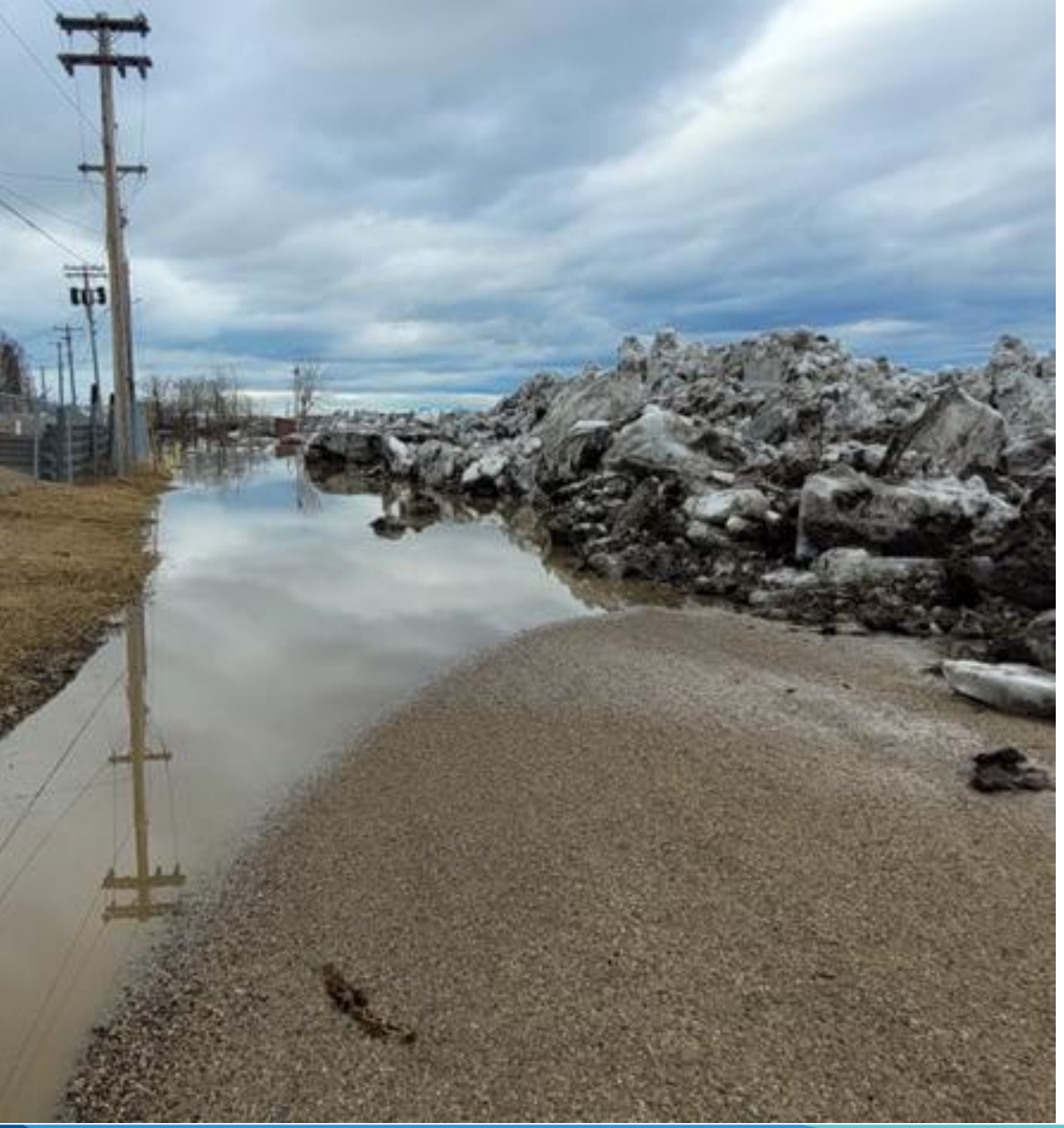


Northwest Territories Ice Jam Flood Mapping Guidelines V1.0

Jad Saade
Hydrologist
GNWT

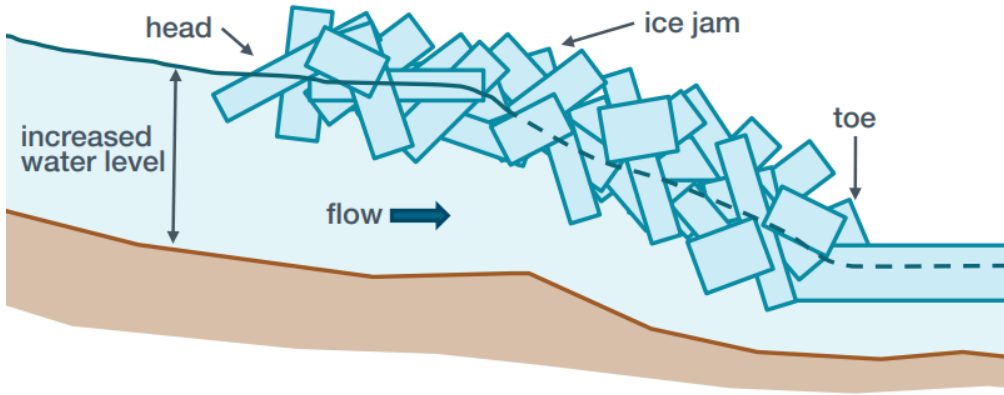
Dan Healy
Principal
NHC

Overview

- Need for ice jam flood mapping guidelines [presented by Jad]
  - Ice jam flooding and flood mapping in NWT
- Ice Jam Flood Mapping Guidelines V1.0 [presented by Dan]
  - Workflow and highlights

Need for ice jam flood mapping guidelines

