>• Flooding, flood risk in Yorkton, flood risk management and mitigation options.</li> </ul> </li> <li>– Common understanding.</li> <li>– Belief change.</li> <li>– Policy change.</li> </ul>

Source: Adapted from [18,25,26,32].

To determine the extent of social learning, the triple-loop learning approach and the indicators developed by Pahl-Wostl [33] were applied. The triple-loop learning approach is one of the most widely used approaches to evaluating social learning [11,34–36]. The triple-loop learning concept identifies three levels of learning based on the level of reflection and change that takes place [33,35]. In single-loop learning, actions are made without examining the guiding assumptions; any change that happens is a mere improvement to the routines within the existing norms [33]. The objective in single-loop learning is to detect errors and correct them [34,37]. Thus, the concern is whether the actions are done the right way [33,34]. In double-loop learning, the established assumptions are brought into question. The actors question whether they are doing the right thing, and, consequently, they examine the problem framing, the objectives, and the assumptions about how these objectives can be realized [33,34]. In triple-loop learning, the underlying values, norms, and institutions that guide these assumptions are questioned and transformed, and here the actors are concerned with figuring out how to decide what is right [33,34].

The limitations of this research are that it is one in-depth case study of one community. Although generalizable findings are a challenge, its contribution to knowledge surrounding social learning as a result of three consecutive floods is significant. In terms of data collection, recruiting participants was difficult, as the research was conducted in a city other than the city we reside in. This difficulty was further exacerbated by the pandemic, as we no longer were able to travel to Yorkton and meet with people in person. However, this difficulty was overcome by utilizing communication technologies to contact potential participants. Another limitation that was noticed during data collection, is that people do not accurately remember the events that happened within the past 10 years. Participants would frequently struggle trying to specify dates and costs. This limitation was addressed by comparing the information provided by the participants with the available documents and newspaper articles published at the time, when recall would have been fresh.

### 3. Results

#### 3.1. Background of Yorkton and Flooding

Until 2010, Yorkton had not experienced a flood since 1983, which makes the 2010 flood the first flooding experience for the vast majority of Yorkton's residents [38]. In 2010, a state of emergency was declared in Yorkton as the city experienced the highest recorded flood, with 70% of homes impacted. Rainfall estimations ranged between 64 mm and 150 mm of rain, making it the highest record flood in more than 50 years [39]. The stormwater drainage system of the city failed [40]. The storm caused power outages, uprooted

trees, destroyed homes and businesses, trapped 70 people in their houses (requiring assistance by boat to exit), and 170 people were displaced [41,42]. After this flood, the City adopted a multi-year, multi-million-dollar drainage plan that included, among other things, building two stormwater ponds and purchasing homes on one particular avenue that experienced some of the worst flooding. These homes were demolished and replaced with a dry bottom pond.

Exactly four years later, in 2014, Yorkton again declared a state of emergency due to a flood. While the 2010 flood resulted from inadequate stormwater drainage, the 2014 flood was a combination of overland flooding and underground sewer system issues. Due to years of excess precipitation, Yorkton's soil was saturated; therefore, more water seeped into the sewer system, significantly increasing the volume of water traveling through the system. Furthermore, many people had incorrectly attached sump pumps to the sewer system instead of the stormwater drainage system, putting enormous pressure on the sewer system and causing it to back up. In addition, because sump pumps at some low-lying locations had to work nonstop, they failed eventually and caused flooding in those basements.

Two years later, in 2016, 60 mm of rain in less than an hour flooded Yorkton. A state of emergency was not declared; however, many public buildings experienced damage [38]. This flood was due to excessive storm water and the inability of the system to drain.

In 2017, the City of Yorkton solicited a citywide study using LiDAR software to identify the causes of the flooding (CY2). The report indicated that most of the problems were happening in low-lying locations and that the railways were also contributing (Council meeting recording, 30 January 2017). The study recommended a list of fixes that included channel upgrades, diversion ditches, and retention ponds totaling CAD 40 million. In 2018 the city fixed the drainage problems in relation to one storm sewer and in 2019 proceeded with upgrading a drainage channel (CY2). Significant activities contained in the 2017 study have yet to be implemented.

### 3.2. Findings

Findings are presented in the order of Table 1, including the technical skills acquired, relational knowledge, knowledge acquisition (including changes in beliefs and policy/governance), level of knowledge change (double and triple loop learning), and social learning over time.

