CLIMATE CHANGE REPORT SERIES

# Technical Report on the Identification of Flood Isolated Areas in PEI

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# Executive Summary

This technical report provides a spatial analysis of flooding impacts in PEI by identifying three critical categories: flooded buildings, flood-isolated buildings, and flood-isolated areas. Using the datasets from the Government of PEI with flood maps developed in recent studies by CHIP (2023), Dau et al. (2024) and Wang et al. (2025), covering coastal flood as well as historical, current, and future pluvial flood scenarios under various return periods.

Flooded buildings are identified based on the extent of flood, applying a threshold of 50% coverage to classify structures as affected. Flood-isolated buildings, which remain physically dry but lose road access to the facilities due to surrounding floodwaters, are identified using a network analysis approach, specifically the Closest Facility tool in ArcGIS Pro. Fire stations are used as representative emergency service facilities to evaluate accessibility. Flood-isolated areas, which remain physically dry but are surrounded by floodwater, are identified.

The study reveals that due to the rapid expansion of the local community, access to the road system would become complex in PEI, leading to flood occurrences in certain residences. . While these maps for flood-isolated buildings and areas provide a critical indirect flood risk, certain limitations exist, including future climate scenarios, the occasional overlapping of the road with floodwater accumulation areas along the road edges, leading to additional network disconnections. Future efforts should focus on improving the PEI's road network alignment to center on the actual roads.

The flood-isolated maps are also made available for public viewing through the PEI Climate Hazard & Risk Information System (CHRIS; [https://chris.peiclimate.ca](https://chris.peiclimate.ca)). This report also summarizes the main assumptions and provides recommendations and potential improvements for future projects.

# Acknowledgements

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# Disclaimer

This project assesses flooded and flood-isolated buildings and areas using various tools and data from various sources. Although significant efforts have been made to ensure the accuracy, completeness, and timeliness for this assessment, it is important to acknowledge that the this assessment is not guaranteed to be correct or complete or current due to these factors: 1) the data collected from various sources may have different resolutions and levels of accuracy, 2) the modeling methods used always have their limitations in representing the real world.

The maps for flooded and flood-isolated areas in this project are produced to support high-level hazard screening, public awareness, preliminary planning, and preliminary risk assessments. Results are approximate and are not meant to support site-specific property or infrastructure assessments, which would require detailed engineering flood hazard mapping studies. For any site-specific questions or concerns, users are encouraged to consult with a competent professional.

The Climate Smart Lab in the Canadian Centre for Climate Change and Adaptation at the University of Prince Edward Island undertakes NO duty or accepts NO responsibility for any inaccuracies or omissions in the data, nor for any loss or damage directly or indirectly caused to any person or body by reason of, or arising out of, any use of these maps.

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# List of Acronyms

| | |
|---|---|
| CHIP | Coastal Hazards Information Platform |
| CHRIS | Coastal Hazard & Risk Information System |
| DSM | Digital Surface Model |
| FHIMP | Flood Hazard Identification and Mapping Program |
| HEC-RAS | Hydrologic Engineering Center's River Analysis System |
| NRCan | Natural Resources Canada |
| PEI | Prince Edward Island |

# 1. Introduction

Flooding is the most devastating climate-based hazard in Prince Edward Island (PEI). Flooding poses a significant and growing threat to communities across coastal regions, particularly in the context of climate change and rising sea levels. PEI is especially vulnerable due to exposure to the combined effects of sea-level rise, storm surges, heavy precipitation events, and rapid snowmelt (Pang et al., 2024). In recent years, flood events have caused significant disruption to both urban and rural areas, isolating road networks and inundating buildings in flood-prone zones.

