Direction de la sécurité civile et de la résilience

Incident and Feedback Report

2017 Floods

Making Montréal a Flood-Resilient Community

Service de sécurité incendie de Montréal (SIM)
Direction de la sécurité civile et de la résilience (DSCR)
December 12, 2017

Montréal

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ABBREVIATIONS AND ACRONYMS

CAM	Centre d'aide multiservices (multi-service assistance centre)
CCMU	Centre de coordination des mesures d'urgence (emergency measures coordination centre)
CEHQ	Centre d'expertise hydrique du Québec (Québec hydrological expertise centre)
CGMU	Centre de gestion de la mobilité urbaine (urban mobility management centre)
CF	Centre de fonctionnement (operations centre)
CGC	(Cellule de gestion de crise) (crisis management cell)
CHU	Centre d'hébergement d'urgence (emergency shelter)
CIUSSS	Centres intégrés universitaires de santé et services sociaux (integrated university healthcare and social service centres)
CLSC	Centres locaux de services communautaires (local community service centres)
CMM	Communauté métropolitaine de Montréal (Montréal metropolitan community)
COUA	Centre des opérations d'urgence des missions d'agglomération (agglomeration emergency operations centre)
COUM	Centre des opérations d'urgence des missions d'agglomération (emergency operations centre for borough missions)
COUS	Centre des opérations d'urgence sur le site (on-site emergency operations centre)
COUV	Centre des opérations d'urgence de ville (municipal emergency operations centre
CR	Canadian Red Cross
SC	Site coordinator
BM	Borough manager
GM	General manager
DSCR	Direction de la sécurité civile et de la résilience (civil protection and resilience division)
DRSP	Direction régionale de santé publique (regional public health division)
CAF	Canadian Armed Forces
ARLUPD	*Act respecting land use planning and development*
EMS	Emergency management software
MAMOT	Ministère des Affaires municipales et de l'Occupation du territoire
MDDELCC	Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques

Abbreviations and acronyms (suite)

MSP	Ministère de la Sécurité publique
ORSC	Organisation régionale de la sécurité civile (regional civil protection organisation)
OSCAM	Organisation de sécurité civile de l'agglomération de Montréal (Montréal agglomeration civil protection organisation)
OSCQ	Organisation de la sécurité civile du Québec (Québec civil protection organisation)
PMAD	Plan métropolitain d'aménagement et de développement—Metropolitan Land Use and Development Plan
PC	Command post
PPI	Plan particulier d'intervention (emergency response plan)
PPRLPI	Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains
PSCAM	Plan de sécurité civile de l'agglomération de Montréal (Montréal agglomeration civil protection plan)
RDP	Rivière des Prairies
ROHCMUM	Regroupement des organismes humanitaires et communautaires pour les mesures d'urgence à Montréal (association of humanitarian and community organisations for emergency measures in Montréal)
SAD	Schéma d'aménagement et de développement (land use and development plan)
SDÉ	Service de développement économique (economic development department)
SIM	Service de sécurité incendie de Montréal (Montréal fire department)
SIVT	Service des infrastructures, de la voirie et des transports (department of infrastructure, roads and transportation)
SMVT	Service de mise en valeur du territoire (land-use development department)
SPVM	Service de police de la Ville de Montréal (Montréal police department)
STM	Société de transport de Montréal (Montréal transit authority)
PW	Public works
US	Urgences - santé (emergency health services)

1 EXECUTIVE SUMMARY

The Montréal agglomeration, like more than 260 Québec municipalities, suffered severe flooding in the spring of 2017 - the worst since 1976. These floods struck many boroughs and coextensive municipalities along Lac des Deux-Montagnes, Rivière des Prairies, Lac Saint-Louis and the St. Lawrence River. It was clearly the worst disaster involving civil protection services to have hit Montréal since the 1998 ice storm.

These events caused damage—occasionally severe—to property and to some infrastructure. Over 430 homes were flooded and some 1,100 residents displaced in the boroughs of L'Île-Bizard–Sainte-Geneviève, Pierrefonds-Roxboro, Ahuntsic-Cartierville, Rivière-des-Prairies–Pointe-aux-Trembles boroughs and the coextensive municipalities of Ville de Sainte-Anne-de-Bellevue and Village de Senneville.

The seasonal flood watch by the DSCR (Direction de la sécurité civile et de la resilience) began March 15, 2017 and continued through to April 6, 2017, when the Montréal agglomeration's civil protection plan (PSCAM) shifted to **STANDBY** mode as a response to flood thresholds being reached and in view of weather forecasts by the CEHQ (a unit of the MDDELCC).

Following a swift rise in water levels, the PSCAM was placed in **RESPONSE** mode from May 3 to 19. 2017, resulting in the mobilisation of OSCAM (Organisation de sécurité civile de l'agglomération de Montréal —Montréal agglomeration civil protection organisation) at the CCMU (Centre de coordination des mesures d'urgence—emergency measures coordination centre) and operations centres. The ORSC (Organisation régionale de sécurité civile—Regional civil protection organisation) and the Canadian Armed Forces (CAF) provided support to OSCAM's staff at the CCMU. A total of some 2,000 responders (fire fighters, police officers and blue and white collar workers, as well as professionals from the city and its coextensive municipalities) were deployed, either in the field and the operations centres.

The unique access to the island sector of Mercier, in the L'Île-Bizard–Sainte-Geneviève borough, was closed following its inundation. With emergency services unable to reach the island, the coordinator of civil protection issued an evacuation order on May 5, 2017, at the height of the response. Many residents refused to comply and remained in their homes. Lack of access to the island posed a major challenge to emergency responders. The issue was partially resolved by establishing a round-the-clock land and water watch by Montréal police and fire fighters. This watch ensured emergency responses for calls to first responders, as well as to reports of break-ins, vandalism or fire. The emergency response coordinator then authorised those residents who wished it to remain in their homes.

In view of this extraordinary situation, the severity of the flooding and the scale of the disaster area, the Mayor of Montréal announced a two-day state of emergency on May 7, as per the *Civil Protection Act.*[1] On May 9, the Agglomeration Council issued a five-day extension of the state of emergency, extending the status to May 14.

The various measures implemented under this state of emergency by the city and the coordinator of civil protection for the Montréal agglomeration were aimed at controlling flooding, ensuring resident safety and protecting property and infrastructure.

This report's recommendations—based on observations, lessons from the response and a feedback session with responders—are intended to make the Montréal agglomeration more resilient to flooding, by improving responder preparedness and our overall knowledge of with respect to this risk.

[1] CQLR, c. S-2.3

The report's recommendations are designed to meet six goals:

1) Improve knowledge of potential risks and impacts so that mitigation measures can be proposed. Meeting this goal will involve updating and expanding flood zone maps, while developing and defining a land-use policy for flood zones.

2) Improve the state of preparedness of different responders with respect to floods by updating the COUS (on-site emergency operations centres), the coordination/management structure, training content and requirements, the flood response plan (PPI — Inondations) and related operational factors as well as planning more extensively for the RECOVERY phase.

3) Improve coordination among responders by considering the possibility of establishing a faster and more flexible process for approving requests for government assistance (such as deploying the Canadian Armed Forces).

4) Improve communication with victims, at-risk persons and the general population, by updating the communication plan and improving flood response tools.

5) Improve support for Montréal agglomeration workers by developing emergency measures workforce relief plans for the boroughs and coextensive municipalities.

6) Improve preparedness of the agglomeration's corporate citizens to optimise recovery with respect to commercial activities and places of business.

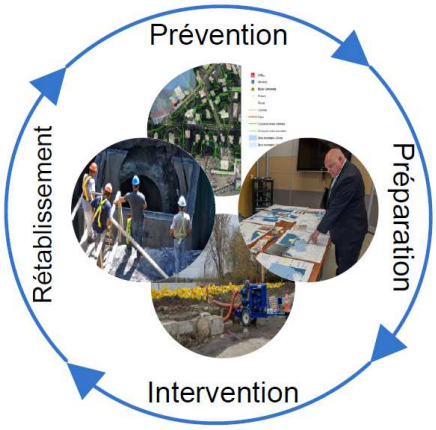
2 Making Montréal a Flood-Resilient Community

The Montréal agglomeration, like more than 260 Québec municipalities, suffered severe flooding in the spring of 2017 - the worst since 1976. Many boroughs and coextensive municipalities along the waterways surrounding the Montréal agglomeration were hit by Montréal's worst disaster since the 1998 ice storm.

As Québec's largest city, Montréal must not only be able to prevent or cope with extreme events, but respond to them proactively, mitigating risk to residents and organisations, while providing for essential needs and ensuring quality of life.

This report has been prepared to highlight lessons learned from the 2017 spring floods and, as such, accompany Montréal in its efforts to become more resilient. These lessons will allow recommendations with respect implementing preventive measures, improving the Montréal agglomeration's preparedness and enhancing its disaster-recovery abilities.

The recommendations of this report, based on lessons learned from the flood response, as well as a feedback session with responders, are listed according to their related risk-management phase: PREVENTION, PREPARATION, RESPONSE or RECOVERY.



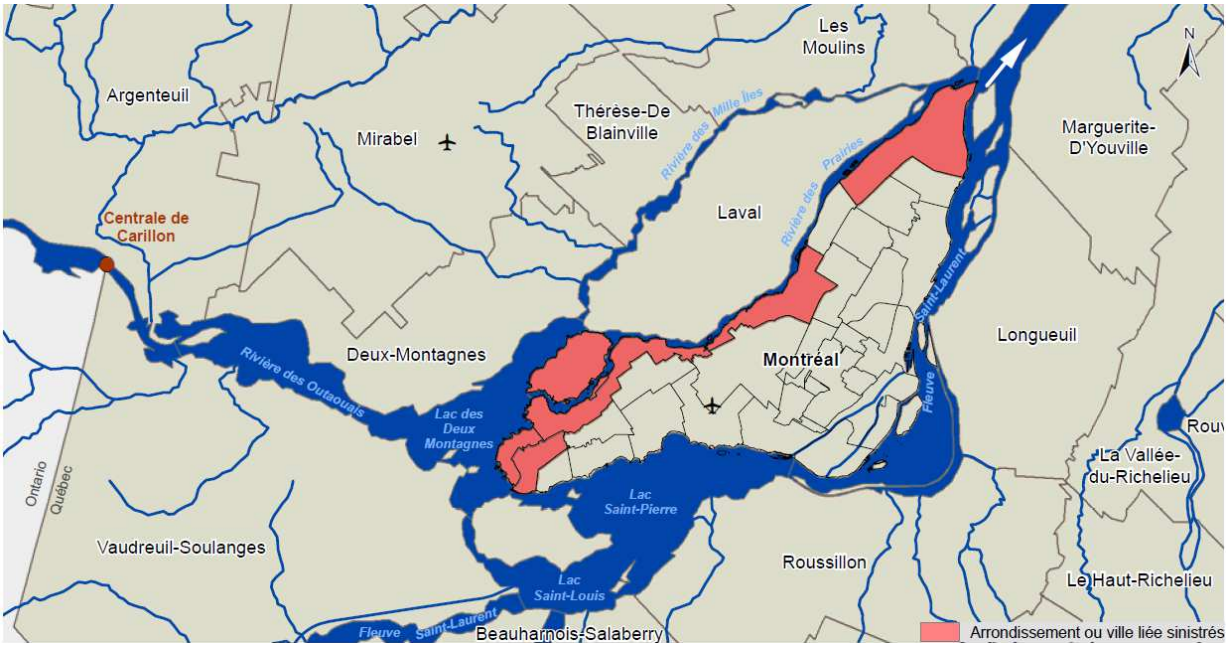
- Taking preventive action will enable Montréal to plan its urban development in a way as to minimise hazards, maintain essential community services and limit impact in at-risk sectors.
- "Preparing" means defining activities that would mitigate the identified impacts, based on risk assessment and evidence. Response can then be formulated by adapting emergency measure plans, response procedures, training and simulations accordingly.
- Taking effective action so Montréal can engage in a coordinated response to such events.
- Recovering quickly from a disaster to support the resumption of Montréal's economic activities and rebuild damaged infrastructure, while restoring pre-disaster living, economic and social conditions.
- Engaging in broader, multiagency planning, enabling Montréal to mitigate or avoid disasters and identify or reduce social, economic and cultural factors that could impair effective response.

3 Background

3.1 Spring Floods

On the night of May 2-3, 2017, water levels bordering the boroughs of L'Île-Bizard–Sainte-Geneviève, de Pierrefonds-Roxboro, Ahuntsic-Cartierville, Rivière-des-Prairies–Pointe-aux-Trembles, as well as Ville de Sainte-Anne-de-Bellevue and Village de Senneville, rose abruptly, triggering Montréal's worst floods since 1976 (see map of affected sectors in Appendix 1).

