2020

Long period return level estimates of extreme precipitation: abstract

Zwiers, Francis

National Research Council Canada

NRC·CNRC

International Workshop on

FLOOD-RESISTANT BUILDINGS

Organizing Committee: A. Attar, Z. Lounis, M. Armstrong and N. Khaliq

National Research Council Canada
Conseil national de recherches Canada

Canada

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International Workshop on

FLOOD-RESISTANT BUILDINGS

Ottawa, Canada
February 26 to 27, 2020

Organizers: A. Attar, Z. Lounis, M. Armstrong and N. Khaliq

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Introduction

International Workshop on FLOOD-RESISTANT BUILDINGS

February 26 to 27, 2020

Ottawa, ON

Canada

The National Research Council Canada (NRC) is leading the Climate-Resilient Buildings and Core Public Infrastructure (CRBCPI) project, with funding from the Federal Government of Canada through Infrastructure Canada. The project will develop decision-support tools, including codes, guides and models, to enhance the resilience of Canada's buildings and core public infrastructure against climate change and extreme weather events, including floods.

The high costs of floods over the last two decades in Canada have resulted in major economic losses and hardships for many communities. There is also an increasing likelihood that the frequency and intensity of future flood events will be impacted by climate change. Therefore, improving the performance of buildings exposed to flooding is an important research and development need that is identified within the CRBCPI project.

As part of the CRBCPI project, the NRC is undertaking, in collaboration with national and international partners, a major effort to develop prescriptive and performance-based requirements for the design of flood-resistant buildings, as well as guidelines for improving the flood resistance of existing buildings. The outcome of this effort will address a gap in the current National Building Code of Canada (NBC), where there are currently no provisions for designing buildings against flood loads.

Considerable progress has already been made, based on the recommendations that came from two international workshops led and organized by the NRC with funding from Infrastructure Canada, in order to develop new decision-support tools, including guides, standards and provisions for building codes, by incorporating the impacts of climate change and extreme weather events, including floods. The January 18 to 19, 2017 International Workshop on Climate Change and Codes Implementation was attended by national and international experts with backgrounds in flood mapping, flood-resistant design, structural engineering, codes and climate science, who identified the knowledge gaps and research needs. Following

this workshop, a second International Workshop on Floods and Climate Change: Codes and Standards Perspective was organized on July 13 to 14, 2017 to identify the needs and to develop guides, standards and codes, for flood-resistant buildings that would significantly reduce the recurring losses from unexpected flood events.

Subsequently, in a combined meeting of the NRC External Advisory Panel for Climatic Data and Loads and the NRC Technical Committee for Flood-Resistant Buildings on July 12 to 13, 2018, progress was made in the development of climatic data and related loads, as well as future planned projects, including the scope of work for generating flood loads data. The proposed work and potential projects were presented and discussed by all attendees, including professionals from federal, provincial, territorial and municipal governments, national and international experts from engineering consulting firms, academia, non-profit organizations, the climate science community, code experts, and code developers.

This two-day International Workshop on Flood-Resistant Buildings is a continuation of the above efforts and is specifically focused on the work that the NRC is undertaking with its partners to develop requirements for flood-resistant buildings.

It will also cover ongoing federal, provincial, territorial and municipal government initiatives on flood mapping and mitigation that are directly or indirectly related to the work on flood-resistant buildings.

This two-day International Workshop on Flood-Resistant Buildings will bring together national and international experts in flood-resistant design and modelling, structural engineering, code development, and climate change science, as well as federal, provincial, territorial and municipal stakeholders and agencies involved in flood mapping and mitigation.

International Workshop on
FLOOD-RESISTANT BUILDINGS

COURTYARD BY MARRIOTT OTTAWA DOWNTOWN

350 Dalhousie Street

Ottawa, ON K1N 7E9

February 26 to 27, 2020

Workshop Program

Day 1: February 26, 2020

8:45–9:00 AM	**Introduction and Opening Remarks** *Ahmed Attar* *National Research Council Canada*
9:00–9:10 AM	**Welcome and Workshop Objectives** *Marianne Armstrong and Zoubir Lounis* *National Research Council Canada*
9:10–9:30 AM	**NRC's Flood-Resistant Buildings Initiative** *Naveed Khaliq and Ahmed Attar* *National Research Council Canada*
9:30–9:45 AM	**Break**
	SESSION 1 - Part 1: Requirements for Flood-Resistant Buildings *Chair, Bruce Ellingwood* *Colorado State University, CO, USA*
9:45–10:15 AM	**Developing Requirements for Flood-Resistant Buildings including Execution Plan and Discussion of Data Needs** *Bill Coulbourne and Kimberly McKenna* *Coulbourne Consulting, MD, USA*