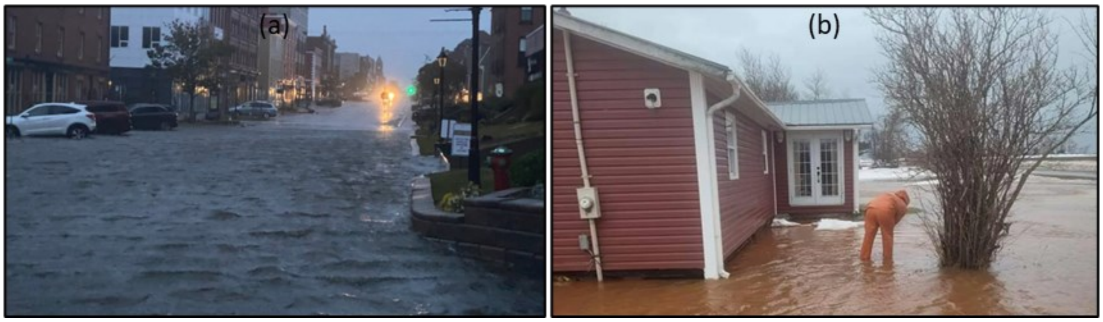


**Figure 1.** Flood impacts in PEI: (a) flooded streets in downtown Charlottetown (Martin Trainor/CBC), and (b) flooded residential building in St. Peters Bay (Juanita Rossiter/PNI Atlantic).

Recent studies by Wang et al. (2025) and Dau et al. (2024) produced flood maps for PEI representing historical events and multiple current and projected scenarios based on return periods (i.e., 10, 25, 50, and 100 years). While these studies provide valuable flood extent data, the impacts of these flood events, such as the damage to residential and commercial structures, isolation of roadways, and disruptions to essential services, are currently unknown across PEI. Moreover, the scattered and decentralized nature of PEI's settlement patterns means that many communities face limited access to emergency services during extreme weather events. Therefore, this technical report focuses on identifying:

- Flooded buildings (buildings which are directly flooded),
- Flood-isolated buildings (buildings that are not directly flooded but are isolated because of the loss of road access)
- Flood-isolated areas (areas that are not directly flooded but are isolated because of the loss of road access)

This report provides technical details on the approaches used to identify the above three categories for all pluvial and coastal flood scenarios. The findings of this study will help both the general public and decision-makers to support emergency response planning, infrastructure risk assessment, and climate adaptation strategies.

# 2. Data Collection

This section outlines the data collected for this study. This study integrates multiple spatial datasets to identify flooded and flood-isolated areas across PEI. The data for wetlands, roads and buildings for the whole of PEI was collated from the Government of PEI's open data portal. Whereas, flood data are sourced from multiple hydrodynamic modelling studies. Scenario-based pluvial flood maps for return periods of 10, 25, 50, and 100 years, under both current and projected future climate conditions, are obtained from Dau et al. (2024). Additionally, event-specific pluvial flood maps for post-tropical storms Fiona and Dorian are obtained from Wang et al. (2025). The flood extent data for coastal flooding scenarios are obtained from the Coastal Hazards Information Platform (CHIP) (CHIP 2023). Tables 1 and 2 provide the list of flood scenarios for pluvial and coastal flood maps, respectively.

**Table 1.** List of scenarios for pluvial flood maps.

| No. | Climate Condition | Return Period/Event |
|---|---|---|
| 1 | Current Climate | 10-yr |
| 2 | | 25-yr |
| 3 | | 50-yr |
| 4 | | 100-yr |
| 5 | Future Climate | 10-yr |
| 6 | | 25-yr |
| 7 | | 50-yr |
| 8 | | 100-yr |
| 9 | Historical | Fiona |
| 10 | | Dorian |

**Table 2.** List of scenarios for coastal flood maps.

| No. | Coastal Flooding Scenario |
|---|---|
| 1 | High Flood Hazard (2020) |
| 2 | Moderate-High Flood Hazard (2050) |
| 3 | Moderate-Low Flood Hazard (2100) |
| 4 | Extreme Flood Scenario |

# 3. Methods

The identification of flood-isolated buildings and areas is critical to support planning an emergency response in PEI. The project team has identified three scenarios related to isolation areas during the flood event, including (1) flooded buildings, (2) flood-isolated buildings, and (3) flood-isolated areas. ArcGIS Pro tool was used to implement the identification process for each category. The detailed steps to identify the buildings/zones for each category are outlined below.