These events resulted from a juxtaposition of meteorological and hydrological factors. Large snowfalls that had accumulated in catchments throughout the winter melted quickly following a sudden rise in temperature and heavy April-May rains.[2] Runoff to rivers and lakes boosted flow rates in tributaries of the Ottawa River and the Carillon Dam—the only dam controlling the Ottawa River's flow. This was followed by a considerable rise in water levels of Lac St-Louis, Lac des Deux-Montagnes and Rivière des Prairies.[3]



3.2 Deploying OSCAM

3.2.1 Mobilisation Timeline

According to the Montréal agglomeration civil protection plan (PSCAM) and flood response plan (PPI — Inondations), members of OSCAM (Organisation de sécurité civile de l'agglomération de Montréal—Montréal agglomeration civil protection organisation) were gradually mobilised and deployed from March 15, 2017 until they were fully deployed from May 3 to 16.

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[2] According to Environment Canada, the Montréal agglomeration received heavy rainfall in April and May 2017:
- April: 156 mm (normal = 68 mm), including 80 mm from April 4 to 7.
- May 1 to 16: 82 mm (normal = 78 mm), including 75 mm from May 1 to 7.

[3] See Table 3 in Appendix 2 for maximum flow rates and water levels in the spring of 2017.

The DSCR's spring flood watch began March 15, 2017. On April 6, 2017, following upwardly revised hydrological forecasts by the CEHQ (MDDELCC) and forecasted rainfall quantities, the Montréal agglomeration's coordinator of civil protection set the PSCAM to STANDBY mode because the possible impact on residents.

Once the PSCAM went to STANDBY, various preventive measures, such as sand bag preparation, were applied locally by the boroughs and coextensive municipalities to lessen the potential impact of flooding on different sectors.

The CCMU (Centre de coordination des mesures d'urgence—emergency measures coordination centre) was opened for three different periods: April 7-8, April 19-21 (in ALERT mode) and May 3-19 in RESPONSE and RECOVERY modes. The CCMU was open 24/7 for 17 days in a row, from May 3 to 19.

Between May 3 and 18, the agglomeration missions,[4] the Canadian Armed Forces (CAF) and the ORSC (Organisation régionale de sécurité civile—regional civil protection organisation) were mobilised at the CCMU, on in their operations centres, to coordinate activities within the agglomeration.

Some 2,000 responders were deployed, including firefighters, police officers, blue and white collar workers and professionals from the city and coextensive municipalities. Crews from DRSP, US (Urgences-santé—emergency health services) and CIUSS (centres intégrés universitaires de santé et services sociaux—integrated university healthcare and social service centres) also worked with the SIM (Montréal fire department) in inspecting flooded residences.

Table 1: Timeline of OSCAM Deployment and Declaration of State of Emergency

Month	Date	Event
March	15	Start of DSCR WATCH.
April	4	Upwardly revised forecasts by the CEHQ, based on meteorological conditions.
	6	PSCAM set to STANDBY mode.
	7-8	PSCAM set to ALERT mode. CCMU opened in reduced mode.
	9-17	PSCAM set to STANDBY mode (reduced water levels and flow rates)
	18-23	PSCAM set to ALERT mode. CCMU opened April 19-21 in reduced mode.
	April 23-May 1	Set to STANDBY mode.
May	2	Set to ALERT mode.
	3-15	Set to RESPONSE mode. CCMU completely opened 24/7.
	7	Declaration of state of emergency. Arrival of Canadian Armed Forces
	9	State of emergency extended.
	14	State of emergency ended.
	16	PSCAM set to RECOVERY mode.
	19	CCMU closed.
	20 and 27	Cleanup operations.
	May 22	Withdrawal of armed forces.

[4] Administrative and logistical support, communications, essential infrastructure, water, transport of people, peace and order, saving lives and protecting property, health and the environment.

3.2.2 Declaration of State of Emergency

In view of the extraordinary situation resulting from spring flooding, the severity of the disaster and the magnitude of the area affected, the Mayor of Montréal declared a two-day state of emergency on May 7, as per the *Civil Protection Act.*[5] The Agglomeration Council extended the state of emergency for five days on May 9, extending the status to May 14.

The declaration of a state of emergency gave the civil protection coordinator additional powers:

1. Controlling access (or applying special regulations) to roads and the sectors in question.
2. Granting authorisations and waivers in areas falling under municipal jurisdiction for a duration deemed necessary to allow for prompt and effective response.
3. When no other protective measures were available, ordering the evacuation of people from all or part of a given sector - in accordance with recommendations from public health officials - as well as seeing to their needs including, if they had no assistance, providing for their lodging, food, clothing and safety.
4. Requesting assistance from able residents in aiding response crews.
5. Requisitioning, within territorial limits, necessary private support and accommodations, other than those needed for the deployment of a civil protection plan adopted under this chapter or Chapter VI.
6. Approving contracts and making the expenditures the coordinator deems necessary.

3.3 PROFILE OF IMPACT AND CONSEQUENCES

Spring flooding affected more than 1,100 people and caused damage—occasionally major—to properties, possessions and some infrastructure.

Impact on people

- More than 1,100 flood victims.
- Order to evacuate Île Mercier.
- Voluntary evacuation of many homes.

Impact on property and possessions

- More than 430 residences flooded.

Impact on essential infrastructure and other public/private infrastructure

- Closure of a fire station, a Montréal police (SPVM) station and a road in Pierrefonds-Roxboro borough.
- Rerouting of more than 8 STM bus lines because of street closures.
- Closure of many bridges, overpasses and streets:
    - Chemin de l'Anse-à-l'Orme
    - Chemin Senneville
    - Pont Galipeault (Highway 20)
    - Pont de l'île Mercier
    - Pont Oakridge
    - Boulevard Gouin
    - Boulevard Saint-Jean
    - Boulevard Pierrefonds

[5] CQLR, c. S-2.3

- Evacuation of three healthcare centres and monitoring of several other sites by the CIUSSS du Centre-Sud, which oversees emergency measures for Montréal agglomeration healthcare institutions:
    - Pavillon Albert-Prévost (6555, boul. Gouin Ouest)
    - Centre hospitalier de soins de longue durée (CHSLD) Vigi Pierrefonds (14755, boul. de Pierrefonds)
    - Centre d'hébergement Notre-Dame-de-la-Merci (555, boul. Gouin Ouest)
    - Résidence Berthiaume-du-Tremblay (1635, boul. Gouin Est)
    - CLSC Laurendeau (1725, boul. Gouin Est)
    - Centre jeunesse Rose-Virginie-Pelletier (6469, boul. Gouin Ouest)
    - CLSC Pierrefonds (13800, boul. Gouin Ouest)
    - CHSLD Château sur le lac (16289, boul. Gouin Ouest)
- Closure of many shops
- Closure of many schools

3.4 Financial Impact

The flooding gave rise to massive, unanticipated expenditures for the affected boroughs and coextensive municipalities, particularly in deploying protective measures, opening reception and information centres for flood victims, opening emergency shelters and employee overtime.

The Montréal agglomeration spent an unplanned $8,014,316.80[6] because of the 2017 spring flooding.

[6] Service des finances, 2017-11-23

4 Prevention

Prevention is "the set of permanent measures aimed at eliminating risk, as well as reducing the chance of unanticipated hazards and mitigating their potential impact"[7] and remains the key focus of investment in boosting community resiliency. Prevention measures can be structural (dykes) or non-structural (land-use policies).[8]

Because watercourses can be complex and hydrological forecasts uncertain, many conventional solutions, such as dam construction, have often yielded unexpected and undesirable results, such as habitat fragmentation of watercourses and wetlands, transfer of impacts to other sectors and sometimes an even greater impact on the protected site if the solution fails. In addition, forecast uncertainty has now been amplified by climate change.

To improve Montreal's resilience to floods, we must start by improving our understanding of Montréal's hazard probabilities and existing vulnerabilities. A better understanding of flood risk will enable us to improve our preventative measures by adapting our in land-use planning and implementing appropriate structural approaches and green infrastructure projects.

4.1 Montréal Agglomeration Floodplain Mapping

The floods highlighted opportunities for more accurate forecasting of changes in watercourses and their resulting impact.

Several technical reports are currently used in calculating 2-year, 20-year and 100-year flood benchmark levels for their respective watercourses:

- Rapport technique de 1985 pour le fleuve Saint-Laurent et le lac Saint-Louis [1985 Technical Report for the St. Lawrence River and Lac Saint-Louis].
- Rapport technique de 1990 pour le tronçon Varennes-Grondines [1990 Technical Report for the Varennes-Grondines Navigation Corridor].
- Rapport technique de 2006 pour la rivière des Prairies (RDP) [2006 Technical Report for Rivière des Prairies].
- Rapport technique de 2006 pour la rivière des Outaouais et le lac des Deux-Montagnes, incluant la rivière à l'Orme [2006 Technical Report for the Ottawa River and Lac des Deux-Montagnes, Including Rivière à l'Orme].

The CMM [Montréal Metropolitan Community] used the 2006 technical reports in mapping the floodplains of Lac des Deux-Montagnes and Rivière à l'Orme in 2008. However, the floodplains of Rivière des Prairies (RDP) were not mapped. Emergency response services still use the RDP floodplain maps, which were produced by the CEHQ[9] and based on benchmark levels defined in its now-outdated 1978 technical report. Updated maps are, accordingly, required.

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7 Ministère de la Sécurité publique (2008). Pour planifier la réponse au sinistre – Guide à l'intention des municipalités, Gouvernement du Québec, September 2008, 98 pages, Online at:www.securitepublique.gouv.qc.ca/fileadmin/Documents/securite_civile/publications/guide_reponse_sinistre/guide.pdf

8 Public Safety Canada (2015). About Disaster Mitigation, Government of Canada, Online: www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr-prvntn-mtgtn/bt-dsstr-mtgtn-en.aspx

9 "In 2017, following organisational restructuring, the CEHQ's units were placed under the Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques."

In addition to updating maps based on the latest technical reports, consideration should be given to climate change-induced uncertainty, which could influence the flood probabilities.,. Furthermore, the impact of increased urbanisation of catchment areas on local flow should be considered. Maps should not only show flood zones, but the evolution of such zones and their vulnerability to flooding. The flood management strategy should accordingly be based on comprehensive maps that are regularly updated and include more than just probabilistic levels based on historical events

The floods of 2017 also provided a chance to collect new data and acquire fresh knowledge that could be used to prevent the impact of future flooding:

- Real-time data on watercourse levels and flows.
- A moving potential inundation line determined by various techniques, with results applied to identifying Montréal's flood-risk areas.
- Identification of the most vulnerable residences and infrastructure.

This new information and knowledge should be used to create flood-risk maps.

Recommendations

1. Finalise Montréal's hazard maps, incorporating knowledge acquired from the 2017 floods and determine the value of including these maps in the Schéma d'aménagement et développement (SAD—Land Use and Development Plan). Then, contribute to the formulation of a technique for identifying the Montréal archipelago's flooding zones. In particular, we recommend the following measures:

    a. Task the Division de la géomatique of the Direction des infrastructures, which is part of the Service des infrastructures, de la voirie et des transports) (SIVT), in conjunction with the Service de mise en valeur du territoire (SMVT), with completing hazard maps based on the 2006 CEHQ report, while integrating knowledge acquired from the 2017 floods.

    b. Task the Direction de l'urbanisme of the Service de mise en valeur du territoire) (SMVT) with assessing the value of incorporating maps produced by the Division de la géomatique of the Direction des infrastructures, which is part of the Service des infrastructures, de la voirie et des transports) (SIVT) in the SDD (Schéma d'aménagement et développement—Land Use and Development Plan).

    c. Task the Direction de l'urbanisme of the Service de mise en valeur du territoire (SMVT) with working conjunction with the CMM to develop a uniform technique for identifying flood zones throughout the archipelago.

2. Task the DSCR, with the support of the Division de la géomatique of the Direction des infrastructures, which is part of the Service des infrastructures, de la voirie et des transports (SIVT), with developing a risk map based on catchment evolution and uncertainty due to climate change, to predict the impact on vulnerable areas of the agglomeration and identify adaptation options.

4.2 Land-Use Planning as a Preventive Measure

Land-use planning can play an important role in mitigating the risk of spring floods, by reducing the exposure of people, property and infrastructure to the occurrence of floods as well as to their potential intensity. Adequate planning must, however, be based on scientific knowledge of the phenomenon, with maps drawn in line with such knowledge. The identification of floodplains and maps showing them can be used to create and apply a specific regulatory framework to define permitted uses and types of construction, and the conditions to which they will be subjected. This regulatory framework must then be incorporated in land-use planning documents and planning by-laws for the municipalities in question.

There are a variety of flood risk management strategies for cities. They range from complete protection for the built environment to respect for watercourse behaviour. Historically, however, the general trend has been to protect the urban setting by encroaching on shorelines, floodplains and occasionally the coastline, with sometimes disastrous consequences.

Sealing surfaces catchment soil surfaces through development can alter their hydrological regime and increase volumes of water draining into watercourses. Development can also destroy wetlands that are part of the watercourses' hydrological regime and act as buffers by absorbing excess water.