- **Ice jams** are accumulations of ice in a river that can lead to flooding. They are a natural part of winter river processes. Ice jams form when the ice blocks the river flow, causing the water level to rise.



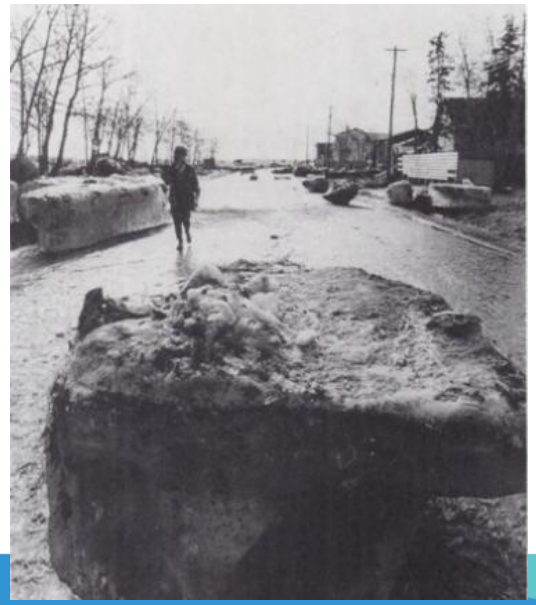
Alberta
Freedom To Create. Spirit To Achieve.

- "While the ice jams themselves are more impressive in the Northwest, with the large rivers and thick ice, …. Ice jams have been a feature of Canadian life from the beginning." (Beltaos, 1995)
- Guidance was lacking, no standard Canadian ice jam flood mapping guideline.