#### 3.2.1. Technical Skills

Many participants stated that the flood helped them gain technical skills. One City official stated that the flood "forced us to do more asset management" (CY1). A journalist who was impacted by both the 2010 and 2014 floods noted that now he is more capable of dealing with water in flood situations (J2).

The City staff became better planners (CY1). In an interview with the local newspaper, Yorkton's former Mayor stated that planning became a priority to the City as they realized that it can save the City money in terms of doing all the roadway and underground reconstruction that are needed in a certain location at the same time [43]. Proactive planning on these construction projects also allows the City to apply for federal and provincial funds when they become available, especially because the notice period for such funds is usually short; unless a plan is in place they might miss the opportunity to apply [43]. This point was emphasized by a City official who explained that having a plan for stormwater management puts them "in an advantageous position" if funding opportunities for flood mitigation become available because they already know what they need to do and they "are not starting from scratch" (CY2).

#### 3.2.2. Relational Knowledge

Because Yorkton is a small city, individual residents did not report relational knowledge, as most of the interviewees pointed out that they already knew everyone and had good relationships with other residents before the flood.



However, participants from the City and Council offered different responses. Council has always been aware of the importance of relationship building, but the flood reemphasized this point. Immediately after the 2010 flood, the Royal Canadian Mounted Police RCMP, the Fire Protective Services, the Salvation Army, the Red Cross, and the Society for the Involvement of Good Neighbors (SIGN) responded [42]. The City staff and Council were in contact with these organizations and with other levels of government, as well as with the flood victims to understand the type of help they needed to provide. City residents not only donated thousands of dollars to support flood victims, but physically assisted them. Hence, Council tries to maintain and strengthen these relationships with organizations operating in Yorkton. One councillor provided a very informative example of how Council fosters relationships with other organizations:

“When they (the Salvation Army) moved their food bank to a new location, they found that the nearest bus stop was a great distance away for their clients, it was too far for their clients to walk and carry, Right? So, they came to us and we recognized that this is a huge need. So, we made a change in where the bus stops, right? Little things, but that kind of relationship that builds when they need us and when we need them.” (CC)

In addition, the flood highlighted the importance of having a full-time professional staff, especially in terms of first response, as opposed to relying on volunteers. One City official explained that when the flood happened “the community couldn’t respond because virtually everybody was touched by the flood. So, all that was left to respond is essentially the City staff” (CY5). A councillor emphasized the same point, stating that in case of disasters communities need to have trained professionals who can be immediately available even on a statutory holiday, as was the case with the Canada Day flood (July 1, 2010). When asked what was learned from the flood, the councillor replied, “I think if we’ve learned anything, it’s the value of the staffing components that we have in our city” (CC).

However, after the flood, the communications with city residents and non-profit organizations were minimal. After the 2010 flood, technical measures to address the flooding and prevent future flooding were undertaken by the City. Data shows that plans regarding stormwater infrastructure upgrades were made by the relevant departments in collaboration with the engineering consultants based on studies conducted by the latter. There was no formal public engagement or participatory processes of any kind. However, despite the lack of public engagement, the City officials had lots of interdepartmental communications as well as communications with Council and other levels of government in relation to flood mitigation (CY1, CY2).

There are advisory committees and boards that work with Council and offer advice on developing policies and other initiatives. Each committee or board has members from Council, the City staff, and the public [44]. Policy decisions are usually discussed in the relevant committee before they are presented to Council. While those committees do not have authority and their role is limited to offering advice and input, Council takes their recommendations seriously and considers them when making decisions (CY5). However, when it comes to stormwater infrastructure upgrades, data shows that those committees did not play a major role. Only one interviewee, the councillor, mentioned their role in response to questions about public participation stating that those committees have citizens on them but also added that “some of those infrastructure projects are very technical and we went out for outside consultation on it” (CC), referring to the engineering firm. Even the residents and the businesses who were the hardest hit by the 2010 flood event did not feel that anybody, other than the City, should be involved in the flood risk mitigation decision making (J2, BO, R2). In general, residents mainly concentrated on dealing with the problems that the flood created. Unless the interviewees’ job required knowledge of City’s plans, residents showed little interest in the details of what the City was doing.