10:15–10:30 AM	**Q&A and Discussion**
10:30–11:00 AM	**Design Flood Conditions and Considerations** *Bill Coulbourne and David Kriebel* *Coulbourne Consulting, MD, USA*
11:00–11:15 AM	**Q&A and Discussion**
11:15–11:45 AM	**Flood Load Formulas and Provisions** *David Kriebel* *Coulbourne Consulting, MD, USA*
11:45–12:00 PM	**Q&A and Discussion**
12:00–1:00 PM	**Lunch**
	SESSION 1 - Part 2: Requirements for Flood-Resistant Buildings *Chair, Zoubir Lounis* *National Research Council Canada*
1:00–1:30 PM	**Performance-Based Design for Flood** *Bill Coulbourne* *Coulbourne Consulting, MD, USA*
1:30–1:45 PM	**Q&A and Discussion**
1:45–2:15 PM	**Improving Flood Resistance for Existing Buildings** *Randall Behm* *Coulbourne Consulting, MD, USA*
2:15–2:30 PM	**Q&A and Discussion**
2:30–3:00 PM	**Flood Standard Related Initiatives and Discussions in the USA** *Bill Brown* *Flood Science Center, WI, USA*
3:00–3:15 PM	**Q&A and Discussion**
3:15–3:30 PM	**Break**
	SESSION 2: Case Studies on Flood Data Generation *Chair, Peter Irwin* *RWDI, ON, Canada*
3:30–3:45 PM	**Analysis and Data Extraction for Flood Load Determination for Selected Case Studies from Alberta and British Columbia** *Dan Healy* *Northwest Hydraulic Consultants Ltd., AB, Canada*

3:45–4:00PM	**Analysis and Data Extraction for Flood Load Determination for Selected Case Studies from Manitoba and Saskatchewan** *Raj Mannem* *Hatch, MB, Canada*
4:00–4:15 PM	**Analysis and Data Extraction for Flood Load Determination for Selected Case Studies from Great Lakes and Arctic coasts** *Derek Williamson and Josh Wiebe* *Baird & Associates, ON, Canada*
4:15–4:30 PM	**Analysis and Data Extraction for Flood Load Determination for Selected Case Studies from Atlantic Provinces** *Vincent Leys* *CBCL, NS, Canada*
4:30–5:00 PM	**Open Discussion**
5:00–5:10 PM	**Closing Remarks and Adjournment** *Zoubir Lounis* *National Research Council Canada*

Day 2: February 27, 2020

	SESSION 3 - Part 1: Federal, Provincial, Territorial and Municipal Initiatives on Flood-Related Issues *Chair, Annick Maletto* *Centre de sécurité civile - Ville de Montréal, QC, Canada*
9:00–9:20 AM	**Standards Used by Conservation Authorities in Ontario for Great Lakes and Riverine Flood Plain and Erosion Management, and How Climate Change May Challenge this Approach** *Mark Peacock* *Lower Thames Conservation Authority, ON, Canada*
9:20–9:40 AM	**Building Flood Resilience in Calgary** *Sandy Davis and Marco Civitarese* *City of Calgary, AB, Canada*
9:40–10:00 AM	**Flood Hazard Management Initiatives in BC** *Jesal Shah* *Ministry of Forests, Lands, Natural Resource Operations, and Rural Development, BC, Canada*
10:00–10:15 AM	**Q&A and Discussion**
10:15–10:30 AM	**Break**

	SESSION 3 - Part 2: Federal, Provincial, Territorial and Municipal Initiatives on Flood-Related Issues *Chair, Marco Civitarese* *City of Calgary, AB, Canada*
10:30–10:50 AM	**An Emergency Response Perspective to What Renders Homes Uninhabitable During Floods** *Annick Maletto* *Centre de Sécurité Civile, QC, Canada*
10:50–11:10 AM	**Newfoundland and Labrador - Provincial Flood Risk Mapping Initiatives** *Amir Ali Khan* *Municipal Affairs and Environment, NL, Canada*
11:10 –11:30 AM	**Flood Mapping Activities, Natural Resources Canada** *Paula McLeod* *Natural Resources Canada*
11:30–12:00 PM	**Q&A and Discussion**
12:00–1:00 PM	**Lunch**
	SESSION 4: Extreme Precipitation *Chair, Laxmi Sushama* *McGill University, QC, Canada*
1:00–1:30 PM	**Long Period Return Level Estimates of Extreme Precipitation** *Francis Zwiers* *Pacific Climate Impacts Consortium, BC, Canada*
1:30–1:45 PM	**Q&A and Discussion**
1:45–2:30 PM	**Summary of Key Issues and Path Forward** *Bruce Ellingwood* *Colorado State University, CO, USA*
2:30–2:45 PM	**Closing Remarks and Adjournment** *Ahmed Attar* *National Research Council Canada*

List of Participants

Name	Institution
Ms. Marianne Armstrong	National Research Council Canada
Dr. Ahmed Attar	National Research Council Canada
Mr. Randall Behm	Behm Hazard Mitigation LLC, NE, USA
Mr. Robin Bourke	Natural Resources Canada
Mr. Bill Brown	Flood Science Center, WI, USA
Mr. David Brown	KGS Group, MB, Canada
Mr. Peter Campbell	Public Services and Procurement Canada
Mr. Marco Civitarese	City of Calgary, AB, Canada
Mr. Bill Coulbourne	Coulbourne Consulting, MD, USA
Ms. Sandy Davis	City of Calgary, AB, Canada
Mr. Stan Dueck	District of Sooke, BC, Canada
Dr. Bruce Ellingwood	Colorado State University, CO, USA
Ms. Laurence Forget-Dionne	Infrastructure Canada
Dr. Jon Galsworthy	Jensen Hughes Consulting Canada Ltd.
Ms. Jamie Gesualdo	Public Safety Canada
Mr. Jim Hanley	ISL Engineering and Land Services, AB, Canada
Ms. Nicky Hastings	Natural Resources Canada
Dr. Dan Healy	Northwest Hydraulic Consultants Ltd., AB, Canada
Ms. Fiona Hill	National Research Council Canada
Dr. Han-Ping Hong	Western University, ON, Canada
Dr. Peter Irwin	RWDI, ON, Canada
Mr. Philip Jarrett	Environment and Climate Change Canada