The spring flooding of 2017 raised a number of issues concerning flood risk knowledge and land-use planning:

- Some flooded sectors were in low-velocity zones (20-100 year flood zones) or were located outside low-velocity zones, while some high-velocity zones (0-20 year flood zones) were unaffected.
- Some sensitive uses were present in low-velocity zones:
    - Certain healthcare institutions had to be evacuated on a precautionary basis because of the vulnerability of patients residing in them.
    - Sites critical to emergency response measures, such as a fire station, a local police station and a municipal roadwork station were closed and their activities relocated.
- Essential infrastructure, bridges, overpasses and roads had to be closed, include the Pont de l'Île Mercier, the only access to the island's residential community.

Floodplain Regulations

The MDDELCC's *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains* (PPRLPI), established a regulatory framework for activities in these sectors. The policy was adopted in 1987 to protect lakes and waterways, as well, more generally, to protect "water" because of developmental pressures on shorelines, the coast and floodplain threatening lake and waterway quality.

The *Act respecting land use planning and development* (ARLUPD), which serves as the legal framework for Québec's land-use planning, obliges regional county municipalities (RCMs) and local municipalities to incorporate the PPRLPI in their planning documents and town-planning by-laws. Furthermore, the ARLUPD requires that planning documents take natural constraints into account. Identification of such zones inevitably results in limits on development, with a direct impact on economic development.

PPRLPI regulations are minimal, which means RCMs and municipalities can opt for stricter standards. They can even submit a management plan for a shoreline, coastline or floodplain in response to special situations in view of the local environment and the extent to which natural shorelines and floodplains have been eliminated.[10]

[10] MAMOT (2017). Outils de protection de l'environnement, La protection des rives, du littoral et des plaines inondables, Guide La de prise de décision en urbanisme, Viewed July 21, 2017, online at: www.mamot.gouv.qc.ca/amenagement-du-territoire/guide-la-prise-de-decision-en-urbanisme/protection-de-lenvironnement/protection-des-rives-du-littoral-et-des-plaines-inondables/

The CMM (Communauté métropolitaine de Montréal) is responsible for creating and implementing a PMAD (Plan métropolitain d'aménagement et de développement—Metropolitan Land Use and Development Plan). A PMAD should, in particular, identify major constraints shared by different RCMs that could influence risks or trigger disasters. The PMAD SHOULD also incorporate the PPRLPI's minimal standards requiring RCMs to include them in their SADs (land use and development plans).

The CMM's current PMAD includes the objective of "3.2 Protecting Greater Montréal's shorelines, coastline and floodplains," with the first criterion (3.2.1) being "floodplain identification." These guidelines highlight the fact the proper land-use planning and effective environmental protection are based on knowledge of the floodplains.

The Montréal agglomeration's SAD incorporates the PPRLPI's requirements and INCORPORATES floodplains for each of its watercourses, along with mapping available for some agglomeration shorelines.

In view of the applicable regulatory framework, a metropolis-wide approach to the hydrological regime and an updated set of regulations for the agglomeration is needed, particularly including the PPRLPI's option of imposing stricter standards or formulating a floodplain management plan that reflects issues specific to the Montréal agglomeration.

Recommendation

3. Task the Direction de l'urbanisme du Service de la mise en valeur du territoire, in conjunction with the DSCR and all other applicable Montréal corporate departments with defining a floodplain management policy and formulating long-term solutions reflecting existing risks, covering such issues as acquiring land in floodplains, protecting more aquatic environments, defining measures for minimising surface sealing in catchments, etc.

4.3 Structural and Green Infrastructural Measures

Despite new knowledge of flood risks, adequate mapping and a regulatory framework tailored to Montréal's actual shorelines and floodplains, some parts of the island may remain at risk to possible flooding.

For this reason, the feasibility of installing structural mitigation measures (permanent dykes) and green infrastructure (such as green spaces) could be considered to protect people, buildings and infrastructure. Implementing such initiatives involves many technical, financial and legal constraints:

- Every dyke construction site or green infrastructure facility should be initially identified according to the intentions of the various stakeholders, such as city or the borough in question, the municipal corporate department concerned and the public.
- Once a potential site has been identified, the technical feasibility of a particular structure or facility, as well as its environmental impact up- and downstream of the site, should be evaluated by a variety of specialists.
- Depending on the site's location, certain measures could require an environmental impact assessment.
- The cost of dyke maintenance and management should be estimated and accepted by the stakeholders and should be less than the cost of damages that may be caused by another flood.

As such, the implementation of such measures must be the result of strategic planning and of appropriately identified sites in an effort to avoid creating a false sense of security in the public or development in vulnerable areas.

Recommendation

4. Task the DSCR and the Bureau de la résilience, in conjunction with the Service des infrastructures, de la voirie, et des transports (SIVT), the Service du développement économique (SDÉ), the Service de l'eau, the Service de l'environnement, the Service de la mise en valeur du territoire (SMVT) and all other relevant municipal corporate departments, with planning resilient techniques, standards and construction, along with green infrastructure.

4.4 Planning the Recovery of Businesses and Business Locations

Despite the rollout of business continuity initiatives, some companies remain more vulnerable to a disaster than others. Small and medium-sized businesses often lack the know-how and resources to reduce risk. The city must accordingly play a role in supporting these local businesses so they can rapidly resume activity following a disaster.

Recommendation

5. Task the DSCR and the Bureau de la résilience, in conjunction with the Service du développement économique (SDÉ) with planning a post-disaster recovery phase for commercial activities and places of business.

5 Preparation

Preparation is the set of activities and measures aimed at enhancing disaster response capabilities.[11] This phase includes planning, creation of a resource inventory and implementation of exercise programs and training sessions. It also serves in developing up-to-date, effective emergency measure plans.[12]

Making Montréal a resilient city requires applying the effort needed to ensure continuous improvement of the agglomeration's general preparedness—which means preparedness of the public, municipal corporate departments, boroughs and coextensive municipalities. The floods of 2017 provided an opportunity to reassess our preparedness and preparedness efforts, and to identify potential changes in both areas.

To respond effectively, Montréal needs significant preparation and planning by the different missions of OSCAM (civil protection organisation). Officials must also devote the necessary efforts to enhance their departments' preparedness.

Recommendation

6. That agglomeration mission directors report on their preparedness to the Direction générale, with this responsibility included in their job description. Ensure that an administrative framework applies to this recommendation.

5.1 The Montréal Agglomeration's Civil Protection Plan (PSCAM)

Established in conjunction with the city's corporate departments, as well as the Montréal agglomeration's boroughs and coextensive municipalities, the PSCAM constitutes the cornerstone of civil protection planning and strategic coordination. It provides general rules on the strategic coordination structure and consists of the agglomeration and local mission plans, as well as emergency response plans. It can be activated for three alert and mobilisation levels—*STANDBY, ALERT and RESPONSE*.

The agglomeration's 10 mission plans fall under the responsibility of Montréal's corporate departments, quasi-municipal entities and non-municipal organisations. Montréal's boroughs and coextensive municipalities are responsible for the four local mission plans.

Table 2: Agglomeration and Local Missions

Agglomeration Missions	Local Missions
- Protecting lives and property - Peace and order - Healthcare - Transportation of people - Essential infrastructure - Water - Environment - Communications - Logistical support - Administrative support	- Assistance to flood victims - Communications - Public works - Administrative and logistical support

[11] Ministère de la Sécurité publique (2008) Approche et principes en sécurité civile, Gouvernement du Québec, 70 pages, Online at:www.securitepublique.gouv.qc.ca/fileadmin/Documents/securite_civile/publications/approche_principes/approche_principes.pdf

[12] Centre de sécurité civile. La gestion du risque, 4 phases de gestion des risques, Ville de Montréal, Online at: ville.montreal.qc.ca/portal/page?_pageid=7637,82029670&_dad=portal&_schema=PORTAL

2017's spring floods demonstrated the importance of the RECOVERY phase following a disaster. Since the PSCAM provide little detail about recovery, the DSCR and SIM's Centre de services – Expertise et de développement de prevention had to develop a spontaneous recovery plan with respect to residents reoccupying their residence. This plan can now serve as a useful model in developing permanent PSCAM standards for recovery.

It was also determined, based on the events of 2017, that the coordination of emergency measures is key in maintaining an integrated and holistic view of events which, in turn, aids in better anticipating their outcome. As such, the RECOVERY phase must also be planned as a coordinated effort with all appropriate responders.

Recommendation

7. Task the DSCR and SIM, in conjunction with OSCAM's partners, with updating and modifying the PSCAM based on the lessons of 2017 and past Plan activations. These changes should include updating alert and mobilisation levels to include a recovery phase,[13] accompanied by clarified roles and responsibilities.

5.2 Flood Response Plan

The flood response plan (PPI — Inondations) deployed for the 2017 floods was prepared to ensure monitoring of Montréal's watercourses and to provide an effective, coordinated response to emergencies resulting from high waters. The plan delineates mobilisation indicators and responder roles and responsibilities.

Despite the set of preventive actions performed and communications disseminated in conjunction with internal and external municipal partners during STANDBY and ALERT periods, the Montréal agglomeration still faced a substantial and unpredictable rise in water levels in the night of May 2-3. The actual situation far exceeded hydrological forecasts, requiring a rapid deployment of personnel to limit impacts.

During the RESPONSE phase, directives within the PPI were at times questioned, particularly with respect to the different roles and responsibilities of the boroughs, coextensive municipalities and emergency services operating in the field.

5.2.1 Mobilisation Monitoring Indicators

Water flows at specific sites (dam and measuring stations) serve as flood response plan (PPI — Inondations) indicators for setting PSCAM activation levels. OSCAM's responses were based on real-time data and the 48-hour CEHQ forecasts. However, the 2017 flooding far exceeded its predicted impact suggesting the need for longer-range (more than 48-hour) forecasts that would permit better preparation actions by responders.

It was also observed that, for many responders, the flows recorded at dams and used as mobilisation criteria failed to suggest the actual field impact of rising water levels. We must, accordingly, be able to translate recorded flows into water levels.

[13] Please refer to the Recovery section for additional information on this topic.

5.2.2 Support Tools

Mobilised responders developed a variety of tools throughout deployment to ensure effective management of the response phase, particularly for tracking orders of equipment, while keeping track of number of victims and flooded homes, as well as the return of victims to their homes, plus a street reopening procedure. These tools proved their worth in the response to flooding and should be enhanced and standardised, so they can be incorporated into the PPI for future use.

Recommendations

8. Task the DSCR, in conjunction with OSCAM's partners, with modifying and improving the flood-response plan (PPI — Inondations) based on recent lessons learned. This change should include updating indicators, clarifying roles and responsibilities, enhancing support tools and developing a specific RECOVERY phase section.

9. Task the DSCR, following modification of the flood-response plan (PPI — Inondations) with developing and deploying a training and exercise plan for all responders concerned, including changes to the flood response plan and to the roles and responsibilities of the different missions.

10. Task the DSCR, in conjunction with the various bodies concerned (Ministère de la Sécurité publique—MSP, MDDELCC, Environment Canada, etc.), with updating water flow and level forecasting procedures and mechanisms, to improve short-, mean- and long-term decision-making.

6 Response

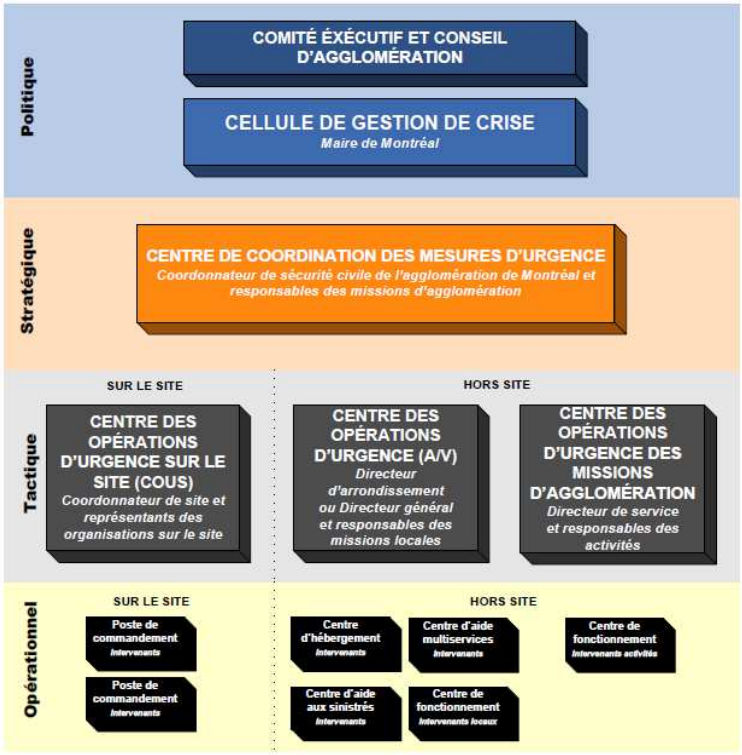
The response phase of risk management constitutes intervention in actual or anticipated disasters. It represents the application, as well as any adaptation, of measures and resources planned during the preparatory phase, according to the nature and scope of the disaster.[14]

The next section will discuss actions, observations and recommendations pertaining to PSCAM activation phases, as well as topics relating to coordination of responders, protection of the public, property and infrastructure, assistance to flood victims, communications, management of human and financial resources and management of offers of assistance from volunteers and private citizens.