## 3.1 Flooded Buildings

Flooded buildings in this study are considered as a separate category because buildings directly affected by floods often coincide with zones where road access is compromised. Identifying flooded buildings in PEI is essential for effective risk management and climate resilience planning. These buildings represent direct infrastructure damage, often resulting in significant economic loss and community disruption.

Steps to identify the flooded buildings across PEI are described as follows:

**Step 1.** Take the flood maps in raster format and exclude the areas with water depths less than 10 cm, as such depths are not considered significantly flooded. Convert these raster maps into polygon shapefiles;

**Step 2.** A shapefile containing building footprints across PEI, representing a total of 85,835 building structures, is used, and the area for each building is calculated. Additionally, a unique ID is assigned to each building;

**Step 3.** Perform a spatial intersection between building polygons and flooded area polygons from step 1. This will provide the intersected portions of the buildings that overlap with flood maps. Here, note that in some cases, a building is flooded from more than one side. As a result, the spatial intersection process may generate multiple overlapping segments for the same building. Therefore, these intersected segments are dissolved based on the unique ID assigned to each polygon;

**Step 4.** Estimate the area of the intersected portions of each building that overlap with the flooded zones. Using these values, calculate the percentage of each building's total area that is covered by flood by dividing the flooded area by the total building area and multiplying by 100;

**Step 5.** A threshold of ≥50% is applied to consider if the building is flooded. Specifically, if 50% or more of a building's total area is flooded, the building is considered flooded. Therefore, buildings with less than 50% of their area intersecting with flood extents are excluded from the flooded building dataset.

These steps are repeated for each scenario of flood maps to ensure consistent identification of flooded buildings across varying flood conditions. Please note that due to the consideration of Digital Surface Model (DSM) (containing building infrastructure) when exporting the pluvial flood map from the Hydrologic Engineering Center's River Analysis System (HEC-RAS) model, flooded buildings do not appear inundated in the Coastal Hazard & Risk Information System (CHRIS). However, it is important to note that buildings located within the flood zones are still included in this analysis, regardless of whether they appear inundated in the CHRIS. Figure 2 shows an example area used to demonstrate the outcome of this process.


**Figure 2.** An example of identified flooded buildings.

## 3.2 Flood-Isolated Buildings

Flood-isolated buildings are buildings which are not directly flooded but are likely to be isolated due to the loss of access to the main road if the specific flood scenario occurs, despite not being directly submerged. Identifying these buildings is critical for emergency response planning, as residents may be unable to evacuate or receive aid during flood events.

To identify the isolated buildings in case of a flood occurrence, network analysis, specifically Closest Facility in ArcGIS Pro is utilized. Closest Facility is a type of network analysis which is used to find the nearest facility (e.g., hospital, fire station) from one or more incident points using distance or time. As the firefighters are the first response in case of an emergency, the project team used all the fire stations available on the Government of PEI's website as a facility in the analysis (Government-of-PEI, 2025). These fire stations were located using Google Earth Pro and then imported as points using ArcGIS Pro. All the buildings in the PEI (i.e., 85,835) are treated as incident points to check if there is road access from the nearest facility (i.e., fire station) to the incident point (i.e., building). Table 3 provides a list of fire stations throughout PEI. The location of all fire stations across PEI is shown in Figure 3.