Informally, the residents were contacting the City Hall about flooding related issues they were facing. One of the City officials mentioned that the public complaints during the

2014 flood helped the City identify locations where sewer backup happened (CY2). The City now knows where the vulnerable locations are located, and they can deploy crews to pump water from those areas in heavy rain events before they become problematic. In addition, residents' feedback helped the City identify 11 areas that get frequent flooding during heavy rain events, those areas are now incorporated in the City's long-term Flood Mitigation plan (CY2, Council meeting recording, 30 January 2017). During those interactions with the City staff, residents were also informed about the City's plans and the feasibility of some solutions (CY2). Furthermore, the residents contacted the councillors, explained their problems, and discussed potential solutions. Watching multiple Council meeting archives, the researchers noticed that councillors take those conversations with the public seriously, bringing them up during Council meetings and discussing them with the related City officials or with the engineering consultant. However, it is safe to say that the interaction with the public contributed more to identifying the problem areas than it did in determining plausible solutions.

### 3.2.3. Knowledge Acquisition

Residents of Yorkton have gained knowledge as a result of the floods and interviewee examples follow. When one journalist was asked whether the flood offered any learning opportunities for him, he said:

"Definitely, yeah. Especially on how the movement of water. I think I learned more about that than I ever expected to learn right after. You definitely learn a lot more about storm sewer and the state underneath the city than you expect after an event like that." (J1)

After the 2014 flood, the Mayor stated, "unfortunately we're getting good at it, we've had so much of this lately, but 2010 taught us a lot of lessons and I would like to think it helped mitigate what happened over the weekend" [45]. Yorkton's hospital managed to avoid service disruption despite getting some water during the flood, offering a concrete demonstration of this learning (ibid.).

One participant pointed out that the flood helped him better understand his abilities as an individual to face this kind of disaster: "I think, like most people, you probably gain some inner confidence or, you know, just recognize that you have maybe more intestinal fortitude than you first thought" (J2). Another recounted how the flood made him very cognizant of his flood resilience, especially in consideration of new developments in Yorkton and their potential contribution to flood (WM). Others interviewed pointed to their now constant consideration of weather (changes and forecast) (J2, CY2).

### Belief Change

Values surrounding floods did change. Participants agreed that the flood events that happened in Yorkton in the past decade changed their perspective on flooding. This is especially true for the City and Council who would not have started making expensive stormwater infrastructure upgrades after the first flood unless they believed that the future will bring more extreme events (CC). However, one journalist pointed out that the 2010 event alone was not enough to convince everyone that this is a trend, as there were individuals from the public who thought that it was a one-off situation (J1). Interestingly, this pattern is also noticed in the newspaper articles. After the 2010 flood, the decision makers in the City were talking about protecting the people from future floods; however, their tone was not as assertive as it became after the 2014 flood, when phrases such as the "new normal" emerged to describe the extreme events with increasing frequency [43,45–47].

What is also important is that the floods did not only change people's perspective on flooding, they changed their perspective on disasters in general—natural and manmade. One of the interviewees explained his perspective before the flood, saying, "I think we thought that we were, I don't know, invincible" (CY4). Another participant described the change by saying:

“For Yorkton Saskatchewan, we don’t get disasters; we don’t get hurricanes, we don’t get earthquakes, we don’t get volcanoes ... it’s just we don’t get those kinds of things. So, when they did come and they come back to back in five years like they did, it changes how you think about things a little bit.” (J2)

Based on the results above, there is evidence of knowledge acquisition, skill development, relational knowledge, and belief change. There is also evidence of knowledge transmission through interaction between the public and the decision makers, City officials among themselves, and with other levels of government. Discussion with participants revealed that residents discuss their flood experiences. For example, when resident R1 was asked to recommend other people for interviews, she recommended resident R2, and said, “They know what I went through” (R1). One City official mentioned that he was aware of the 2010 flood from his relatives before moving to Yorkton (CY2). He also mentioned that people interested in moving to Yorkton sometimes call him and ask about houses they are interested in to find out whether they were in flood prone neighborhoods. One resident mentioned that she would tell newcomers to her neighborhood if the house they are planning to move to was flooded (R2).