Mr. Clive Kamichaitis	Public Services and Procurement Canada
Dr. Naveed Khaliq	National Research Council Canada
Dr. Amir Ali Khan	Municipal Affairs and Environment, NL, Canada
Dr. David Kriebel	Coastal Analytics LLC, MD, USA
Mr. Vincent Leys	CBCL Limited, NS, Canada
Dr. Zoubir Lounis	National Research Council Canada
Ms. Annick Maletto	Centre de sécurité civile - Ville de Montréal, QC, Canada
Mr. Raj Mannem	Hatch, MB, Canada
Dr. Ghyslaine McClure	McGill University, QC, Canada
Mr. Glenn McGillivray	Institute for Catastrophic Loss Reduction, ON, Canada
Ms. Kimberly McKenna	Stockton University, NJ, USA
Ms. Paula McLeod	Natural Resources Canada
Ms. Natalia Moudrak	Intact Centre on Climate Adaptation, ON, Canada
Mr. Enda Murphy	National Research Council Canada
Mr. George Nasr	National Research Council Canada
Mr. Chad Nelson	Infrastructure Canada
Mr. Mark Peacock	Lower Thames Valley Conservation Authority, ON, Canada
Mr. Joe Rogers	Department of Municipal Affairs and Housing, NS, Canada
Ms. Chris Rol	Insurance Bureau of Canada, ON, Canada
Mr. Jesal Shah	Ministry of Forests, Lands, Natural Resource Operations and Rural Development, BC, Canada
Mr. Kevin Smith	Environment and Climate Change Canada
Dr. Laxmi Sushama	McGill University, QC, Canada
Mr. Hariharasankaran Vaidyanathan	National Defence – Government of Canada
Mr. Derek Williamson	Baird, ON, Canada
Ms. Adrienne Yuen	Standards Council of Canada, ON, Canada
Dr. Xuebin Zhang	Environment and Climate Change Canada
Dr. Francis Zwiers	Pacific Climate Impacts Consortium, BC, Canada

Abstracts and Biographies

NRC's Flood-Resistant Buildings Initiative

NAVEED KHALIQ and AHMED ATTAR

National Research Council Canada

Abstract

Within the framework of the Climate-Resilient Buildings and Core Public Infrastructure project, the National Research Council of Canada (NRC) is developing guidelines for the design of flood-resistant buildings and improving the flood-resilience of existing buildings, in collaboration with national and international experts. To support the development of these guidelines, a number of initiatives have been undertaken to generate data on a range of expected and extreme flood-loading conditions in riverine, coastal and large lake environments in Canada. This presentation will provide an overview of these initiatives and associated timelines and various data products.

Biographies

Dr. Naveed Khaliq is a Research Engineer at the Ocean, Coastal and River Engineering Research Center of the NRC. He has a PhD degree in Engineering Hydrology, two Master of Science degrees, one in Hydrology and another in Water Resources Engineering, and over 30 years of professional experience in various settings, ranging from applied research and academics to software industry. At the NRC, his research focus is on advancing innovation and solving applied problems in hydrology and water resources, based on advances in hydrotechnical engineering, hydrologic process modelling and analysis, and multi-disciplinary approaches to water management. His expertise includes stochastic and deterministic modelling, river flow forecasting, environmental change and its impact on water cycle components, hydro-climatology, time series analysis, and applied software development.

Dr. Ahmed Attar is the Lead Technical Advisor for the Standing Committee on Structural Design at Codes Canada. In this role, he provides

expertise and guidance to several design standards, regulators and industries, including the National Building Code (NBC) 2015 and its Structural Commentaries. In recognition of his Code expertise, Dr. Attar has been selected by NRC Management to lead the development of climate change provisions, including flood-resistant buildings, for implementation in the NBC and its user's guides. Prior to his functions as a Lead Technical Advisor, Dr. Attar has been an Evaluation Officer at the NRC's Canadian Construction Materials Centre (CCMC) since 2008. In his tenure at the CCMC, Dr. Attar integrated the technological expertise of the NRC, universities and external experts to provide technical opinions on the compliance of innovative construction products to the NBC, aiding more than 70 companies in the development, marketing and acceptance of their products. Dr. Attar also worked with the NRC's Industrial Materials Institute (IMI) for 3 years (1997-2000), where he brought his expertise in composite materials and modelling, and led the development of optimization techniques for plastic processes within two major consortium projects, providing a manufacturing competitive edge to 40 North American plastic manufacturers by adding new performance features in design. Before joining the NRC, Dr. Attar was a Researcher at McGill University (1996-1997) where he led the work on deterioration assessment using non-destructive methods as part of large project on the assessment of Montreal's Dickson Bridge. Dr. Attar was a Research Engineer for five years at France's "Centre Scientifique et Technique du Bâtiment" (CSTB) (1992-1995) working on innovative structural materials and experimental methods, leading to higher performance and robust designs.