6.1 Coordination Among Stakeholders

The PSCAM provides for several disaster-management decision centres: a crisis management cell (CGC—cellule de gestion de crise), an emergency measures coordination centre (CCMU—Centre de coordination des mesures d'urgence), an on-site emergency operations centre (COUS—centre des opérations d'urgence sur le site), borough (COUA) and city (COUV) emergency operations centres and agglomeration mission emergency operations centres (COUM), as well as command posts (PCs) and operations centres (CFs) (Figure 1). Each of these decision centres has a director, a response site and specific responsibilities, while corresponding to distinct management levels (political, strategic, tactical and operational).

Figure 1: OSCAM Deployment Coordination Levels



[14] Ministère de la Sécurité publique (2008) Approche et principes en sécurité civile, Gouvernement du Québec, 70 pages, Online at: www.securitepublique.gouv.qc.ca/fileadmin/Documents/securite_civile/publications/approche_principes/approche_principes.pdf

6.1.1 Emergency Measures Coordination Centre (CCMU)

The CCMU (Centre de coordination des mesures d'urgence), which is headed by Mr. Bruno Lachance, Coordinator of Civil Protection for the Montréal Agglomeration, is the strategic decision centre for the coordination of the Montréal agglomeration's emergency response. The CCMU was in operation 24/7 during flooding from May 3 to 19.

The PSCAM provides for a management cycle that can be tailored to events. To ensure adequate and regular information transfers during flooding, the following management cycle was established at the CCMU:

- Overview of the situation to the coordinator by 7:00 a.m.
- Coordination meeting with representatives of missions of the agglomeration, and the flooded boroughs and coextensive municipalities, as well as with various experts, such as Environment Canada and the CEHQ at 9:00 a.m.
- Transmission of status report to OSCAM's partners in the afternoon.
- Late afternoon coordination meeting, as required.

In addition to the presence of representatives from the agglomeration missions concerned, a representative of the ORSC (Organisation régionale de sécurité civile—regional civil protection organisation) and a Canadian Armed Forces (CAF) liaison officer were present at the CCMU.

Management Cycle and Coordination Meetings

Comments made during the feedback process indicate that responders generally valued the morning coordination meetings. These meetings provided an overall picture of the situation and near-term impact in affected areas, while raising each organisation's issues. Various recommendations were made to shorten the length of conference calls and instead have more frequent roundtable discussions at the CCMU during the day to obtain situation updates. also It was also suggested to consider creating subcommittees to handle specific issues pertaining to the event in progress (disaster assessment, street openings, etc.).

Status Reports

The afternoon status reports provided a portrait of the situation as described in the morning conference call, along with its evolution during the day. Because of the partners' different information needs, it seems necessary to produce status reports more quickly after coordination meetings and to supplement these with updates when necessary.

Solutions of this kind are now being applied. They include using a specific feature of emergency management software (EMS), which is now being deployed among the agglomeration and local missions, to merge status reports from each department, city and borough, providing a more comprehensive and easily updated overall status report.

Recommendation

11. Task the DSCR with implementing the EMS quickly and updating the status report production process using mission, borough and coextensive municipality status reports.

Request Management

CCMU successfully handled over 600 requests from the coextensive municipalities, boroughs and certain departments during the response. Some requests were sent directly to the coordination assistant, while others were addressed directly to the agglomeration missions in the CCMU or in the COUS. These different, non-uniform practices resulted in some duplication of requests and a difficult follow-up of their fulfillment. A standardised emergency measure request management would minimise the risk of mistakes with respect to any specific request, while ensuring rapid and trackable request processing.

It was also noted that agglomeration departments should better prepare in their role as service providers to the entire agglomeration, including coextensive cities

Recommendation

12. Task the DSCR with updating the emergency measures request management process by systematising the procedure and making requests trackable.

Coordination Structure

Activation of the PSCAM and implementation of the emergency measures coordination structure during the 2017 floods served to illustrate differences in the various organisations' (primarily emergency responders) command modes. These differences were also mentioned in the feedback sessions. It seems important, in seeking improved coordination, to align these different structures operationally and strategically. Such alignment would be supported by exercises and simulations.

Tools Available to CCMU Stakeholders

The presence of responders from OSCAM, the ORSC and the Canadian Armed Forces (CAF) for 16 days in a row demonstrated that some work equipment was not suited to external stakeholders (CAF) and that CCMU's resources should be modernised to improve responder effectiveness in a future mobilisation.

Existing technological resources should be evaluated to ensure that the CCMU can respond to present and future strategic management needs during emergency measures.

Recommendation

13. Task the DSCR with developing a CCMU modernisation plan, including:

    a. A review and update of CCMU technological resources.

    b. The creation of working infrastructure permitting external responders, such as the CAF, to work effectively, accompanied by necessary required to enable responders, who have been mobilised for several days, to rest.

6.1.2 COUS

The COUS (Centre des Opérations d'Urgence sur le Site), as its name suggests, is the on-site emergency operations centre. Field responders gather at a COUS there to share information and coordinate operations with the site coordinator. The latter is appointed by the coordinator of civil protection based on the nature of the event and is responsible for "overseeing coordination of the activities of organisations present in the disaster operations perimeter."[15]

[15] Taken from the document *Cadre de coordination de site de sinistre au Québec*, Ministère de la Sécurité publique, 2008.

Three COUSs were set up during the 2017 floods in the boroughs of Pierrefonds-Roxboro, L'Île-Bizard–Sainte-Geneviève and Ahuntsic-Cartierville. Members of Montréal's fire department (SIM), police department (SPVM) and the Canadian Armed Forces (CAF) were present to oversee the coordination of necessary activities in the field, such as dyke construction and emergency responses among the public.

During the response, it was observed that the presence in the COUSs of additional responders—and particularly representatives of the public works departments of the boroughs and coextensive municipalities and of as well as Urgences-santé (Emergency Health Services)—would have facilitated tighter coordination of field activities. Public works representatives of the boroughs and coextensive municipalities are an important asset for the COUS, because of their knowledge of the land and protective measures implemented before the emergency measures.

The 2017 floods demonstrated the importance of the role the COUS can assume in a disaster and it would be appropriate to maintain this practice by consolidating the COUS's planning and preparations, while providing such training to responders.

Recommendations

14. Task the DSCR, in conjunction with the OSCAM partners concerned (SIM, US, SPVM, public works), with assessing with the possibility of assigning the coordination of the COUS to a representative of a borough or coextensive municipality (director of public works) during a flood because of such officials' knowledge of the land and their responsibilities for managing dykes and sand bags.

15. Task the DSCR, in updating the flood-response plan (PPI — Inondations) with identifying, in conjunction with the coextensive municipalities and boroughs concerned, sites suitable for setting up a COUS.

16. Task the DSCR and SIM, in conjunction with the OSCAM partners concerned (Urgences-santé, SPVM and public works representatives), with revising the COUS's coordination and management structure, as well as coordination needs and training content for the disaster site to incorporate the training schedule for first responders who may perform such functions.

6.1.3 COUA/COUV

Borough managers and city managers of the coextensive municipalities are responsible for overseeing the implementation and execution of local plans from COUAs and COUVs (Borough/City Emergency Operations Centres). They must oversee the delivery of services falling under their four local missions. For this reason, each of the affected boroughs and coextensive municipalities opened a centre during the floods.

6.1.4 Provincial and Federal Government Support

As of May 7, 2017, between 250 and 300 service personnel were deployed in the Montréal agglomeration in response to a support request from municipal officials. An ORSC and a CAF liaison officer were present at the CCMU until May 19.

The Ministère de la Sécurité publique (MSP) coordinated requests for assistance to the CAF from regional (ORSC) and provincial (OSCQ) civil protection organisations.

The CAF intervened in Montréal to build, reinforce and remove dykes, install sand bags to protect certain critical infrastructure and provide support in cleaning up L'île-Bizard–Sainte-Geneviève borough.

All requests for support to the CAF had to be explicitly detailed, prioritised and submitted to the MSP, which forwarded them for approval from the appropriate authorities. The task approval process was rigid and included a substantial turnaround time for the necessary approvals. Responders from the boroughs, coextensive municipalities and emergency services would have preferred a more flexible procedure, especially in the field where obtaining ad hoc assistance from the CAF would have improved efficiency.

Recommendation

17. Task the DSCR with assessing, in conjunction with the MSP, the possibility of establishing a faster and more flexible process for requesting and approving support from the different levels of government (mobilisation of the Canadian Armed Forces, public meetings, etc.).

6.2 Protecting Residents, their Property and Infrastructure

6.2.1 Coverage of Flooded Sectors by Emergency Services

Throughout the emergency measures, the emergency services (SPVM, SIM and US—police, fire, emergency health) maintained coverage for the entire agglomeration, despite longer response times in certain flooded areas. Closure of the Pont de Île Mercier in L'Île-Bizard–Sainte-Geneviève borough required the use of boats and amphibious vehicles to access this flooded sector.

The scale of the flooding highlighted certain constraints to an effective response by emergency services. This is because the equipment used in the course of their normal activities was not always suitable for flood conditions. For example, it soon became impossible to drive SPVM and US (police and emergency health) vehicles in certain sectors because they sat too low with respect to the water level. This meant police and emergency services could not provide adequate coverage in some sectors. It was also quickly noted that onsite responders needed high boots and waterproof pants.

These constraints also demonstrate the need to consider limits that emergency services should place on responding in order to ensure the safety of their personnel, and on ways other services could assist them (using first responders rather than sending ambulance workers in an unsuitable vehicle).

Recommendation

18. Task the emergency services (SIM, SPVM and US) with reviewing the scope of their future responses and prehospital care during floods and identify opportunities for improvement, such as the possibility of formulating mutual assistance and support protocols.

6.2.2 Logistical Support

The Service de l'approvisionnement (procurement department) was responsible for ordering some 400,000 sand bags and other equipment needed to ensure an effective response, including boots, waterproof pants, pumps, vehicles, signage equipment, etc. The Service du materiel roulant (automotive equipment department) also contributed available municipal equipment.

The exceptional situation of 2017 illustrates the importance of rapidly mobilising logistical support.

Recommendation

19. Accelerate mobilisation of the logistical support mission and all of its activities, in view its importance during flooding events.

As mentioned in the Request Management section (6.1.1), management of equipment orders is occasionally complicated. Substantial quantities of goods were ordered by different response organisations, but it was not always possible to track requests or equipment during delivery or following the emergency measures.

Some problems were also encountered when specific equipment was needed outside suppliers' working hours.

Following the floods, it is now possible to draw up a list of prospective suppliers of each type of equipment that could be used in future disasters. It would also be useful to produce an inventory of equipment and materials available from the city, so they can be quickly mobilised if needed.

Recommendations

20. Task the logistical support mission, in conjunction with the DSCR, with completing the list of required equipment and enhancing the list of prospective suppliers when revising the flood-response plan (PPI — Inondations).

21. Task the logistical support mission officer with establishing a stock management strategy to ensure that requests, equipment and deliveries can be tracked.

6.2.3 Dykes

The boroughs and coextensive municipalities, fire department (SIM) and armed forces (CAF) installed nearly 8 km of dykes in flooded areas to protect certain sectors and prevent flooding of homes and critical infrastructure. In hindsight, much effort was devoted to the construction and reinforcement of various dykes that were unable to withstand the water level. Lessons must be learned from the spring 2017 response to ensure effective intervention should a similar flood occur, by employing and systematic and predictable approach to dyke construction.

Recommendation

22. Task the DSCR, when updating the PPI, with developing, in conjunction with the affected boroughs and coextensive municipalities, a temporary dyke deployment plan in line with water levels, and ensure management of this plan by emergency services and the respective boroughs and coextensive municipalities. At the same time, assess available options and their effectiveness in creating temporary dykes, such as "big bags" to make sand dykes, and the value of maintaining stocks of such materials in case of flooding.

6.2.4 Protecting infrastructure

Various municipal and private infrastructures were threatened by flooding throughout the crisis. Any impact observed in the field was communicated to the CCMU to allow for more informed decision making. It was, however, difficult to determine precise water levels in different areas.

Having a resource in the field to obtain real-time data of water levels, georeference the situation's evolution and provide this information to the CCMU, could improve the response to a future flood. The Division de la géomatique of the Service des infrastructures, de la voirie et des transports (Geomatics Division of Infrastructure, Roads and Transportation) could assist in designing a user-friendly tool for this purpose.

Recommendation

23. Task the Division de la géomatique of the Service des infrastructures, de la voirie et des transports (SIVT) and the DSCR with identifying and assessing means of mapping flood zones in real time or on a daily basis.

Many entities outside OSCAM, such as Bell Canada, Gaz Métro and Hydro-Québec, devoted significant effort during the flooding to protecting their infrastructure. Damage to this essential infrastructure could have a significant impact on services which these companies offer. This situation highlights an incomplete understanding of the vulnerability of such infrastructure. It will be important, in the future, to understand, anticipate and incorporate potential problems with these networks in evaluating impacts.