This shows that people learned from the flood events and spread this learning to others through social interaction. Hence, it can be concluded that social learning has occurred in Yorkton and that it was motivated mainly by two drivers: the first one is the flood itself. The occurrence of the flood is the situation that created the experience for people. Going through the event and trying different methods to protect themselves, their families, properties, and belongings made them understand what are the things that helped them during this event, what are the things that did not help, and what are the things that they need to do to protect them from future floods. Although the floods that happened in Yorkton did not cause any fatalities, the disruption and the financial losses they caused were substantial enough to make people fear going through a similar event again. As such, it encouraged people to learn from their experience and to make changes to reduce their vulnerability to future flood events. One City official, who was impacted by the 2010 and 2014 floods, explained how distressing the flood experience was to him and his family. He talked about the changes that he made after the first flood to protect his property from future floods and then the additional measures that he took when the initial ones failed the test of the 2014 flood (CY4). Without the flood, people would have little incentive to expend time and money to create flood related knowledge and to make changes.

The second driver is the different channels of communication, and the increase in communication around flood at the city level. The severity of the floods made people realize that whatever changes they make on the individual level is not sufficient to protect them and their properties from similar future events. Changes on the city level are needed, which created the need for people to communicate with the City staff and the Councillors. While preparing their plans to reduce flood risk in Yorkton, City officials and the Councillors also communicated among themselves and with the consultants and other levels of government. However, it is important to point out the fact that Yorkton is a relatively small city, where everyone knows everyone and the City staff and Councillors are easily accessible to the public. This has made the communications easier and further contributed to social learning.

#### Policy Changes and Governance Improvements

The major change in regulatory institutions in relation to flood risk management is the change in stormwater sewer design standards. Associated Engineering’s ‘Yorkton West Drainage Study’ (2011) recommended that the City adopt the following design criteria to guide future developments: The minor system to be designed to a 1:5 year peak flows and the major system to be designed for a 1:100 year peak flow events. Council adopted those recommendations in May 2011. This is an important change that defines the City’s future flood mitigation efforts. However, no other changes in regulatory institutions were identified.



The 2010 flood took the city by surprise. It was the first major event that the city experienced in years, so there was some confusion, things were not very clear, and the public could not find answers to all their questions regarding what will happen next [42]. One City official that was involved with the emergency response explained the situation by saying:

“I don’t really want to say we were not prepared, but I think it’s probably a pretty good way to look at it. We weren’t prepared to respond to something like that because we thought in Yorkton we don’t have any lakes, we don’t have any rivers. It’s just overland flooding. So, you know, how bad could it ever get, quite honestly, which was probably a tough lesson to learn.” (CY5)

The 2010 flood provided lessons about the importance of preparedness for such events and, to some extent, shaped the emergency response practices. At that time, the City was in the midst of revising the Emergency Measures Organization (EMO) plan and the experience of the 2010 flood influenced the final product as many of the lessons learned from the flood were incorporated in the plan. Furthermore, the City now also has an internal administrative document that they refer to as Basic Framework to Emergency Response (CY5). This document includes information on the roles of the City staff during emergencies, their responsibilities, where they meet, to whom they report, what are the things that they need to consider, and other things. This framework is reviewed annually in April. In addition, the City also updates the list of organizations and individuals that they need to contact in case of an emergency as much as possible. When the City official who is involved with emergency response was asked how the 2010 prepared them for the 2014 flood, he said:

“We didn’t overreact, we didn’t come in with everybody. We just could sit back and assess the situation. We didn’t panic, I guess that’s the best way to say it, we didn’t panic in 2014 because we went through 2010 already.” (CY5)

Yorkton residents are now better prepared for future flood events as the majority of them took some precautionary measures, such as installing sump pumps, weeping tiles, extending and regularly cleaning the eaves troughs, and other measures, which helped them through the 2014 and 2016 floods (CY2, CY4, CY5, WM, BO, R2). In addition to the changes that the residents did to protect themselves from future floods, it was also noticed that some businesses impacted by the flood took the opportunity to introduce changes that helped them grow. For example, Yorkton Public Library took the opportunity to add a “family area” to make the library a more inviting place [48] while Dairy Queen rebuilt the store with a drive-through [49].

Furthermore, the residents are now better off because of the upgrades that the City made since 2010. The majority of the interviewees believe that the upgrades that the City has made reduced the impact of the following floods. When one business owner, who was severely impacted by the first flood, was asked if the second flood affected his business, he noted that the precautions he took helped him with the second flood, “plus, the City has done a lot of work with the infrastructure on moving the water from downtown Yorkton to the outskirts. So that also helped” (BO). A similar response came from a resident who believes that the new pond on Brodie avenue has protected her property from the second flood (R2).