Developing Requirements for Flood-Resistant Buildings, Including the Execution Plan and Discussion of Data Needs

BILL COULBOURNE and KIMBERLY MCKENNA

Coulbourne Consulting, MD, USA

Abstract

This presentation will discuss the scope of the project that Coulbourne Consulting is undertaking to prepare guidance documents for the requirements for flood-resistant buildings that are intended to be used as the basis for eventually developing Canadian building code requirements for flood design of buildings. This presentation will also cover the execution plan developed for this project and the data-needs requirement for successfully developing the guidance documents.

Biographies

Mr. Bill Coulbourne has nearly 50 years of experience as an engineer and manager. His expertise includes building design, methods, materials, and codes. He is experienced in hazard-related design and the construction of wind- and hurricane-resistant structures. He has performed structural inspections and building investigations on thousands of structures to assess past or future performance during a natural hazard event. He is leading the Coulbourne Consulting team effort and is the leader for performance-based design guidelines.

Mr. Coulbourne actively participates in engineering standards development by working on the American Society of Civil Engineers (ASCE) standards ASCE 7, Minimum Design Loads for Buildings and Other Structures, including the Wind Load and Flood Load Task Committees, and ASCE 24, Flood Resistant Design and Construction.

Ms. Kimberly McKenna has over 35 years of experience in coastal geology and is the current Director of Sponsored Programs & Senior Project Manager, Coastal Research Center, at Stockton University in Port Republic, NJ, USA. She has extensive experience in GIS (Geographic Information Systems) and is leading the team's effort in data collection and manipulation needed for this project. She has led teams of coastal geologists for the Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Watershed Stewardship, Shoreline and Waterway Management Section, Dover, DE. Her roles there included being a coastal processes expert, research coordinator, and a scientific advisor for state policy development and special projects. She was an interagency team leader for studies related to shoreline change, tidal inlet management, beach nourishment design, storm surge impacts and sea level rise, and beach nourishment sediment quality/quantity.

Design Flood Conditions and Considerations

BILL COULBOURNE and DAVID KRIEBEL

Coulbourne Consulting, MD, USA

Abstract

This presentation will review recommended guidance for defining flood conditions and considerations across all Canadian provinces. The flood conditions discussed include depth, velocity, duration, debris, scour and erosion, and ice jams. The elements of the design flood will be discussed, including flood frequency considerations, freeboard, and considerations for future conditions. Also included are the results of research into how to approach developing flood frequency information and how to infer riverine flow velocity based on mapped flood hazard zones and flood elevations.

As background, flood loads on buildings in riverine flood plains require an estimate of both flood depth and flow velocity. Most flood hazard maps, however, only provide information on flood elevation and do not include information on flow velocity. While flood flow velocity may be obtained from application of a detailed numerical model, code provisions and commentary in the National Building Code of Canada should include a prescriptive method that allows a user to develop a fairly simple and robust estimate of velocity without using a complex numerical model. A method has therefore been developed to allow a user to approximate flow velocity from information contained on a flood hazard map.

Biographies

Mr. Bill Coulbourne has nearly 50 years of experience as an engineer and manager. For more information, see "Developing Requirements for Flood-Resistant Buildings" above.

Dr. David Kriebel has nearly 40 years of experience in coastal and ocean engineering, with an emphasis on ocean waves, wave forces, wave-structure interaction, sediment transport and erosion processes, marine soil mechanics and foundations, and coastal flooding and natural hazards. In addition, he has experience in naval architecture, including ship-generated waves, the effects of passing vessels, vessel berthing and mooring, and the response of floating structures. He is leading the report development for flood load formulas and provisions.

Dr. Kriebel teaches at the US Naval Academy in the areas of: coastal engineering, ocean wave mechanics, random wave analysis, wave loading, offshore structural analysis, marine soil mechanics and foundations, marine environmental engineering, naval architecture, and ocean engineering design. In addition, he has had a consulting practice for nearly 40 years and participates as a member of the ASCE 7 Main Committee on Minimum Design Loads for Buildings and Other Structures, the Flood Load Task committee, and the committee on Tsunami Loads and Effects.

Flood Load Formulas and Provisions

DAVID KRIEBEL

Coulbourne Consulting, MD, USA

Abstract

This presentation will review existing provisions for computing flood loads based on international design guidance as summarized in the 50% draft report on Flood Load Formulas and Provisions. The goal is to consider a wide range of flood-induced loads on buildings for possible inclusion in the National Building Code of Canada, or its Commentary. Most of the cited sources and guidance comes from the US Federal Emergency Management Agency (FEMA) as well as the US Army Corps of Engineers, as these are the only international guidance documents that include the full range of flood effects on buildings.

Loads are considered for entire buildings and for primary structural elements, including vertical piles and columns, horizontal beams and bracing, floor systems, and vertical walls. Conditions reviewed include both riverine and coastal flooding scenarios.

Riverine flood loads occur mainly due to hydrostatic effects, hydrodynamic effects of moving flood waters, and the effects of debris carried in the river flow.

Coastal flood conditions include all of these, but also add in the effects of waves, which are split into effects of non-breaking oscillatory waves and more damaging impact loads of breaking waves.

The presentation will include some aspects that require discussion and decisions from the NRC, and will point out areas in need of further work. This presentation will also include the current revisions being prepared for the new edition of the ASCE 7 Flood Load standard.

Biography

Dr. David Kriebel has nearly 40 years of experience in coastal and ocean engineering. For more information, see "Design Flood Conditions and Considerations" above.