Recommendation

24. Task the DSCR, in conjunction with the essential infrastructure mission, with setting up an essential infrastructure and network committee that will: 1. Develop and share, over the long-term, expertise in essential infrastructure with Montréal network managers, researchers and public officials, to enhance the preparedness of these networks. 2. Ensure a communications link with OSCAM during emergency measures.

6.2.5 Flooded Homes and Evacuations

320 homes were evacuated in flooded areas during the worst of the disaster. Some shops and public buildings, such as Sacré-Coeur Hospital's Pavillon Albert-Prévost, which accommodates 86 severely disabled residents, were also evacuated. The coordinator of civil protection, along with representatives of the health mission, requested the Pavillion be evacuated before it, and roads to it, became flooded in the case of dyke failure. The day after the evacuation, the water overflowed the dyke and flooded the Pavillon and all its access roads. Evacuation of this building was an excellent example of good decision-making by the CCMU team. Proper planning of the evacuation and relocation of residents by the health mission, emergency services and the transport of people mission made this delicate operation a success.

Most of those evacuated were taken in by friends or family, while those with no other options were accommodated by the boroughs or coextensive municipalities. Temporary housing was available depending on the sector or the vulnerability of the victim. Several elderly or disabled people were referred to healthcare institutions, while others used an emergency shelter run by L'Île-Bizard–Sainte-Geneviève borough. Others went to multiservice assistance centres, which then referred them to commercial lodging. A total of some 1,100 people throughout the Montréal agglomeration were displaced by the flooding.

Several evacuations were ordered based on the inspections and subsequent recommendations of fire department crews. However, the fact that many residents left their homes without the assistance of

emergency services made it more difficult to track and count the displaced. Furthermore, since residents could return whenever they liked, it was difficult or impossible to determine in real time which residences were evacuated and which were occupied.

Order to Evacuate Île Mercier

With the only bridge to Île Mercier closed, substantial increases in water level forecasted over subsequent days and lack of access to the island by emergency services, an evacuation order was issued on May 5 for this sector of L'Île—Bizard–Sainte-Geneviève borough. Many residents refused to comply with the order and remained at home.

Lack of access to the island posed a major obstacle in responding to potential police and medical emergencies or fires. This issued was partially resolved by creating a 24/7 land and water watch by Montréal police and firefighters, ensuring an emergency response in calls for first responders, theft, vandalism and fire. The coordinator of civil protection and the Service des affaires juridiques (legal services department) established a legal procedure assigning responsibilities to residents and protecting the city from lawsuits. At that point, the coordinator of civil protection authorised those residents who wished to remain on the island. The risk to these residents was at that point limited to the difficulty of evacuating, as was the case with other flooded and inaccessible sectors.

It would, in light of the problems enforcing the evacuation order and risks to responder safety, be useful to clarify the scope of the response desired by responders in the field, to avoid any lack of clarity should a similar situation recur.

Recommendation

25. Task the emergency services (SIM, SPVM and US—fire, police and health emergency) with clarifying, in conjunction with the Service des affaires juridiques (legal services department), the scope of their responsibilities and emergency responses (procedures) within the perimeter of a sector covered by an evacuation order given by the coordinator of civil protection. In particular, clarify enforcement responsibilities in the case of residents who refuse to leave their homes.

Cutting Power

In addition to problems with the evacuation order, there was some confusion over who was responsible for cutting power to a home following an evacuation. It should be determined if Hydro-Québec, the fire department or public works is responsible for this task.

Flooded Homes

The fire department counted the number of homes with protection (pumps, sand bags), the number of flooded homes and the number of evacuated homes during its preventive field inspections. The fire department was able to give figures on the buildings it had seen, but since it did not visit all buildings, obtaining a clear picture of the situation is difficult.

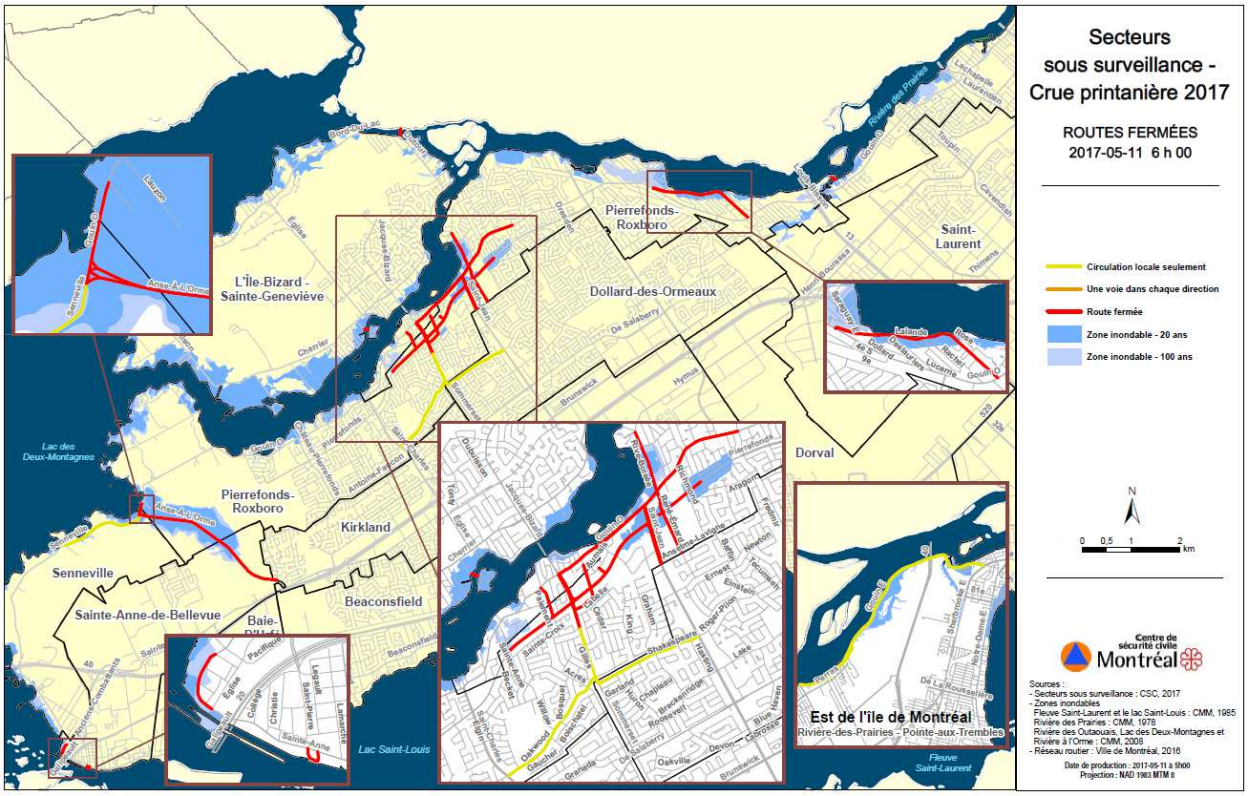
Recommendation

26. Task SIM (fire department), in conjunction with the stakeholders concerned, with updating the flood-response plan (PPI — Inondations; see Recommendation 8) and establishing a standard procedure and developing related tools for the emergency services, to determine the status and obtain a count of flooded homes, along with the number of people evacuated. This procedure and these tools should provide an accurate and evolving view of the situation during the RESPONSE and RECOVERY phases.

6.2.6 Traffic Management

A number of streets, bridges, overpasses and tunnels were closed throughout the flooding, whether due to uncertainty about a structure's integrity or because of the quantity of water. Streets were sometimes

shut by boroughs and coextensive municipalities, sometimes by the police and sometimes at the request of the essential infrastructure mission through the CGMU (Centre de gestion de la mobilité urbaine—urban mobility management centre).



Because of the many parties involved and the challenges facing each of them, aligning the closure of roads, bridges and overpasses, installing signage and disseminating information to the public was complicated throughout the flood event. Much verification was needed to follow up on, and obtain accurate information about, streets that were completely or partially closed to traffic as well as the reason for their status.. Furthermore, municipal equipment used in usual street closures and detours was quickly depleted.

Recommendation

27. Task the DSCR, in conjunction with the stakeholders in questions, with reviewing the emergency measures street closure/reopening procedure to meet the needs of all responders, including public works, the CGMU, communications, the SPVM (police) and the CCMU.

6.3 Assistance to Flood Victims

6.3.1 Emergency Shelter and Multiservice Assistance Centres

An emergency shelter (CHU—centre d'hébergement d'urgence) provides dormitory-style accommodation for those evacuated in a disaster that meets the immediate needs of displaced persons. A multi-service assistance centre (CAM—Centre d'aide multiservices), on the other hand, provides a range of services other than lodging to disaster victims.

CHUs and CAMs are run by a borough or coextensive municipality and host a variety of activities, including providing information on the disaster and assistance in obtaining lodging, food, clothing, personal care items and psychosocial services. All such services are offered primarily during the emergency's RESPONSE phase.

L'Île-Bizard–Sainte-Geneviève was the only borough to open a CHU during flooding. The boroughs of Ahuntsic-Cartierville and Pierrefonds-Roxboro, as well as Ville de Sainte-Anne-de-Bellevue, however, opened a multi-service assistance centre (CAM—Centre d'aide multiservices) and residents were sent from there to commercial lodging (hotels). On October 30, 2017, 65 families were still in hotels.[16]

The 2017 floods demonstrate that the boroughs and coextensive municipalities should pursue their efforts to enhance their preparations for providing support to disaster victims.

6.3.2 Data Compilation

As with the number of homes evacuated, there was difficulty in tabulating the number of people displaced throughout the agglomeration because many residents left their homes voluntarily, without notifying their local responders or emergency services. This made it impossible to keep all affected citizens well informed.

Recommendation

28. Task the DSCR, in conjunction with representatives of the flood victim assistance mission of the boroughs and coextensive municipalities, with standardising a process for accounting for displaced persons and monitoring their situations.

6.4 Communication

6.4.1 With the Media and Public

Communication with the public and victims is essential in all emergencies. Last year's floods were no exception.

OSCAM communicates with disaster victims through traditional and Web media, as well as in person at CAMs/CHUs, and during response team field inspections. During the worst flooding, daily news briefings with the civil protection coordinator provided information to the media.

Coordinating all of the messages disseminated on various platforms was complicated, largely due to the situation's rapid evolution, the varied sources of information and the message approval process. During the disaster, publication on different platforms of various interactive maps showing street closures revealed issues of information duplication.

The Service des communications (communications department), on the other hand, adjusted its communication strategy during the event to properly coordinate message dissemination. Nonetheless, it appears necessary to more effectively define requirements for messages from OSCAM's central, local communications and other communication services, so that set procedures can be planned for future response. Communications must also be maintained with the coextensive municipalities.

It bears mention that the 2017 floods served in developing communication tools that may prove helpful in future disasters. Lessons learned should also help in developing new tools to facilitate communications with disaster victims.

[16] Source: Canadian Red Cross—Quebec

Recommendations

29. Task communication mission officials with updating their mission plan to take into account lessons of 2017 on mobilisation and operating procedures.

30. Task communication mission officials, in conjunction with OSCAM's partners, such as local communications, with developing a specific flood communication plan, identifying preferred communication methods and resources to be developed (FAQs, brochure on services for flood victims, guide to returning home, etc.), including all relevant interactive maps, as well as the responsibilities of each partner concerned. Messages encouraging resident preparation for flooding should also be disseminated.

31. Task communications mission officials, in conjunction with the DSCR, with proposing a plan for modernising CCMU communication resources, including a message approval procedure during emergency measures.

6.4.2 With Flood Victims

Flood victims who had questions or special requests for their borough or coextensive municipality during the flooding were told to call 311 or visit the Web portal. They were also told to call 911 for any emergencies.

There were problems calling 311 during the event. On the night of May 7, at the peak of the flooding, 311 was unavailable for nearly 4 hours. Residents then turned to 911 services, which became overwhelmed.

Residents of the coextensive municipalities also had trouble obtaining information from 311 during the event. Under normal circumstances, 311, which is run by the Service de la concertation des arrondissements (borough coordination department) is available to borough residents only, while the Service pour les villes liées (coextensive municipality department) is run by the municipality concerned. During the floods, the service run by the Service de la concertation des arrondissements should have answered calls from anywhere in the Montréal agglomeration, but many residents of the coextensive municipalities remained unable to reach 311.

As for messages about the MSP's financial assistance program, flood victims would have preferred prompter information sessions. People wanted information quickly about what was ongoing and needed to be reassured about next steps.

With respect to communications during recovery, the absence of a list for contacting evacuees personally complicated the task of responders in charge of getting people back home.

Recommendations

32. Task the Service de la concertation des arrondissements, in conjunction with the Service des technologies de l'information (STI), with ensuring redundancy for 311 to prevent service interruptions during emergency measures.

33. Task the Service de concertation des arrondissements with creating a communications tools available to all Montréal agglomeration residents, including those of the coextensive municipalities, during emergencies.