In addition to the infrastructure upgrades, the City now has a citywide storm sewer model that is supported by a LiDAR survey. This model allows the City officials to understand how water flows throughout the city (CY2). When problems arise, the consultant can run different scenarios to see how alternative solutions will impact the system overall. Furthermore, this model is helpful when adding new developments, as the model can show the implication of the new development on the current system (CY2).

### 3.2.4. Single- and Double-Loop Learning

In evaluating social learning in Yorkton, it can be seen that there are signs of double-loop learning. There was a widespread change in perspective regarding flooding, both among the City officials and the residents. Namely, the perspective that ‘Yorkton does not get flooded and that action is not required in this regard’ changed into ‘Yorkton has a flooding problem and action is required’.

In addition, discussion on climate change and its relation to the flood became more prominent, although not dominant enough to be considered triple-loop learning. All the research participants asked whether they believe the flood events that the city experienced are related to climate change answered ‘yes’, except for one person (BO). In addition, when one City official was asked the same question, he said that he personally believes it is related, and this is how it is seen among the City officials; however, he said, “I think we’re careful about using that term because nobody wants to talk about it” and he added “we don’t promote the climate change agenda necessarily here, but we are aware of it. Some people don’t want to talk about it at all. It’s just the nature of who they are, I guess” (CY5). This means that, after three floods, there are individuals who define the flooding events in a narrow way as independent isolated events that are disconnected from climate change. From the available data, it is difficult to generalize to the whole city; nonetheless, the fact that the City officials are cautious in using the term indicates that this view is common, or at the very least persuasive.

At the other end of the spectrum, there are City officials who look at the flooding issue in terms of the broader climate change picture. From discussions with City officials it was clear that climate change is front and centre in their approach to flood risk mitigation. They would mention climate change without being asked about it. When one City official was asked whether the Flood Mitigation study was motivated by the 2014 flood, he said, “I think it is more motivated by climate change and by the frequency of thunderstorms” (CY2). Another City official highlighted the connection between flood mitigation and drought mitigation measures in response to a question about what he learned from the flood events. He said:

“You look at the connection now with going into some drier conditions. It’s the connection with flood mitigation is also then tied to drought mitigation. So, then you build the storage area to prevent flooding, but now it’s a water source for irrigation or something like that.” (CY1)

Articles linking the recent flood events in Yorkton to climate change started to appear after the second flood. Those articles acknowledge that not everyone agrees that climate change is happening, and then cite scientists and recent reports as evidence to the connection between the extreme weather events and climate change [50–52]. Those “ideological debates” [33] indicate that double-loop learning is happening.

An important point was raised by a local watershed member. Although this point is more pertinent to rural settings, it sheds light on people’s short-sightedness when it comes to dealing with the impact of climate change. He observed that:

“All these guys in 2014 and then afterwards, they were all draining their land, they had all the equipment out there to drain their land off, get rid of the water with no real foresight, thinking ‘well, you know, one day might be dry again. Maybe we should, I don’t know...dig a holding pond or something. And so, we can use some of this water if it ever gets dry’. And lots of these guys that have done this drainage, now they’re coming to us and they’re saying, ‘hey, is there funding so I can dig a dugout because the slough that I used to fill my sprayer up now it’s gone dry and I need a more permanent source of water’. So, it’s kind of ironic that way.” (WM)

Another indicator that exhibited a double-loop learning is related to uncertainty. The high uncertainty around flooding and climate in Yorkton did not prevent the City from taking action to reduce people’s vulnerability to future floods. Instead, the decision

makers in the city acknowledged uncertainty and proceeded to implement an expensive infrastructure upgrade.

However, there were no changes in the actors' roles. Actors remained within their networks, with the City and Council being the main decision makers regarding drainage issues. The City did not seek advice from the public, or from experts (other than the engineering firm), no new roles emerged, and no initiatives from other organizations or individuals were put forward, indicating a single-loop learning. There were no changes in the dominant governance mode either. All the communication among the City, Council, and other levels of government were conducted within the established channels.

### 3.2.5. Social Learning over Time

Generating social learning and preserving social learning are two different issues. Overtime, people forget the experiences they lived through and the knowledge they acquired. This issue was pointed out by many participants. When one participant was asked whether he thinks the flood of 2010 changed people's perspective on flooding, he said that there was change immediately after the flood, but he added that people "have such a short term memory" (WM) and offered examples from the watershed how people were rebuilding their flood damaged property in flood prone areas. A City official brought up the same issue and offered similar examples from different places in the province to support the argument that people do forget past experiences (CY1).