Performance-Based Design for Flood

BILL COULBOURNE

Coulbourne Consulting, MD, USA

Abstract

This presentation will present the concepts of performance-based design (PBD) for flood as an alternative design method that could be adopted by the National Building Code of Canada. There is discussion about how this alternative could be used in practice, how performance objectives could be developed for the building types described in the National Building Code, what hazard levels to consider, and how to define damage levels. The connection between defining the parameters of PBD, defining a design flood frequency, and the associated flood conditions is made with the use of an example situation for Newfoundland. Additional case studies are expected to be added from other provinces. Possible recommendations for including PBD in the National Building Code are suggested.

Biography

Mr. Bill Coulbourne has nearly 50 years of experience as an engineer and manager. For more information, see "Developing Requirements for Flood-Resistant Buildings" above.

Improving Flood Resistance for Existing Buildings

RANDALL BEHM

Behm Hazard Mitigation LLC, NE, USA

Abstract

This presentation will summarize the 50% report submittal of the technical report on Improving Flood Resistance for Existing Buildings. The first part of the presentation will focus on a discussion of the common building stock, a description of the most common techniques for mitigating the flood risk to existing buildings, and the importance of reducing flood risk to critical facilities and public safety operations. The second part of the presentation will focus on a process for conducting a flood risk vulnerability assessment of existing buildings, determining the effective mitigation techniques for implementation, and will provide background information regarding flood barriers, flood resistant materials, and potential economic considerations.

Biography

Mr. Randall Behm has 35 years of experience in government service with the US Army Corps of Engineers (USACE) and with his own consulting practice, established after retirement from the USACE. He is a subject-matter expert in the effective use of physical and non-physical nonstructural mitigation techniques for establishing comprehensive flood risk management and reducing property damages due to flooding. He has comprehensive skills in flood risk management, planning processes, hydrologic engineering, and cultural resources. He is leading the report development for guidelines related to floodproofing existing buildings.

Mr. Behm has conducted detailed workshops on floodplain mitigation for the Ashokan Watershed Stream Management Program in the Catskill Mountains of New York for local, regional and state floodplain managers. He was instructor of nonstructural mitigation for USACE Planning Associates Program. He has led the nonstructural assessment and report development for studies in the St. Louis, Missouri metropolitan area, for the City of La Crosse, Wisconsin, and Fire Island in New York. He is the co-chair of the ASFPM Floodproofing Committee and was the Chair for the USACE National Nonstructural Committee.

Flood Standard Related Initiatives and Discussions in the USA

BILL BROWN

Flood Science Center, WI, USA

Abstract

Flood standards have been in place in much of the United States for the past 50 years. Participation in the National Flood Insurance Program requires a participating community to adopt minimum flood standards. The standards are generally based on a 1% chance flood risk standard. While these standards have been adopted and implemented in more than 22,000 communities, flood losses continue to rise in the US. As flood losses continue to rise, many people are reassessing the flood initiatives and practices. These efforts include questioning what is an appropriate risk standard, planning for resilience, the use of technology to improve risk estimates, and establishing standards for protecting structures from flooding. Also the issue of urban flooding (water overwhelming existing stormwater management systems) is coming to the forefront.

Many standards are based upon a 1% chance standard in the mapped Special Flood Hazard Area (SFHA). Unfortunately, SFHAs are only mapped for 1.2 million miles of streams, rivers and coastlines in the US, out of 3.5 million that exist. This standard tends to be the median probability based upon past observations. No consideration is made for a factor of safety, which is typical in virtually all other engineering designs, or consideration of future conditions (both watershed physical change and climate change). There are initiatives to move beyond the 1% chance standard and consider future conditions, statistical certainty and factors of safety. We are seeing a trend where communities are using the 2% chance standard (often as a proxy for future conditions), and many others are adding freeboard of up to 4 feet (Nashville, TN).

Recent publications by the American Planning Association, Planning for Infrastructure Resilience and Subdivision Design and Flood Hazard Areas provides users with tools they need to broker important discussions, inform decisions with the best available science, and consider future conditions when allocating present and future resources. The latter publication recommends over 60 standards that can be used to maximize flood-loss reduction when planning residential commercial subdivisions or commercial and industrial developments.

From a technology perspective, there are many new products that have evolved significantly beyond the sandbag that can be used to make existing development more resilient to flooding. There is growing interest in the National Flood Barrier Testing and Certification Program. Through a partnership with the Association of State Floodplain Managers (ASFPM), FM Approvals and the US Army Corps of Engineers,

there is a certification testing of many of these products, including temporary perimeter barriers, closure devices, backwater valves, mitigation pumps, sealants, and glazing (glass) based upon ANSI 2510 Standards. The certification requires water-based testing, component/material testing and manufacturing facility audits.

The general use of modelling techniques has rapidly evolved over the past 20 years. Many engineers and scientists are moving beyond the traditional steady state models to dynamic 1 or 2 dimensional models. Traditional tools and standards, such as the floodway concept, which are widely used for floodplain management, are not well-suited for these advanced modeling techniques.