34. Task the DSCR, in conjunction with OSCAM's partners, with planning and standardising an information meeting model for disaster victims, by targeting facilities and required resources, such as (psychosocial) healthcare teams, as well as the MSP, and incorporating it in the flood plan's RECOVERY phase.

6.4.3 At-Risk Persons

Many people considered to be at-risk, because of their age, their limited autonomy or their disability, were affected by the floods. Communication with these individuals was difficult, as it was hard to determine where they were living, how to reach them and what specific information they needed.

Recommendation

35. Task the DSCR, in conjunction with healthcare mission and the Bureau de la resilience (resiliency office), with establishing a strategy for creating a list of people considered to be at-risk, along with communications resources, to give them specific messages and appropriate support during a major disaster.

6.5 Human and Financial Resource Management

6.5.1 Psychological Assistance to Personnel

The magnitude of the response highlighted the importance of psychological support for staff participating in flood mitigation efforts. Many employees worked nonstop, while confronted on a daily basis with the distress of victims. The victims required psychological support, but such support is equally important for Montréal agglomeration staff.

While psychological support was offered to all such workers, many were not able to receive it. In a future disaster of this scope, it will be important to make sure that every worker in the boroughs, coextensive municipalities and central departments has access to help services.

Recommendation

36. Task the administrative support mission with improving the delivery of psychological support and promote access to such services by all employees during an emergency.

6.5.2 Relief/Mutual Assistance/Resource Sharing

The dedication of agglomeration workers throughout the flooding was unequivocal. Some employees and managers worked long hours, many days in a row. At a certain point, it was clear numerous workers were exhausted—particularly in the boroughs and coextensive municipalities, with their limited staffs.

Some boroughs and coextensive municipalities spared by the flooding sent assistance to the affected boroughs and municipalities. This assistance was essential to preserving the physical and mental well being of responders.

The experience of the affected boroughs and coextensive municipalities demonstrates the need to plan for relief and breaks for responders during a disaster, in order to prevent exhaustion.

Recommendation

37. Task the Service des ressources humaines (human resource department) with establishing a workforce relief plan from the start of an incident and develop a draft agreement for the boroughs and coextensive municipalities supporting loans of human and material resources in an emergency. Also, define a mechanism by which the boroughs can lend staff to the coextensive municipalities.

6.5.3 Financial Management

The Services des finances (Finance) created accounting keys during the emergency measures to consolidate all expenditures. All spending for civil protection as defined in the PSCAM (during the STANDBY, ALERT and RESPONSE phases) fell under the authority of the Agglomeration Council and were accordingly paid by the agglomeration. Expenditures during RECOVERY were paid by the municipalities. A variety of concerns were mentioned during the emergency measure about expense sharing by the boroughs and coextensive municipalities.

Recommendation

38. Task the administrative support mission with updating emergency measure expenditure reimbursement tools and procedures.

6.6 Volunteer Services and Assistance from Residents

Offers of donations and volunteer work quickly deluged the CCMU and 311 during flooding. The CCMU then sought assistance from ROHCMUM (Regroupement des organismes communautaires et humanitaires en mesures d'urgence de Montréal—association of Montréal community and humanitarian organisations) to create a structure for handling offers of volunteer assistance, including a phone number to which residents could be referred.

On May 11, ROHCMUM published a donation management information guide for the 2017 floods. Gifts of money would be channelled to the Canadian Red Cross and of materials to the Société de Saint-Vincent de Paul de Montréal and the Salvation Army, while non-perishable foods were accepted by Moisson Montréal.

The generosity of fellow citizens during such situations should be factored in from the start of the event. In this case, guidelines were not defined at the beginning. The condition and special skills of volunteers should also be taken into account, to protect their health and safety.

Recommendation

39. Task the DSCR with developing a strategy for managing needs and offers of donations and volunteer assistance during emergency measures, and include this strategy in information disseminated under the communications plan (see Recommendation 30).

7 Recovery

Recovery is the set of efforts made to ensure a quick return to normal, while maintaining essential community services.[17] It usually requires much flexibility, since these measures should be planned according to the disaster's actual impact, all aspects of which cannot be predicted.[18]

The 2017 flood RECOVERY phase, including restoration of the land and rebuilding of houses, should continue for several months, or even years.

Despite the creation of a committee that planned all recovery activities, some could be improved and included in the PSCAM.

7.1 OSCAM's Role

As part of the feedback process following the floods, the boroughs and coextensive municipalities said they would have liked additional support during RECOVERY. Since the CCMU was closed following the RESPONSE phase, with no coordination meetings or status reports, some boroughs and coextensive municipalities felt they had been left to their own devices.

Recommendation

40. Task the DSCR with promoting, in updating of the PSCAM and flood-response plan (PPI — Inondations) (see Recommendations 7 and 8), a coordination and information-sharing level among responders during the RECOVERY phase.

7.2 Return to Homes/businesses

As soon as the waters began receding, the Montréal agglomeration deployed multidisciplinary teams to inspect homes and facilitate the return of displaced persons. The inspections focused on such issues structural integrity, as well as on electrical and public health hazards.

Over 1,100 homes were inspected by multidisciplinary teams consisting of the fire department's (SIM's) operational measures team, police (SPVM) officers, electricians, representatives of the DRSP (Direction régionale de santé publique—regional public health division) and building inspectors. Many homes were declared total losses.

From the start of the return-home phase, the fire department (SIM) established a comprehensive action plan, including placement of colour codes visible from the street indicating if it was possible to move back into a home, move back only under certain conditions on not habitable. Along the way, it was noted that SIM and public health used different colour codes, creating confusion among flood victims.

Resource availability, particularly for building inspection, was also a major problem during home inspection tours. The number of municipal inspectors available was less than that needed for the number of inspections to be performed. The same situation was present in the MSP for inspection under the disaster victim reimbursement program.

[17] ville.montreal.qc.ca/portal/page?_pageid=7637,82029670&_dad=portal&_schema=PORTAL
[18] www.securitepublique.gouv.qc.ca/fileadmin/Documents/securite_civile/publications/approche_principes/approche_principes_partie_3.pdf

Post-flood recovery activities highlighted the need for inspection crews consisting of specialists in all fields checking a structure, before a resident is allowed to move back home.

Recommendation

41. In updating the flood-response plan (PPI — Inondations) (see Recommendation 8), task the DSCR and SIM, in conjunction with the coextensive municipalities, boroughs and other partners concerned with establishing a home identification, inspection and classification procedure incorporating different issues to be considered before classifying a home as habitable. Provide an app enabling the various responders to complete online assessment forms.

7.3 Equipment Clean-Up and Recovery

7.3.1 Management of Waste and Unused Materials

The cleanup of homes and public spaces generated substantial waste, which was sent to Raylobec and RCI sites. Used and contaminated sand bags were sent to the Complexe environnemental Saint-Michel (Saint-Michel Environmental Complex).

Handling unused sand bags also posed major hurdles once the waters receded. The boroughs, coextensive municipalities and municipal storage facilities were overwhelmed with palettes of unused bags; these were eventually retrieved by a logistical support mission supplier.

Recommendation

42. In updating the PSCAM and flood-response plan (PPI — Inondations) (see Recommendations 7 and 8), clarify responsibilities for waste management and the return of excess provisions distributed during the RECOVERY phase.

7.3.2 Clean-Ups

Clean-ups were conducted in the boroughs of L'Île-Bizard–Sainte-Geneviève and Pierrefonds-Roxboro and in the coextensive municipality of Sainte-Anne-de-Bellevue on May 20 and 27. Residents, volunteers, municipal workers and CAF personnel worked together collecting debris and contaminated sand bags.

More garbage trucks were put into service throughout the cleanup and dumpsters installed in various locations.

Lessons from these clean-ups will serve in improving our planning for this activity.

Recommendation

43. Task the DSCR, in conjunction with its partners, with creating a clean-up guide.

7.4 Post-Flood Reconstruction and Land-Use Planning

Existing planning documents (PMAD, SAD and Plan d'urbanisme) express policies on future development, but such policies are coloured by the existing built environment and the fact that land-use by-laws are not applied retroactively.

7.4.1 Government Order

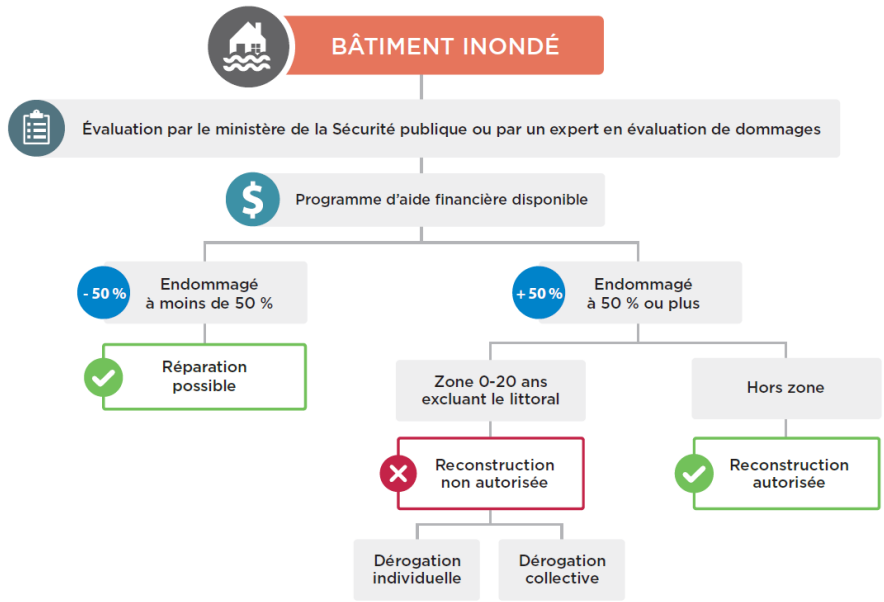
The order pertaining to the declaration of a special intervention zone in certain local municipalities hit by the April and May 2017 floods (*Déclaration d'une zone d'intervention spéciale sur le territoire de certaines municipalités locales affectées par les inondations survenues en avril et en mai 2017)* took effect on July 20, 2017.[19] It focused on reducing the number of people and amount of property exposed to future flooding by applying the *Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Floodplains* (PPRLPI) to municipalities hit by flooding. It also authorised reconstruction[20] of certain buildings under conditions mentioned in the order.

The special intervention zone specified in the order was the high-velocity zone of 0-20 year floodplains and both high- and low-velocity zones of 20-100 year floodplains, as identified in a planning document.[21]

Repairs were authorised for buildings with damage of at least 50% of their new reconstruction cost (excluding Responsible Party immunisation measures under the PPRLPI). Buildings with 50% or more damage in high-velocity zones (0-20 years) could not be rebuilt.

Any major repairs equal to less than 50% of the new construction value and all reconstruction required application of the PPRLPI's immunisation measures.

Diagram—Application of the PPRLPI and Additional Enforcement Mechanisms



Source : MAMOT, 2017

[19] Following the April and May 2017 floods, the Québec government adopted a draft order on June 23, 2017 under sections 158 and 159 of the *Act respecting land use planning and development* (ARLUP). The government held public hearings as stipulated by ARLUP before adopting the order. These hearings took place in all affected areas on July 10. The government subsequently amended the order based on comments made at these meetings.

[20] "Reconstruction means repair work costing less than half (50%) the cost of the cost of new construction. Repairs consist of all other remedial work." (from MAMOT, Guide à l'intention des citoyens et des municipalités – Décret relatif à la déclaration d'une zone d'intervention spéciale sur le territoire de 210 municipalités touchées par les inondations survenues au printemps 2017).

[21] Schéma d'aménagement et de développement, règlement de contrôle intérimaire, ou réglementation d'urbanisme (land-use and development plan, interim control by-law or urban development regulations).

The government order did, however, include a waiver process permitting a local municipality to issue an individual or group waiver permitting rebuilding in a high-velocity zone.

Individual waivers could be applied to a principle residence with a repair cost of 50% to 65% of the building's new value and any other structure or construction, as well as all other work, excluding residential structures and work pertaining to such structures. An expert committee created by MDDELCC reviewed waiver applications based on various criteria specified in article 14 of the order.

A group waiver could apply to reconstruction of a principle residence in a designated zone if conditions set out in the order were met. The group waiver must be accompanied by a flood response plan (PPI — Inondations).

Principle residences eligible for reconstruction under an individual or group waiver must, in addition to the PPRLPI's immunisation measures, also include additional immunisation measures:

- the basement cannot include any habitable rooms, such as a bedroom or living room;
- no major component of mechanical system for the building (electrical, plumbing, heating or ventilation systems) may be installed in the basement, unless this is required by its nature;
- any finish for the basement must be water resistant.

7.4.1.1 Challenges for a Resilient City

Since regulatory authority is distributed throughout the agglomeration of Montréal, the order applied locally to coextensive municipalities to the boroughs. Waiver applications had to be approved, however, by the municipal council.