**Table 3**. List of fire stations across PEI.

| No. | Name | No. | Name |
|---|---|---|---|
| 1 | Alberton Fire Department | 20 | Murray Harbour Volunteer Fire Department |
| 2 | Belfast Rural Community Fire Company | 21 | Murray River Fire Department |
| 3 | Borden-Carleton Fire Department | 22 | New Glasgow Rural Community Fire Department |
| 4 | Cardigan Fire Department | 23 | New London Fire Department |
| 5 | Central Kings Fire Department | 24 | North River Fire Department |
| 6 | Charlottetown Fire Station#1 | 25 | North Rustico Fire Department |
| 7 | Charlottetown Fire Station#2 | 26 | North Shore Fire Department |
| 8 | Crapaud Fire Department | 27 | O'leary Volunteer Fire Department |
| 9 | Crossroads Fire Department | 28 | Souris Fire Department |
| 10 | East River Fire Company | 29 | St. Peters Fire Department |
| 11 | Eastern Kings Fire Department | 30 | Summerside Fire Department#1 |
| 12 | Georgetown Volunteer Fire Department | 31 | Summerside Fire Station#2 |
| 13 | Kensington Volunteer Fire Department | 32 | Tignish Fire Department |
| 14 | Kinkora Volunteer Fire Department | 33 | Tyne Valley Volunteer Fire Department |
| 15 | Lennox Island Fire Department | 34 | Vernon River Fire Department |
| 16 | Miminegash Volunteer Fire Department | 35 | Victoria Volunteer Fire Department |
| 17 | Miscouche Volunteer Fire Department | 36 | Wellington Fire Department |
| 18 | Montague Volunteer Fire Department | 37 | West Point Volunteer Fire Department |
| 19 | Morell Fire Department | | |

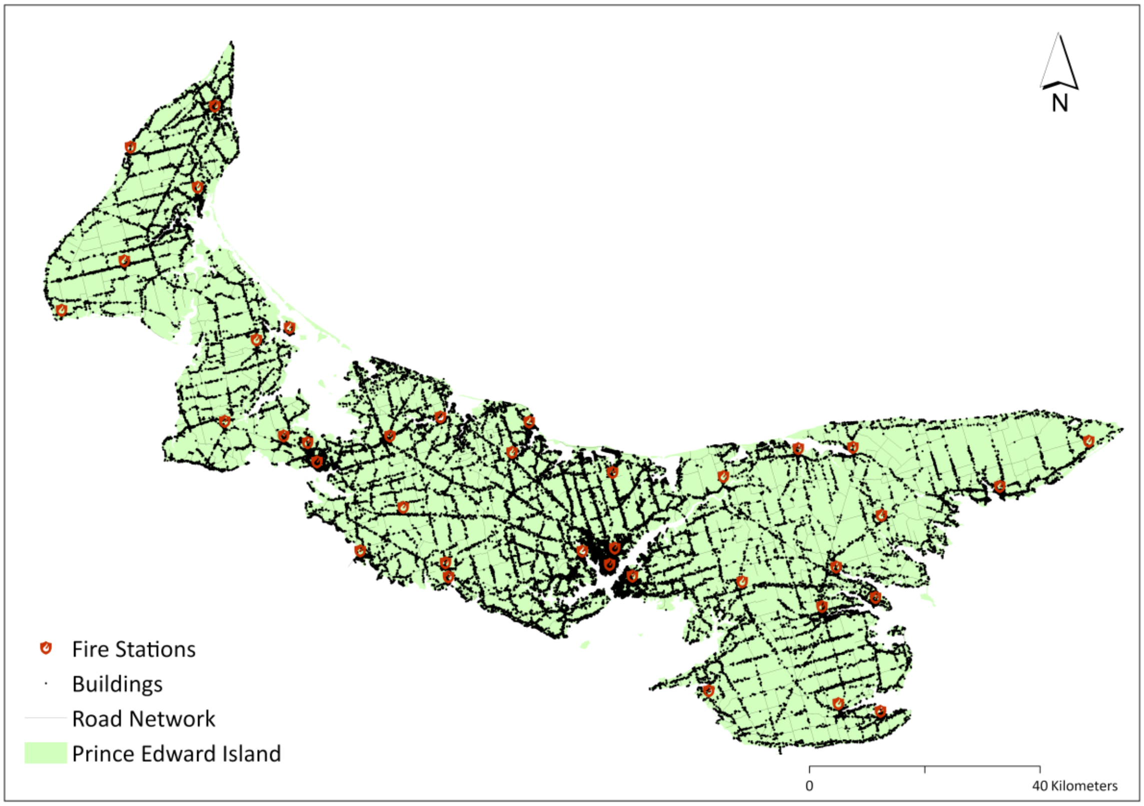


**Figure 3.** Location of all fire stations and buildings across PEI.

Steps to identify the flood-isolated buildings across PEI are described as follows. ArcGIS Pro is used to run this analysis and implement the process to identify the buildings.