Biography

Mr. Bill Brown is a Senior Project Manager and Past Director of the Association of State Floodplain Managers' Flood Science Center. He facilitates, develops and manages collaborative relationships with federal, academic, foundation, and NGO partners, with a mission of studying the technical, biologic, social, and economic aspects of flood science. Prior to his tenure with ASFPM, he was the inaugural Stormwater Executive Manager for the City of Arlington, Texas, where he directed the development of a comprehensive, integrated stormwater and floodplain management program. Over his 30-plus year career, Mr. Brown has worked in the private sector, municipal and county stormwater and floodplain management programs, academia, and not-for-profit organizations focused on integrating stormwater and floodplain management programs that reduce flood risks while improving the environment. He previously served as Chair of the Illinois Association for Floodplain and Stormwater Management; was past Co-Chair of ASFPM's Mapping and Engineering Standards Committee and ASFPM's Urban Stormwater Committee; was Adjunct Faculty member for the University of Texas at Arlington Department of Civil Engineering; served on a National Research Council for the National Academy of Science committee studying FEMA Flood Maps; served an appointment to the federal Advisory Committee on Water Information; and was a Subject Matter Expert for FEMA's Technical Map Advisory Committee. Mr. Brown holds Bachelor of Science degrees in Agriculture and Agricultural Engineering from the University of Illinois Urbana-Champaign and a Master of Science in Agricultural Engineering from Oklahoma State University.

Analysis and Data Extraction for Flood Load Determination for Selected Case Studies from Alberta and British Columbia

DAN HEALY

Northwest Hydraulic Consultants Ltd., AB, Canada

Abstract

Part of the work of the NRC's Climate-Resilient Buildings and Core Public Infrastructure Initiative (CRBCPI) is to: develop decision-support tools (including codes, guides and models) for the design and rehabilitation of resilient buildings and CPI in key sectors to ensure that climate change and extreme weather events are addressed. This project will support the development of guidelines for the provision of data arising from completed and new floodplain studies that will inform the NRC's role in supporting the development of the National Building Code.

The purpose of this study is to generate flood data from existing and new floodplain mapping studies to derive flood loads for the design of new buildings and rehabilitation of existing buildings. The methodology used to generate the flood data is presented, along with some of the initial findings.

Biography

Dr. Dan Healy is a Principal at Northwest Hydraulic Consultants Ltd. and works from the main office in Edmonton. He has some expertise in river ice hydraulics and most of his graduate research was based on ice jam physical model studies. Recently he has been spending a considerable portion of his time working on flood hazard studies for the Province of Alberta. Recent and ongoing projects Dan manages and/or assumes a lead technical role include:

- North Saskatchewan River Hazard Study (2017, ongoing) – Project Manager, Lead Project Engineer, Hydraulic Modelling Specialist
- Medicine Hat River Hazard Study (2017, ongoing) – Hydraulic Modelling Specialist
- Peace River Hazard Study (2015, ongoing) – Project Manager, River Ice Hydraulics
- North Saskatchewan River Dam Breach Inundation Study (2018) – Project Manager, Lead Engineer
- Floodway Criteria and Flow Change Impact Analysis Project (2017) – Hydraulic modelling
- Flood Hazard Identification Study of the Athabasca and McLeod Rivers, Woodlands County, Alberta (2015-2016) – Project Manager, Hydraulic Modelling, River Ice Hydraulics

Analysis and Data Extraction for Flood Load Determination for Selected Case Studies from Manitoba and Saskatchewan

RAJ MANNEM

Hatch, MB, Canada

Abstract

The National Building Code of Canada (NBC) provides loading criteria for wind, snow, ice, seismic and live loads for the design of buildings. The topic of flood loading is not addressed in the current version of the NBC. The National Research Council Canada (NRC) wants to cover the topic of flood loading for buildings in the floodplain area and requires information on flood loads and load combinations. Hatch has vast experience modelling flood inundation and performing dam break analyses. This data will be made available for use by the NRC for the design of flood-resistant buildings.

Biography

Mr. Raj Mannem is currently the Engineering Manager and Senior Civil-Structural Engineer for the Winnipeg Office of Hatch. He has been the Structural Discipline Lead and has more than 22 years of experience in engineering, construction and project management. Since completing his Master of Engineering at Memorial University of Newfoundland, Raj has worked on many industrial, offshore and hydraulic structures, including spillways, dams, control structures, powerhouses / generating stations and diversion structures, dealing with ice loads and developing specifications, design criteria, and structural designs. His Forrest Kerr Hydroelectric Station Project located in BC received both the Award of Excellence and Tree for Life Award from the Canadian Association of Consulting Engineers in 2015.

Analysis and Data Extraction for Flood Load Determination for Selected Case Studies from Great Lakes and Arctic coasts

DEREK WILLIAMSON and JOSH WIEBE

Baird & Associates, ON, Canada

Abstract

The National Research Council (NRC) is in the process of developing national guidelines for the design of flood-resistant buildings. W.F. Baird & Associates (Baird) is supporting the NRC in the development of the guidelines and design procedures by undertaking case studies that are developing new datasets of water depths, velocities, and wave conditions for select flood-vulnerable communities on Canada's Great Lakes and Arctic coasts. These case studies are expansions of coastal flood hazard studies that Baird undertook for Ontario Conservation Authorities and the Government of Northwest Territories in 2019 and 2020. The case study locations are affected by relatively large storm surges (greater than 2 m) and waves (greater than 5 m). The case studies focus on select neighbourhoods that have experienced building damage in the past or are known to be at high risk.

Biographies

Mr. Derek Williamson has been a coastal engineer with Baird & Associates since 1991, and is a principal and director at Baird & Associates. He has worked extensively in the field of numerical modelling and risk analyses for riverine and coastal processes. He has also led field studies, undertaken design work, and developed software systems for analysing and mapping hazards and risk. Mr. Williamson combines a strong technical background with a practical approach to projects.