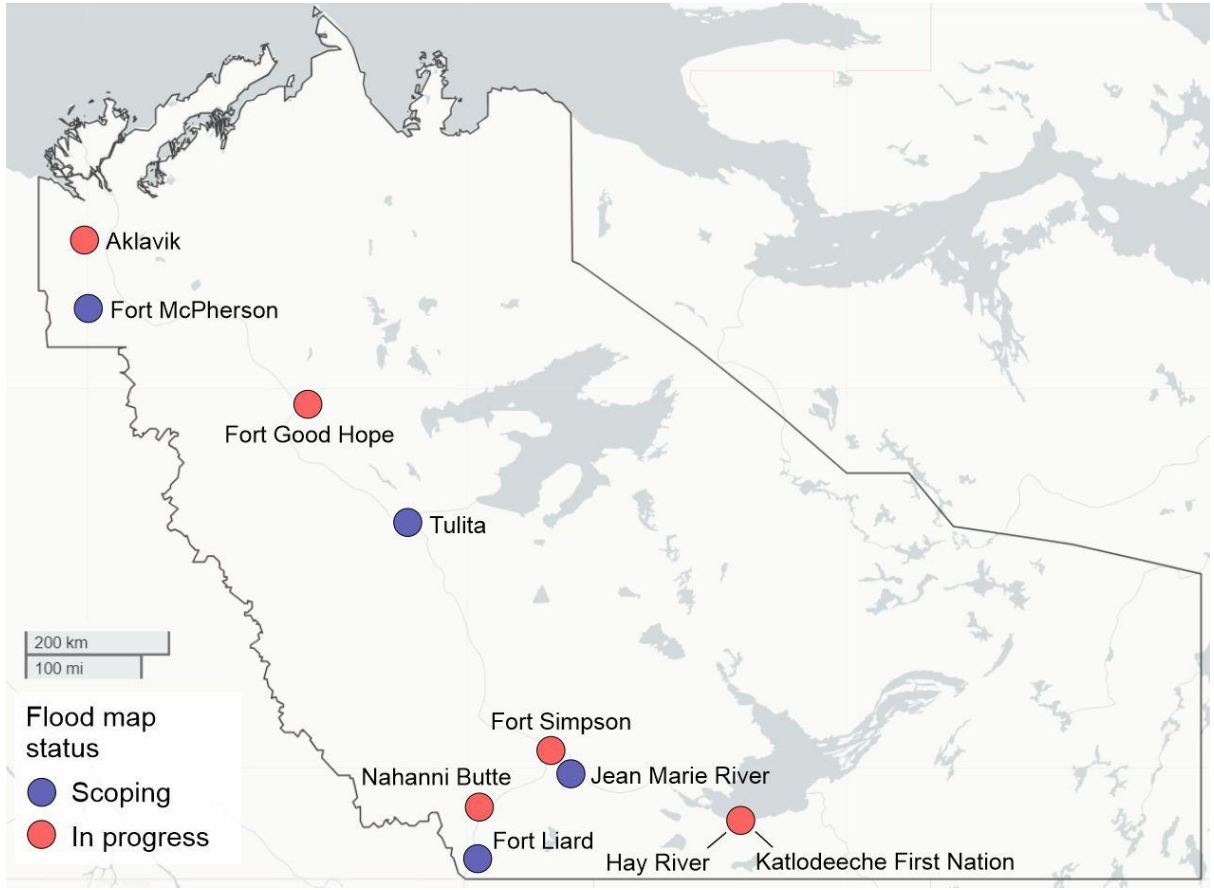
Gap in the Guideline

Need for ice jam flood mapping guidelines

- Historically, ice jam flooding being major flood mechanism in the NWT.
- Significant cost and damage on communities and infrastructure.
- Ice Behavior - River ice regime/dynamics is a complicated field of science.



Liard-Mackenzie Confluence at Fort Simpson, NWT (Edmonton Journal, 1989)