Memory is precarious, and even big events can slip one's memory. For example, the document analysis indicated that Yorkton experienced three floods. However, none of the participants who were asked about the 2016 flood clearly remembered it. Some were not completely sure and offered answers along the lines of 'we might have had one in 2016' but could not really provide any specifics, and those are City officials (CY1, CY2 and CY5). Others said that they do not remember anything happening in 2016 (J1, BO and CY4). After mentioning to City staff (CY4) that there is a newspaper article about the 2016 flood, he decided to check the records to confirm whether there was a flood in 2016. This is both interesting and surprising, given the fact that, although it was not as damaging as the 2010 flood, it still affected a significant proportion of the city, and is the most recent flood.

Not only passage of time diminishes social learning, but also people's belief that they are no longer at risk and that they do not have the need to use the knowledge they acquired from past experiences. For example, in Yorkton it was stressed over and over again that the upgrades that has been done so far are not enough to protect the city from extreme events, and even when all the upgrades are done, the city is flood proofed up to 1:100 year events; any storms that are more severe will still flood the City (CY1, CY2, CC). Yet, many residents feel that the upgrades that the City implemented addressed the flooding problem and they are no longer at risk although they believe that more severe events may happen in the future (BO, R2).

The diminishing of social learning has policy implications. When decision makers feel that the public is no longer concerned about flooding, they will have less incentive to invest scarce resources in stormwater system upgrades and will divert those resources towards the projects they believe the public is more interested in. As one journalist pointed out, "the further out we get from the event itself, the harder it's going to be for some people at least to justify investing more money in flooding mitigation rather than some of the other things that the city needs" (J2).

The recurrence of flooding played an important role in preserving social learning in Yorkton so far. Some people relived the 2010 experience to some extent, while others were impacted for the first time in 2014 or 2016; this maintained the urgency for learning and change. One useful comparison was offered by a journalist who explained that people in Yorkton did not know how to deal with water because the 2010 flood was the first flood experience in 20 or 30 years, but "if it was snow, everybody knows how to deal with snow in Saskatchewan. I mean, it just kind of bred into our bones. Oh, we got a snowstorm. This is exactly what you do" (J2). Because of the recurrence of snowstorms in Saskatchewan,

people over time learned how to deal with them. The recurrence of flooding also maintains the political urgency. As one City official put it, “on years where we have several bad thunderstorms you know our politicians are very eager to do something about it” (CY2).

Recurrence is important because it keeps the flood experience and all its adverse impacts fresh in people’s minds, forcing them to make changes to protect themselves from similar future events. Flood awareness is at its highest immediately after the flood and it fades away within 4 to 6 years [53]. Without recurrence, people forget those experiences and the need to make changes diminishes. For this reason, it is important to keep the flood memories in peoples’ minds as long as possible.

#### 4. Discussion

The social learning that occurred in Yorkton in relation to knowledge acquisition, skill development, relational knowledge, and belief change differs from other studies. The Yorkton case is different from those that found previous knowledge and experience are inversely related with knowledge acquisition [13,31,54]. Knowledge acquisition and skill development in Yorkton was common to all. This finding might be attributed to the fact that the 2010 flood was the first firsthand flood experience and social learning was mainly motivated by the flood event, and not participatory processes that existed in the literature.

Yorkton also differs as relational knowledge was different from what the literature proposes [13,21,25,26]; no new relations were created, trust was not increased, and there was not a convergence of perspectives, due to Yorkton’s small size. Instead, the flood reinforced the importance of maintaining existing relationships with local organizations and highlighted the importance of institutions such as the Fire Protective Services.

The main drivers for social learning were the flood event itself and the resulting communication and interaction among stakeholders. The literature suggests that experiences, such as living through a flood event, offer a basis for learning; people start learning as they go through the event, they reflect on their experience, develop abstract conceptualizations, and then put them into test, which leads to new experiences [26,55], as cited in [53]. As a result, the subsequent flood events contributed to reinforcing and refining the acquired learning with new measures and solutions applied and shared through social interactions. This process has also been noticed among the City officials, when considering the measures the City have been taking to reduce flood risk in the city.