Mr. Josh Wiebe has over 11 years of consulting experience in coastal engineering and has been the project manager for several coastal flood hazard and risk assessment studies. His recent project experience includes coastal hazard and risk assessment studies for Toronto Islands, Haldimand and Norfolk Counties (Lake Erie), Tuktoyaktuk, and Barbados. Mr. Wiebe is also a member of the Technical Advisory Committee for the National Research Council's guidelines document on Coastal Flood Risk Assessment for Climate-Resilient Buildings and Core Public Infrastructure.

Analysis and Data Extraction for Flood Load Determination for Selected Case Studies from Atlantic Provinces

VINCENT LEYS

CBCL, NS, Canada

Abstract

An overview of CBCL's work will be presented to the NRC to support the Development of Requirements for the Design of Flood Resilient Buildings. The project includes four case studies with 2D riverine modeling and 2D coastal flood modeling in urban settings. For each flooding scenario, floodplain maps will be produced and representative model transects will be extracted for key parameters such as discharge, depth, flow velocity and bed resistance. Flood loads will be developed for various return periods, based on mean and standard deviation of model outputs. It is intended that each case study be used to determine data requirements and identify potential challenges with the development of flood loads based on hydrodynamic model outputs.

Biography

Mr. Vincent Leys is a Senior Coastal Engineer with the Halifax-based engineering firm CBCL. He leads coastal infrastructure and environmental projects related to harbours, waterfronts, and adaptation to climate change and sea level rise. His work focuses on mitigating coastal impacts from extreme events on people and infrastructure, while accommodating natural processes such as sediment transport and flooding. Over the last 20 years, he has provided scientific and engineering inputs to a wide variety of projects across Atlantic Canada and in the Caribbean.

Standards Used by Conservation Authorities in Ontario for Great Lakes and Riverine Flood Plain and Erosion Management, and How Climate Change May Challenge this Approach

MARK PEACOCK

Lower Thames Conservation Authority, ON, Canada

Abstract

This presentation will review the existing standards used for floodplain management by Conservation Authorities in Ontario. This will include flood and erosion elements that might be affected in both riverine and Great Lakes hazard areas. The review will include considering the three riverine flood zones of Ontario, and how these standards may need to change. Additionally, flood elevation and erosion setback standards used in management of Great Lakes hazard areas will be reviewed. Results of recent floods and erosion events will be used to comment on how a new approach may be needed.

Biography

Mr. Mark Peacock graduated from the University of Guelph in 1988 with a bachelor degree in Water Resources Engineering. Prior to this, he graduated from the University of Toronto with an Honours Bachelor of Arts Degree with a Specialist Certificate in English Literature. He is currently a registered Professional Engineer.

In December of 2017, Mark moved to Southwestern Ontario to become the CAO / Secretary Treasurer of the Lower Thames Valley Conservation Authority. In the past, Mark provided watershed engineering direction and services to the Ganaraska Region, Central Lake Ontario, Kawartha Region, Otonabee Region and Nottawasaga Valley Conservation Authorities. Mark has produced a number of technical studies looking at elements of floodplain mapping and policy. In 2015, Mark coauthored a review of floodplain mapping in Ontario entitled “Metadata Inventory of Existing Conservation Authority Flood Mapping”.

Before working with Conservation Authorities, Mark was a Water Resources Engineer at Long Associates Consulting Limited, in Orangeville, Ontario.

Building Flood Resilience in Calgary

SANDY DAVIS and MARCO CIVITARESE

City of Calgary, AB, Canada

Abstract

The presentation will summarize Calgary's current flood-related building regulations, current challenges in regulating for flood resiliency and where codes could help, and a tool for post-disaster building assessments.

Biographies

Ms. Sandy Davis is the River Engineering Team Lead at the City of Calgary. Sandy and her team focus on river-flow monitoring and forecasting, modelling, mapping, development application reviews and policy development, and public education and communication for river flooding.

Mr. Marco Civitarese is the Manager and Chief Building Official for Calgary Building Services, and has worked in different departments and varied capacities at the City of Calgary for 33+ years. He has participated in numerous initiatives, industry partnerships, investigations and educational forums over his career. He currently is the Service Owner for Building Safety and a member of the Advisory Committee on Accessibility at the City of Calgary. At the provincial level, Marco sits on the Board of Directors for the Alberta Safety Codes Council, and at a national level he serves on the Canadian Commission on Construction Materials Evaluation and most recently was a member on the Standing Committee for Housing and Small Buildings.

An Emergency Response Perspective to What Renders Homes Uninhabitable During Floods

ANNICK MALETTO

Centre de Sécurité Civile - Ville de Montréal, QC, Canada

Abstract

A flood event in an urban setting significantly impacts the built environment as well as the safety of citizens. As such, authorities may choose to evacuate citizens living in flood-prone areas in an effort to ensure their safety for the duration of the event. A residential building is generally considered unsafe if much or all of its living space is flooded or if the flood is affecting the structural integrity of that building. For this reason, mitigating measures tend to focus on protecting structural integrity or stopping water infiltration within the living space. Such mitigating measures do much to protect a home but they do not always ensure the safety of its residents. This presentation looks at home safety during flood events from a public safety perspective.