**Step 1.** Take the flood maps in raster format and exclude areas with water depths less than 30 cm from the raster flood maps. This threshold of 30 cm is applied, higher than the 10 cm used in the previous section, because this analysis focuses on emergency response scenarios where vehicle access is essential. Water depths below 30 cm are not considered significant barriers for vehicular movement. After applying the threshold, convert the flood maps into polygon shapefiles for further spatial analysis.

**Step 2.** Apply the Extend Line tool to connect disjointed segments within the road network, ensuring topological continuity for accurate network analysis. Once the road network is topologically corrected, overlay it with the flood extent polygons to identify and remove road segments that intersect with flooded areas. This process ensures only accessible roads are retained for analysis. Next, build a network dataset using the modified road network, configuring the travel mode to “Driving” to reflect conditions relevant to emergency vehicle access and routing.

**Step 3.** Assign a unique identifier to each building in the PEI building dataset using a field calculation tool, which will enable us to identify if the particular building has access to the nearest facility.

**Step 4.** Run the Closest Facility analysis using the modified road network dataset. Fire stations are designated as facility locations, while all buildings across PEI serve as incident locations. This analysis determines the shortest accessible route from each building to the nearest fire station. Buildings that have a valid route to a facility are included in the output with generated paths, while those without a viable route due to surrounding flooded road segments are excluded. The analysis identifies and outputs the names or unique IDs of buildings for which no route could be established.

Figure 4 presents an example of the Closest Facility analysis, illustrating the generated routes from buildings with access to the nearest facility, while omitting buildings that have disconnected roads due to flooding.


**Figure 4.** Example showing routes to accessible buildings, excluding those buildings that have disconnected roads due to flooding.

The project team applies the same automated approach for all flood scenarios except for the future climate scenarios for pluvial flooding. The project team noted that in future climate scenarios, increased flood volumes result in accumulating the water in small depressions or percolation zones adjacent to roads. Also, Additionally, it is observed that the road polylines in the road network shapefile are not perfectly aligned with the actual road. As a result, the road polylines occasionally overlap with floodwater accumulation areas along the road edges as shown in Figure 5. Therefore, in Step 2, these small portions of the road network become disconnected when overlapping segments between roads and flood polygons are removed. To address this disconnection issue, the water depth threshold in Step 1 is increased from 30 cm to 50 cm. This adjustment effectively eliminates minor flood polygons adjacent to roads. Figure 6 shows examples of areas where roads occasionally overlap with floodwater accumulation along the edges of the roads.

**Figure 5.** Examples of roads overlapping with water accumulations along the edges of the roads.

## 3.3 Flood-Isolated Areas

To accurately delineate flood-isolated areas across PEI, a spatial analysis approach is developed for flood maps. This approach aims to identify regions that remain unflooded yet become inaccessible due to the surrounding flood. These isolated areas are critical for understanding the broader functional impacts of flooding, particularly where infrastructure and communities may be cut off from emergency services, transportation networks, and essential facilities.