Although the City did not seek input from the public, the informal interaction between the residents, the City staff, and the Councillors contributed to improved knowledge and helped the City staff identify problem areas and refine their plans, which is consistent with the findings of Den Boer et al. [56]. However, it is important to point out that the data suggest that these informal interactions are individualistic and disorganized, in that the residents would contact the City or the Councillors on an individual basis regarding problems they personally face. They do not rise to the level of informal networks that the literature suggests are important for double- and triple-loop learning [12,15,33].

Some double-loop learning is taking place. The adoption of the new design standards to guide new developments, the increased prominence of the discourse around climate change, and decision to upgrade stormwater system even in the face of uncertainty are all indicative of double-loop learning. The flood experience did not encourage the people in Yorkton to question the prevailing normative institutions or actor roles, nor did it encourage them to change the patterns of interaction among levels of government or the governance mode—all of which indicate single-loop learning.

The view that the public has no role to play when it comes to flood risk management is so prevalent that it is shared among the City officials, the Council, and the residents. This view may have inhibited the degree of social learning achieved in Yorkton. This belief is what made the people of Yorkton hold on to the conventional actors’ roles and prevented the City from seeking advice/input from actors outside the City and engineering consultants. It also prevented changes in the dominant governance mode.

One of the important findings of this research, is that social learning diminishes as a result of passage of time or because of the sense of safety that people developed as a result of the infrastructure upgrades. Diminishing of social learning is especially important in Yorkton's case because the flood mitigation plan is still a long way from being implemented and it is an extremely costly plan for a city of Yorkton's size. In another case, Johannessen and Hahn [2] reported that forgetting the flooding experience has moved a flood mitigation project down the decision makers' agenda and caused at least three years delay in implementation. If this is also the case in Yorkton, and people feel that they are safe, they will not support spending millions of dollars on stormwater infrastructure upgrades, leaving them vulnerable to future extreme events.

## 5. Conclusions

This paper demonstrates that social learning can occur after floods, producing favorable outcomes in terms of disaster preparedness and reduced vulnerability to future events, both at an individual and community level. However, a concerning finding of this study suggests that social learning fades with the passage of time or because people mistakenly feel that the flood risk is eliminated. When social learning fades, people's vulnerability to flood risk increases because they stop taking the precautions needed to protect themselves and their properties and also because they stop supporting spending on flood risk mitigation.

To maintain the learning, accurately documenting the flood events that happened is essential, but not sufficient to keep the flood risk in peoples' minds. People will not intentionally seek this information. The City will have to actively remind residents of these events and the extent of the damage through different communication channels (e.g., the City's official website, social media, and the local newspaper). Additionally, the City can install High Water Marks, which indicate the height of the flood water, to provide constant and visible reminders of past floods. Combining this with spreading awareness about climate change will also increase the salience of the message.

It is equally important to set realistic expectations about the infrastructure upgrades and their ability to protect the residents from flooding, by stressing that complete flood proofing of any city is impossible because there are limits to the amount of water a storm water system can handle; when this limit is exceeded, floods occur. Finally, encouraging public participation in stormwater management issues is vital for Yorkton. Inviting a diverse range of stakeholders to participate in decision-making processes can help the City maintain the acquired learning and find innovative and cost-effective solutions to future flood problems.

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### Appendix A List of Participants

No.	Position	Date	Code
1	City of Yorkton Employee	17-Jul-2019 26-Jan-2021	CY1
2	City of Yorkton Employee	26-Jul-2019 20-Jan-2021	CY2
3	City of Yorkton Employee	29-Jul-2019	CY3
4	City of Yorkton Employee	18-Sep-2019 21-Jan-2021	CY4
5	A Local Watershed member	05-Oct-2020	WM
6	Water Expert	21-Oct-2020	WE
7	Journalist (Yorkton This Week)	03-Nov-2020	J1
8	SIGN Employee	12-Nov-2020	S
9	Journalist (Yorkton This Week)	17-Dec-2020	J2
10	Former Yorkton Public Library Employee (By Email)		YPL
11	Resident who was severely impacted by the 2010 flood	6-Jan-2021	R1
12	Resident who was severely impacted by the 2010 flood	15-Jan-2021	R2
13	A Business owner who was severely impacted by the 2010 flood	21-Jan-2021	BO
14	City Councillor	27-Jan-2021 2-Feb-2021	CC
15	City of Yorkton Employee	2-Feb-2021	CY5

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