Biography

Ms. Annick Maletto is Section Chief at the Montréal Fire Department and heads the Montréal Civil Protection Centre. As such, she manages and oversees emergency planning and preparedness for Montréal, and assists the Emergency Management Coordinator in his duties when emergency measures are implemented. She has worked for the City of Montréal for 13 years and contributed to both climate change adaptation and disaster response. She holds an Honours Bachelor of Environmental Science from Concordia University and a Master of Atmospheric Science from the University of British Columbia.

Flood Hazard Management Initiatives in BC

JESAL SHAH

Ministry of Forests, Lands, Natural Resource Operations and Rural Development, BC, Canada

Abstract

Since 2016, the Province of BC has spent approximately $200M to respond to and recover from flooding. To help reduce these costs in the future, the province is investing over $10M in several important flood hazard management initiatives such as risk assessments of BC dikes, flood risk strategies, Emergency Program Act modernization, and the BC Extreme Flood project. This presentation will provide an overview of these projects and describe how they will help improve BC's resilience to flooding.

Biography

Mr. Jesal Shah holds a B.S. and M.S. in civil and environmental engineering from the University of Southern California, and in 2015 he completed his MBA from the University of Victoria.

Jesal has been a part of BC Public Service for the last 11 years, working as a Flood Safety Engineer in the Water Management Branch, the Director of the Disaster Mitigation Unit at Emergency Management BC, and currently as the Manager of Dam Safety and Water Utilities. In his career in BC, he has managed several hazard mitigation funding programs and flood hazard management projects with total value worth over $150 million. Prior to moving to BC, Jesal worked as a civil engineer in both the public and private sectors in California.

Newfoundland and Labrador - Provincial Flood-Risk Mapping Initiatives

AMIR ALI KHAN

Department of Municipal Affairs and Environment, NL, Canada

Abstract

The Province of Newfoundland and Labrador, in conjunction with the federal government, has worked to reduce the human hardship and economic loss of floods through the Canada-Newfoundland Flood Damage Reduction Program (CNFDRP), the Atlantic Climate Adaptation Solutions (ACASA) Project, and more recently the National Disaster Mitigation Program (NDMP). A new template for flood-risk mapping was developed in 2009 and has been enhanced over the years to include climate change flood-risk mapping, inundation mapping, velocity mapping and hazard mapping.

The presentation describes this work, including the templates and tools developed by the Province.

Biography

Dr. Amir Ali Khan, Ph.D, P.Eng, is the Manager of the Water Rights, Investigations and Modelling Section with Newfoundland and Labrador's Department of Municipal Affairs and Environment. His responsibilities include water rights, flood-risk mapping, flood forecasting, flood alerts and climate change adaptation. He developed the climate change flood-risk mapping template used in Newfoundland and Labrador.

His Ph.D. in Civil Engineering is from Memorial University of Newfoundland. He is also a sessional instructor at Memorial University of Newfoundland.

He and his work are the recipients of several awards and commendations, including the 2005 Government of Newfoundland and Labrador Individual Public Service Award for Excellence for Innovation and Service Delivery Excellence, the 2005 ESRI Canada Award of Excellence for Drinking Water Quality GIS Application, the 2018 PEGNL Environmental Award for the Badger River Ice Service, and a "Fellow of the School of Graduate Studies" title from Memorial University.

He has worked on several International Technology Innovation and International Water Resources Capacity and Technology Building Projects with international agencies such as the European Space Agency (ESA) and the North American Treaty Organization (NATO).

Long Period Return Level Estimates of Extreme Precipitation

FRANCIS ZWIERS

Pacific Climate Impacts Consortium, BC, Canada

Abstract

Statistical extreme value theory (EVT) is a fundamental tool for characterizing climate extremes and understanding whether they are changing over time. Most operational frequency and intensity estimates are obtained by using EVT to analyze time series of annual maxima; for example, of short duration precipitation accumulations or some aspect of wind speed. A key implicit assumption in the application of EVT is “max-stability”; i.e., that the statistical behaviour of annual maxima is predictive of maxima calculated over multi-decadal or longer intervals. This assumption cannot be tested using available observational records, and it is rarely discussed in studies of extremes. Here we use a recent large ensemble simulation to assess whether max-stability holds for annual maxima of extreme precipitation. We find that annual maxima tend not to be max-stable in the model-simulated climate. We explore the implications of the lack of max-stability on the estimation of very long period return levels, and discuss reasons why the annual maxima of precipitation extremes may not be max-stable. We also demonstrate a possible solution that is based on an alternative statistical approach and that incorporates additional process-based information into the analysis. While our study focuses on precipitation simulated by a regional climate model, our findings have serious implications for the estimation of high return levels of many climate and weather elements from models and observations that may potentially impact engineering practice.

Biography

Dr. Francis Zwiers is director of the Pacific Climate Impacts Consortium (PCIC) at the University of Victoria. His former roles include chief of the Canadian Centre for Climate Modelling and Analysis and director of the Climate Research Division, both at Environment and Climate Change Canada. As a research scientist, his expertise is in the application of statistical methods to the analysis of observed and simulated climate variability and change. Dr. Zwiers is a Fellow of the Royal Society of Canada, the American Geophysical Union and the American Meteorological Society. He is also a recipient of the Patterson Medal and President’s Prize, and has served as an IPCC Coordinating Lead Author of the Fourth Assessment Report and as an elected member of the IPCC Bureau for the Fifth Assessment Report.