Steps to identify the flood-isolated areas across PEI are described as follows:

**Step 1.** Apply a water depth threshold of 10 cm to exclude areas with shallower flooding from flood maps in raster format, as such depths are not considered significantly flooded. Convert these raster maps into polygon shapefiles, donate this as dataset A;

**Step 2.** From the shapefile for PEI and remove the flooded areas from Dataset A using spatial analysis tools to get the non-flooded regions. A minimum area threshold of 100 m² is applied to remove small, fragmented polygons that are unlikely to contain residential buildings, donate this as dataset B;

**Step 3.** Exclude the wetland shapefile from dataset A, to exclude natural flood-prone zones from analysis, and donate this as dataset C;

**Step 4.** Use the “Select by Location” tool to identify all polygons in Dataset B that are fully enclosed by the flooded polygons in Dataset C. These enclosed, non-flooded polygons are then exported as the final set of flood-isolated areas.

The above steps are then applied to all the pluvial and coastal flood maps to identify the isolated areas across PEI. Figure 6 shows a construction site near East Royalty in the City of Charlottetown for future climate conditions under a 100-year return period.

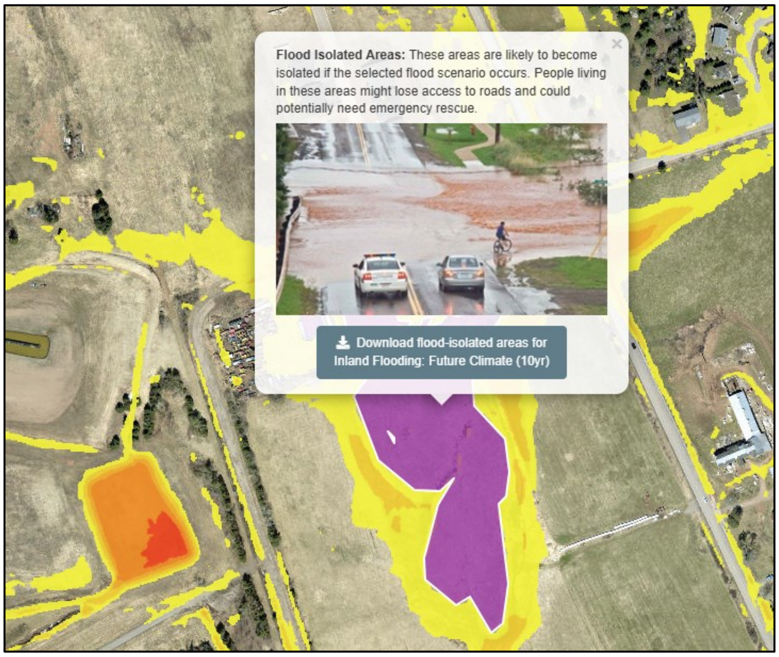


**Figure 6.** An example of isolated areas, a construction site near East Royalty, Charlottetown.

# 5. Summary & Recommendations

This report presents a detailed analysis of flooding impacts across PEI, with a focus on identifying flooded buildings, flood-isolated buildings, and flood-isolated areas under both pluvial and coastal flood scenarios. Using a combination of hydrodynamic model outputs, spatial datasets, and a GIS-based approach, this analysis evaluates not only direct flood exposure to buildings but also functional isolation due to the loss of road access. The analysis is based on the flood data from key studies by Dau et al. (2024) and Wang et al. (2025), as well as publicly available data from the Government of PEI's CHIP platform.

To identify flood-isolated areas and buildings, the team developed methodological frameworks in ArcGIS Pro that leverage spatial intersection, network analysis and set specific rules to make the results more realistic, e.g., a threshold for water depths. Results reveal that many parts of PEI, especially low-lying and spread-out areas, are at high risk during floods.

Despite efforts to develop reliable results, several recommendations should be taken into account:

- It is recommended that the road network dataset be updated and spatially aligned with high-resolution elevation models. This will enhance the accuracy of flood-road intersection analysis and reduce misclassification of accessible routes.
- Adjustments to analysis thresholds, such as increasing the water depth cutoff from 30 cm to 50 cm in specific cases, proved necessary to maintain the integrity of network connectivity for the analysis.

The framework developed in this study is robust and adaptable, allowing for consistent assessment across multiple flood scenarios. It not only supports immediate emergency response planning but also informs long-term infrastructure investment, land-use planning, and climate adaptation policy.

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