Ice jam flooding in NWT – Hay River 2022

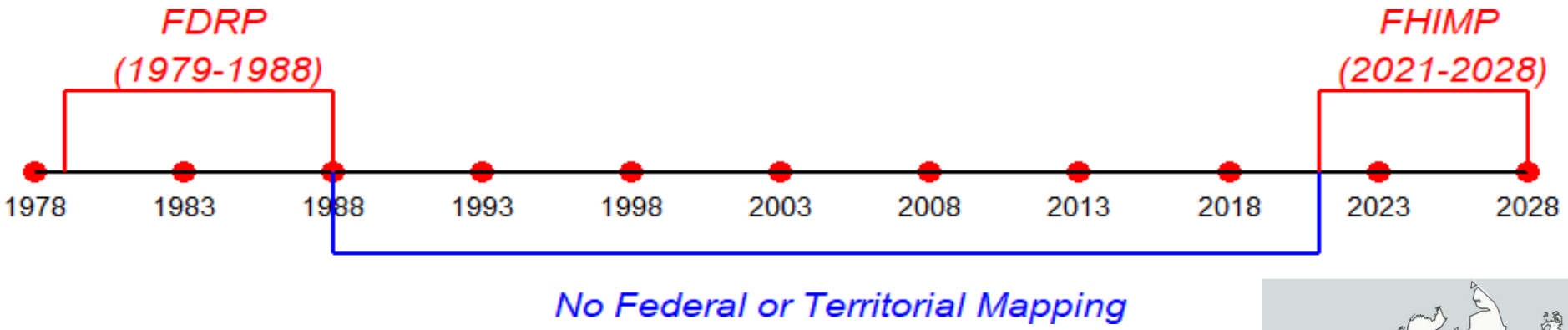
Ice jam flooding in NWT – Fort Simpson 2021