This approach maintains initial problem of non-uniform application throughout the agglomeration, since the order, which includes concepts set out in the PPRLPI, stipulated that the building must be immunised in the case of major work. It also said that no waiver can be issued for reconstruction of a building housing at-risk persons (healthcare institution, daycare centre or seniors' residence). However, boroughs and coextensive cities are responsible for defining "major work" and "at-risk persons." This means the impact of the order may be greater in a municipality with a stricter definition of major work than another.

The order also stipulated that any group waiver application include a flood-response plan (PPI — Inondations). The Montréal agglomeration's PSCAM already includes a flood-response plan (PPI — Inondations) corresponding with the requirements of the Ministère des Affaires municipales et de l'Occupation du territoire as indicated in the Guide à l'intention des municipalités pour la présentation d'une demande de derogation.[22] All of these affected sectors should be advised that the agglomeration's flood response plan (PPI — Inondations) must accompany such an application.

The order also provided the opportunity to obtain a better picture of the impact, since it required each local municipality that it identified to provide the MAMOT (Ministère des Affaires municipales et de l'Occupation du territoire) with a report, within 60 days of the order's expiration, describing building permits issued, inspections performed and violation of the urban planning by-law mentioned in the order from it came into force and for the special intervention zone.

[22] MAMOT (2017) Guide à l'intention des municipalités pour la présentation d'une demande de dérogation au décret déclarant une zone d'intervention spéciale sur le territoire de certaines municipalités locales affectées par les inondations survenues au printemps 2017, Document PDF, 7 pages. Online at: www.mamot.gouv.qc.ca/fileadmin/publications/ministere/inondations_printanieres_2017/guide_municipalites_demande_de_derogation_au_decret.pdf

The order finally required that a principle residence that must be immunised in a high-velocity zone must comply with immunisation standards set out in the PPRLPI, as well as with three additional standards mentioned in Appendix 2 of the order. Since structures in low-velocity zones also had to be immunised, it would be worth considering the possibility of requiring these three additional immunisation measures for principle residences in low-velocity zones.

Recommendations

44. To promote uniform application of an order issued during a disaster, task the DSCR, in conjunction with the Bureau de la resilience (resiliency office) and partners concerned, with assessing the value of including Land use and development plan of the Montréal agglomeration (SAD) in a definition of major work and of at-risk individuals to provide a proper framework for building reconstruction rules.

45. Task the DSCR with assessing the value of adding three additional immunisation measure provided in the order to the SAD for all new principle residences situated in low-velocity zones (20-100 years) to which the PPRLPI's immunisation measures already apply.

46. Task affected boroughs and coextensive municipalities with giving the DSCR their final statistics (building permits issued, inspections performed and violations of the urban development regulation set out in the order), as part of the accountability process mentioned in the order.

8 Conclusion

The recommendations in this report aim first and foremast at improving the Montréal agglomeration's overall preparedness and resiliency with respect to floods.

Various adjustments can be made to our various procedures during PREVENTION, PREPARATION, RESPONSE and RECOVERY modes to facilitate management of future emergency measures on the scale of the 2017 flooding.

The floods of 2017 confirmed the importance of resident preparation to disaster mitigation. Before another emergency, we must continue our public awareness efforts so that people will be better prepared to deal with a major disaster. Promoting the 72-hour kit is one example of this effort.

Despite the many lessons learned from these events, it is clear that all municipal stakeholders and OSCAM's partners possess the resources and skills needed to respond to a major disaster and do so as quickly as possible. It is now up to the Montréal agglomeration to prepare adequately for the next disaster and draw lessons from the 2017 floods in making the right decisions to prevent or reduce any impact on residents.

However, the reoccurrence of such events and their magnitude requires multiagency planning, a responsibility that involves more than the response by emergency workers.

Concepts of risk and resilience should be an integral part of the planning process to mitigate the impact of adverse weather.

The Montréal fire department (SIM) and the DSCR must be properly positioned to enforce these considerations and stakeholders (particularly those engaged in economic development, the environment and urban planning) should play an integral role in this discussion.

9 Summary of Recommendations

To ensure better strategic planning for flooding, we recommend:

Recommendations	Responsible Party	Deliverables	Time Frame
1. Finalise Montréal's hazard maps, incorporating knowledge acquired from the 2017 floods and determine the value of including these maps in the Schéma d'aménagement et développement (SAD—Land Use and Development Plan). Then, contribute to the formulation of a technique for identifying the Montréal archipelago's flooding zones. In particular, we recommend the following measures:			
a) Task the Division de la géomatique of the Direction des infrastructures, which is part of the Service des infrastructures, de la voirie et des transports) (SIVT), in conjunction with the Service de mise en valeur du territoire (SMVT), with completing hazard maps based on the 2006 CEHQ report, while integrating knowledge acquired from the 2017 floods.	Division de la géomatique	a) Mapping 2006 CEHQ benchmark levels, incorporating information acquired in 2017	Late 2018
b) Task the Direction de l'urbanisme of the Service de mise en valeur du territoire) (SMVT) with assessing the value of incorporating maps produced by the Division de la géomatique of the Direction des infrastructures, which is part of the Service des infrastructures, de la voirie et des transports) (SIVT) in the SDD (Schéma d'aménagement et développement—Land Use and Development Plan).	Direction de l'urbanisme	b) Opinion Assessment of the value of including maps in the SAD	Late 2018
c) Task the Direction de l'urbanisme of the Service de mise en valeur du territoire (SMVT) with working conjunction with the CMM to develop a uniform technique for identifying flood zones throughout the archipelago.	Direction de l'urbanisme	c) Common method of identifying the Montréal archipelago's flood zones	Early 2019

Recommendations	Responsible Party	Deliverables	Time Frame
2. Task the DSCR, with the support of the Division de la géomatique of the Direction des infrastructures, which is part of the Service des infrastructures, de la voirie et des transports (SIVT), with developing a risk map based on catchment evolution and uncertainty due to climate change, to predict the impact on vulnerable areas of the agglomeration and identify adaptation options.	DSCR Division de la géomatique	Up-to-date sector risk/vulnerability map	Late 2018
3. Task the Direction de l'urbanisme du Service de la mise en valeur du territoire, in conjunction with the DSCR and all other applicable Montréal corporate departments with defining a floodplain management policy and formulating long-term solutions reflecting existing risks, covering such issues as acquiring land in floodplains, protecting more aquatic environments, defining measures for minimising surface sealing in catchments, etc.	Direction de l'urbanisme DSCR	Action plan identifying long-term land-use solutions that take flood risk into account.	2019-03-01
4. Task the DSCR and the Bureau de la résilience, in conjunction with the Service des infrastructures, de la voirie, et des transports (SIVT), the Service du développement économique (SDÉ), the Service de l'eau, the Service de l'environnement, the Service de la mise en valeur du territoire (SMVT) and all other relevant municipal corporate departments, with planning resilient techniques, standards and construction, along with green infrastructure.	DSCR Bureau de la résilience SMVT SIVT SDÉ Service de l'eau Service de l'environnement	Propose a distinct Montréal method for planning techniques, standards and regulations for resilient construction and green infrastructure.	2019-03-01
5. Task the DSCR and the Bureau de la résilience, in conjunction with the Service du développement économique (SDÉ) with planning a post-disaster recovery phase for commercial activities and places of business.	DSCR Bureau de la résilience SDÉ	Presentation of a post-disaster recovery planning procedure for businesses and business locations.	2019-03-01
24. Task the DSCR, in conjunction with the essential infrastructure mission, with setting up an essential infrastructure and network committee that will: 1. Develop and share, over the long-term, expertise in essential infrastructure with Montréal network managers, researchers and public officials, to enhance the preparedness of these networks. 2. Ensure a communications link with OSCAM during emergency measures.	DSCR Essential infrastructure mission	Creation of an essential networks and infrastructure committee.	2018-03-01

40. Task the DSCR with promoting, in updating of the PSCAM and flood-response plan (PPI — Inondations) (see Recommendations 7 and 8), a coordination and information-sharing level among responders during the RECOVERY phase.	DSCR	Updating the PSCAM	2018-03-01
44. To promote uniform application of an order issued during a disaster, task the DSCR, in conjunction with the Bureau de la resilience (resiliency office) and partners concerned, with assessing the value of including Land use and development plan of the Montréal agglomeration (SAD) in a definition of major work and of at-risk individuals to provide a proper framework for building reconstruction rules.	Direction de l'urbanisme DSCR Bureau de la résilience	Opinion on incorporating definitions in the SAD.	Late 2018
45. Task the DSCR with assessing the value of adding three additional immunisation measure provided in the order to the SAD for all new principle residences situated in low-velocity zones (20-100 years) to which the PPRLPI's immunisation measures already apply.	Direction de l'urbanisme	Technical opinion and recommendation on adding the three immunisation measures set out in the order to the SAD.	Late 2018
46. Task affected boroughs and coextensive municipalities with giving the DSCR their final statistics (building permits issued, inspections performed and violations of the urban development regulation set out in the order), as part of the accountability process mentioned in the order.	Boroughs and coextensive municipalities	Transmission of final statistics to the DSCR as part of the accountability process set out in the government order	Late 2017

To improve operational planning for future floods, we recommend:

Recommendations	Responsible Party	Deliverables	Time Frame
10. Task the DSCR, in conjunction with the various bodies concerned (Ministère de la Sécurité publique—MSP, MDDELCC, Environment Canada, etc.), with updating water flow and level forecasting procedures and mechanisms, to improve short-, mean- and long-term decision-making.	DSCR	Updated communication procedures between the different partners in question.	Late 2018
15. Task the DSCR, in updating the flood-response plan (PPI — Inondations) with identifying, in conjunction with the coextensive municipalities and boroughs concerned, sites suitable for setting up a COUS.	DSCR	Selection of facilities for setting up a COUS in at-risk boroughs and coextensive municipalities.	Late 2018
18. Task the emergency services (SIM, SPVM and US) with reviewing the scope of their future responses and prehospital care during floods and identify opportunities for improvement, such as the possibility of formulating mutual assistance and support protocols.	SIM SPVM US	Recommendations for improving mutual assistance and support agreements among emergency services, particularly with respect to prehospital care.	Late 2018
20. Task the logistical support mission, in conjunction with the DSCR, with completing the list of required equipment and enhancing the list of prospective suppliers when revising the flood-response plan (PPI — Inondations).	Logistical support mission director DSCR	Creation of a list of required flood equipment.	Late 2018
22. Task the DSCR, when updating the PPI, with developing, in conjunction with the affected boroughs and coextensive municipalities, a temporary dyke deployment plan in line with water levels, and ensure management of this plan by emergency services and the respective boroughs and coextensive municipalities. At the same time, assess available options and their effectiveness in creating temporary dykes, such as “big bags” to make sand dykes, and the value of maintaining stocks of such materials in case of flooding.	DSCR Boroughs AND coextensive municipalities	Plan for erecting temporary dykes.	2019-03-01

23. Task the Division de la géomatique of the Service des infrastructures, de la voirie et des transports (SIVT) and the DSCR with identifying and assessing means of mapping flood zones in real time or on a daily basis.	STI DSCR Division de la géomatique	Identification of resources for mapping floods in real time.	2019-03-01
25. Task the emergency services (SIM, SPVM and US—fire, police and health emergency) with clarifying, in conjunction with the Service des affaires juridiques (legal services department), the scope of their responsibilities and emergency responses (procedures) within the perimeter of a sector covered by an evacuation order given by the coordinator of civil protection. In particular, clarify enforcement responsibilities in the case of residents who refuse to leave their homes.	SIM SPVM US	Legal opinion defining the scope of responsibilities and emergency responded (procedures) within a sector under an evacuation order.	Late 2018
28. Task the DSCR, in conjunction with representatives of the flood victim assistance mission of the boroughs and coextensive municipalities, with standardising a process for accounting for displaced persons and monitoring their situations.	DSCR OSCAM's partners	Tool for counting disaster victims.	Late 2018
41. In updating the flood-response plan (PPI — Inondations) (see Recommendation 8), task the DSCR and SIM, in conjunction with the coextensive municipalities, boroughs and other partners concerned with establishing a home identification, inspection and classification procedure incorporating different issues to be considered before classifying a home as habitable. Provide an app enabling the various responders to complete online assessment forms.	DSCR SIM	Inspection procedure for the displaced persons returning home.	Late 2018
42. In updating the PSCAM and flood-response plan (PPI — Inondations) (see Recommendations 7 and 8), clarify responsibilities for waste management and the return of excess provisions distributed during the RECOVERY phase.	DSCR Environment and logistical support mission officials	Updated roles, responsibilities and support tools under the PSCAM and PPI. Surplus sand bag management plan.	Late 2018

43. Task the DSCR, in conjunction with its partners, with creating a clean-up guide.	DSCR	Clean-up guide.	Late 2019

To improve and upgrade our various plans and tools, we recommend:

Recommendations	Responsible Party	Deliverables	Time Frame
7. Task the DSCR and SIM, in conjunction with OSCAM's partners, with updating and modifying the PSCAM based on the lessons of 2017 and past Plan activations. These changes should include updating alert and mobilisation levels to include a recovery phase, accompanied by clarified roles and responsibilities.	DSCR OSCAM's partners	Updated PSCAM.	Late 2018
8. Task the DSCR, in conjunction with OSCAM's partners, with modifying and improving the flood-response plan (PPI — Inondations) based on recent lessons learned. This change should include updating indicators, clarifying roles and responsibilities, enhancing support tools and developing a specific RECOVERY phase section.	DSCR OSCAM's partners	Updated and improved flood-response plan (PPI — Inondations).	Late 2019
9. Task the DSCR, following modification of the flood-response plan (PPI — Inondations) with developing and deploying a training and exercise plan for all responders concerned, including changes to the flood response plan and to the roles and responsibilities of the different missions.	DSCR	Training and exercise plan.	Late 2018 Ongoing
11. Task the DSCR with implementing the EMS quickly and updating the status report production process using mission, borough and coextensive municipality status reports.	DSCR	Deployment of EMS.	Late 2017
12. Task the DSCR with updating the emergency measures request management process by systematising the procedure and making requests trackable.	DSCR	Updated request management procedure for emergencies.	Late 2018

13. Task the DSCR with developing a CCMU modernisation plan, including: **a)** A review and update of CCMU technological resources. **b)** The creation of working infrastructure permitting external responders, such as the CAF, to work effectively, accompanied by necessary required to enable responders, who have been mobilised for several days, to rest.	DSCR	Add a workstation for outside responders CCMU modernisation plan.	Late 2018
21. Task the logistical support mission officer with establishing a stock management strategy to ensure that requests, equipment and deliveries can be tracked.	Logistical support mission official	Establishment of a stock management strategy.	Late 2018
26. Task SIM (fire department), in conjunction with the stakeholders concerned, with updating the flood-response plan (PPI — Inondations; see Recommendation 8) and establishing a standard procedure and developing related tools for the emergency services, to determine the status and obtain a count of flooded homes, along with the number of people evacuated. This procedure and these tools should provide an accurate and evolving view of the situation during the RESPONSE and RECOVERY phases.	SIM	Tool for counting damaged homes.	Late 2018
27. Task the DSCR, in conjunction with the stakeholders in questions, with reviewing the emergency measures street closure/reopening procedure to meet the needs of all responders, including public works, the CGMU, communications, the SPVM (police) and the CCMU.	DSCR	Emergency street closure/reopening procedure.	Late 2018

To ensure effective coordination among responders during floods, we recommend:

Recommendations	Responsible Party	Deliverables	Time Frame
14. Task the DSCR, in conjunction with the OSCAM partners concerned (SIM, US, SPVM, public works), with assessing with the possibility of assigning the coordination of the COUS to a representative of a borough or coextensive municipality (director of public works) during a flood because of such officials' knowledge of the land and their responsibilities for managing dykes and sand bags.	DSCR SIM US SPVM Public works	Establishment of a responder training program.	Late 2019 Ongoing
16. Task the DSCR and SIM, in conjunction with the OSCAM partners concerned (Urgences-santé, SPVM and public works representatives), with revising the COUS's coordination and management structure, as well as coordination needs and training content for the disaster site to incorporate the training schedule for first responders who may perform such functions.	DSCR SIM SPVM US Public works	Updated COUS training requirements. Present a training plan.	Late 2018
17. Task the DSCR with assessing, in conjunction with the MSP, the possibility of establishing a faster and more flexible process for requesting and approving support from the different levels of government (mobilisation of the Canadian Armed Forces, public meetings, etc.).	DSCR	Updated MSP request approval plan.	Late 2018
19. Accelerate mobilisation of the logistical support mission and all of its activities, in view its importance during flooding events.	DSCR	Rapid mobilisation of the logistical support mission.	Immediately
38. Task the administrative support mission with updating emergency measure expenditure reimbursement tools and procedures.	Administrative support mission	Updated emergency expense management and accounting tools.	Late 2018

To ensure better communication with the public, victims and media, we recommend:

Recommendations	Responsible Party	Deliverables	Time Frame
29. Task communication mission officials with updating their mission plan to take into account lessons of 2017 on mobilisation and operating procedures.	Communications mission	Updated mission plan.	Late 2018
30. Task communication mission officials, in conjunction with OSCAM's partners, such as local communications, with developing a specific flood communication plan, identifying preferred communication methods and resources to be developed (FAQs, brochure on services for flood victims, guide to returning home, etc.), including all relevant interactive maps, as well as the responsibilities of each partner concerned. Messages encouraging resident preparation for flooding should also be disseminated.	Communications mission OSCAM partners	Updated flood-response plan (PPI — Inondations) communications plan.	Late 2018 Annual update
31. Task communications mission officials, in conjunction with the DSCR, with proposing a plan for modernising CCMU communication resources, including a message approval procedure during emergency measures.	Communications mission DSCR	Updated CCMU communication tools.	2018-06-01
32. Task the Service de la concertation des arrondissements, in conjunction with the Service des technologies de l'information (STI), with ensuring redundancy for 311 to prevent service interruptions during emergency measures.	Service de concertation des arrondissements STI	Redundant 311 system.	Late 2018
33. Task the Service de concertation des arrondissements with creating a communications tools available to all Montréal agglomeration residents, including those of the coextensive municipalities, during emergencies.	Service de concertation des arrondissements	Creation of an emergency agglomeration-wide communication tool.	Late 2018

Recommendations	Responsible Party	Deliverables	Time Frame
34. Task the DSCR, in conjunction with OSCAM's partners, with planning and standardising an information meeting model for disaster victims, by targeting facilities and required resources, such as (psychosocial) healthcare teams, as well as the MSP, and incorporating it in the flood plan's RECOVERY phase.	DSCR OSCAM's partners	Definition of a model for disaster information meetings.	Late 2018
35. Task the DSCR, in conjunction with healthcare mission and the Bureau de la resilience (resiliency office), with establishing a strategy for creating a list of people considered to be at-risk, along with communications resources, to give them specific messages and appropriate support during a major disaster.	DSCR Mission Santé Bureau de la résilience	Implementation of a strategy for creating a list of people deemed at risk.	Late 2019
39. Task the DSCR with developing a strategy for managing needs and offers of donations and volunteer assistance during emergency measures, and include this strategy in information disseminated under the communications plan (see Recommendation 30).	DSCR Local communications mission officials Communications mission	Definition of a strategy for managing needs and offers of donations/volunteer services.	Late 2018

To improve support to Montréal agglomeration personnel in a disaster, we recommend the following:

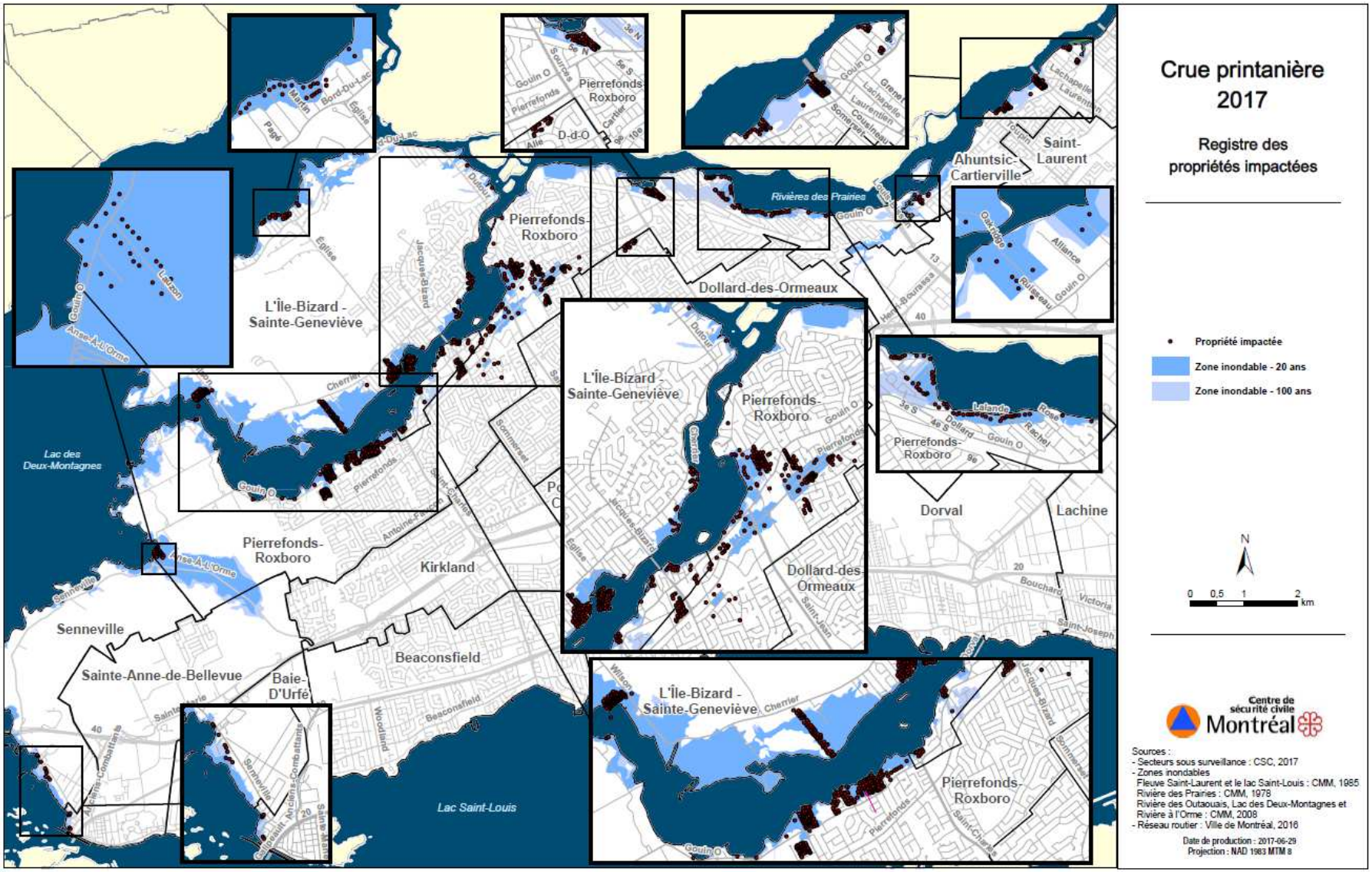
Recommendations	Responsible Party	Deliverables	Time Frame
36. Task the administrative support mission with improving the delivery of psychological support and promote access to such services by all employees during an emergency.	Administrative support mission	Implementation of a strategy for providing improved psychological assistance to personnel in a major disaster.	Late 2018
37. Task the Service des ressources humaines (human resource department) with establishing a workforce relief plan from the start of an incident and develop a draft agreement for the boroughs and coextensive municipalities supporting loans of human and material resources in an emergency. Also, define a mechanism by which the boroughs can lend staff to the coextensive municipalities.	Service des ressources humaines	Draft agreement between the boroughs and coextensive municipalities for loading human and material resources in an emergency.	Late 2018 Implementation: Late 2019

Finally, to ensure the accountability of managers with respect to the preparation of this mission, we recommend:

Recommendation	Mandatory	Deliverable	Time Frame
6. That agglomeration mission directors report on their preparedness to the Direction générale, with this responsibility included in their job description. Ensure that an administrative framework applies to this recommendation.	Direction générale	Add responsibility for planning emergency measures to job descriptions of mission directors.	Late 2018

APPENDICES

Appendix 1


Crue printanière
2017
Registre des
propriétés impactées
Propriété impactée
Zone inondable - 20 ans
Zone inondable - 100 ans
N
0 0,5 1 2
km
Centre de
sécurité civile
Montréal
Sources :
- Secteurs sous surveillance : CSC, 2017
- Zones inondables
Fleuve Saint-Laurent et le lac Saint-Louis : CMM, 1985
Rivière des Prairies : CMM, 1978
Rivière des Outaouais, Lac des Deux-Montagnes et
Rivière à l'Orme : CMM, 2008
- Réseau routier : Ville de Montréal, 2016
Date de production : 2017-06-29
Projection : NAD 1983 MTM 8
Pierrefonds-
Roxboro
L'Île-Bizard -
Sainte-Geneviève
Dollard-des-Ormeaux
Ahuntsic-
Cartierville
Saint-
Laurent
Rivières des Prairies
Lac des
Deux-Montagnes
Kirkland
Senneville
Sainte-Anne-de-Bellevue
Baie-
D'Urfé
Beaconsfield
Lac Saint-Louis
Dorval
Lachine

Appendix 2

Table 3: Maximum Flow Rates and Levels During Spring Freshest and the 2017 Flood

Watercourse	Minor Flooding	Severe Flooding	Mobilisation Indicators for the RESPONSE phase of the flood-response plan (PPI — Inondations)	Maximum Flow Rates and Levels on May 8, 2017
Carillon	5,100 m^3/s	6,800 m^3/s	>5,400 m^3/s	9,000 m^3/s
Rivière des prairies (RDP)	2,550 m^3/s	/	>2,550 m^3/s	3,438 m^3/s
Lac des Deux Montagnes	23.30 m	/	>23.30 m	24.78 m
Lac Saint-Louis	22.10 m	22.48 m	/	22.54 m