Photo Credits: Roger Piling

Ice jam flooding in NWT – Fort Simpson 2021

10GC001 Gauge Photos

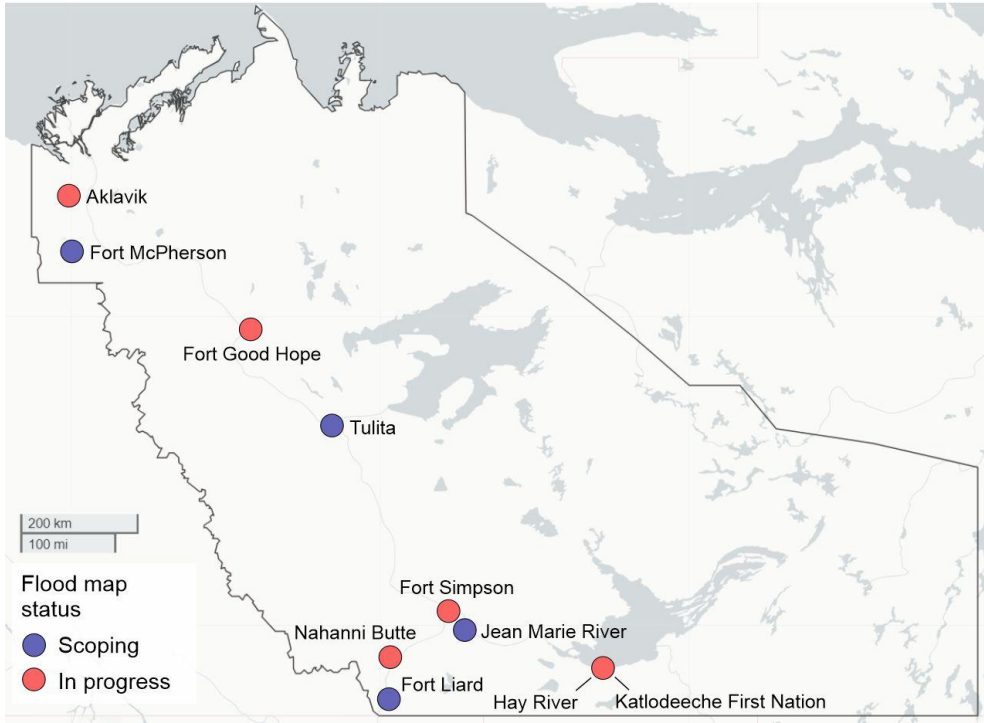
History of flood mapping in NWT



Federal mapping programs

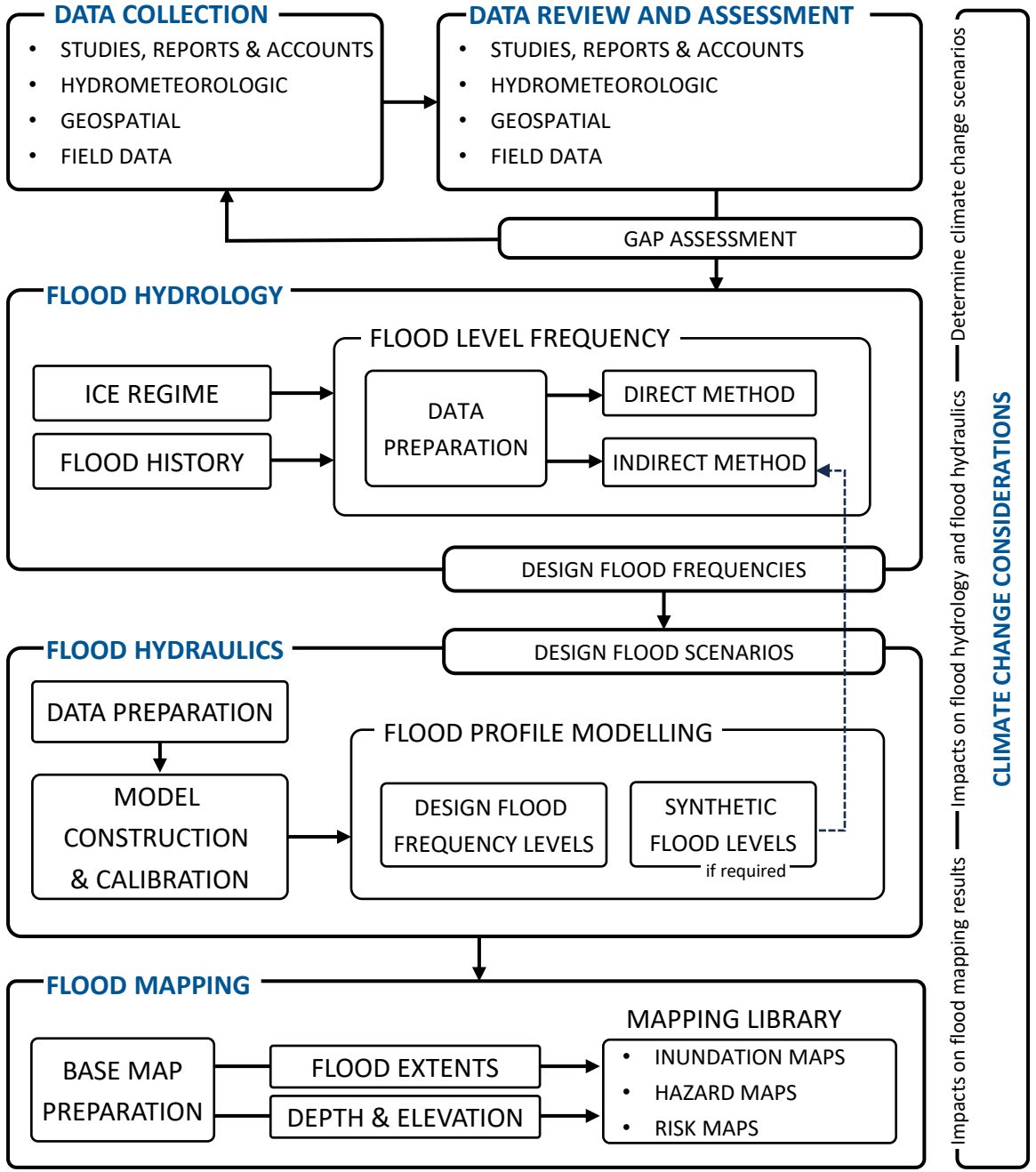
FDRP – Flood Damage Reduction Program

FHIMP – Flood Hazard Identification and Mapping Program



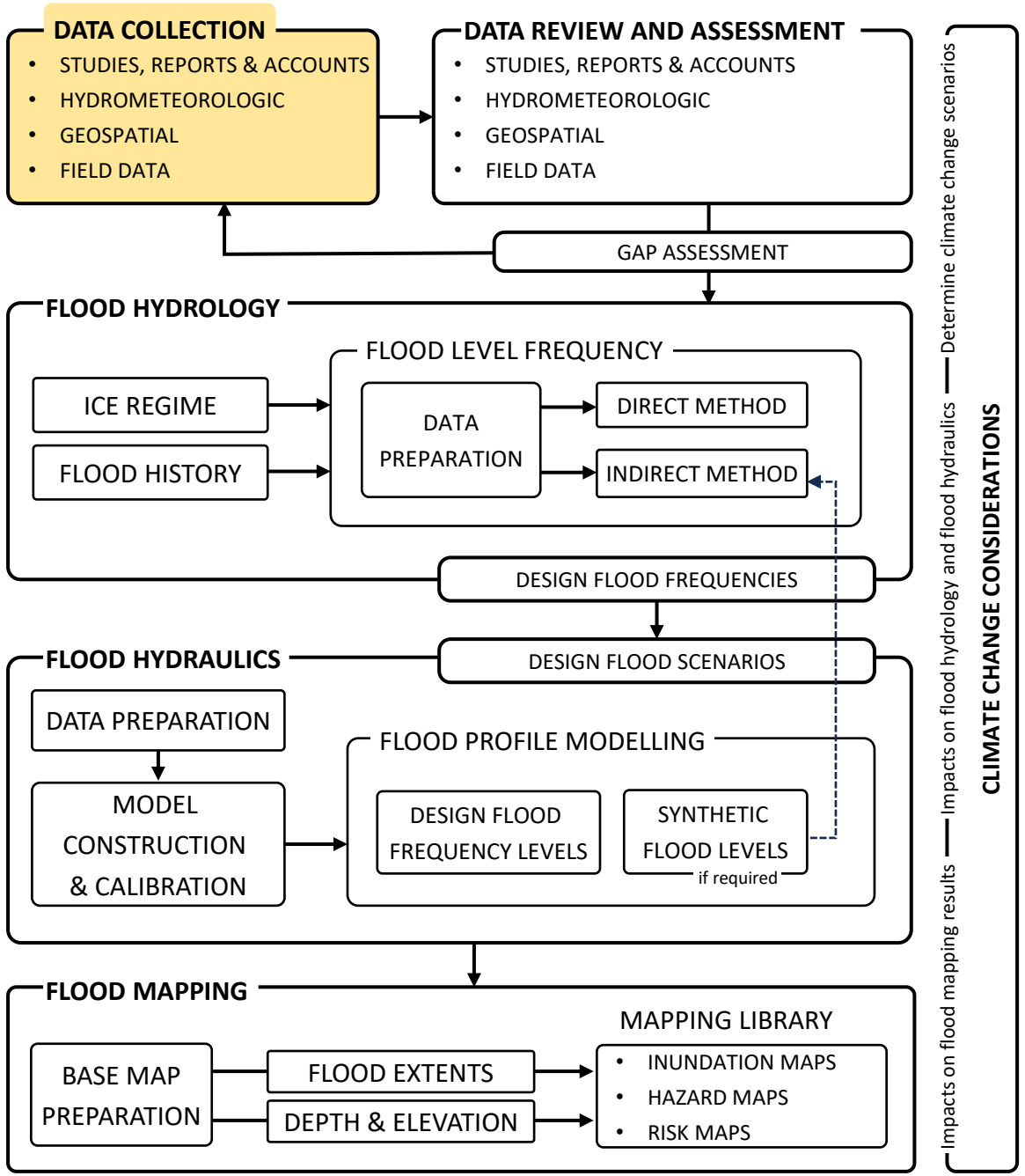
Ice jam flood mapping guidelines V1.0

- Intended to inform on best practices for developing engineered flood hazard maps where ice jam flooding is the dominant flood mechanism.
- Complementary to the Federal Flood Mapping Guideline Series (FFMGS)
  - Program framework
  - LiDAR data acquisition
  - Hydrologic and hydraulic procedures
  - Geomatics
  - Flood damage estimation
  - Climate change
  - Bibliography and references for flood mitigation
- Evergreen



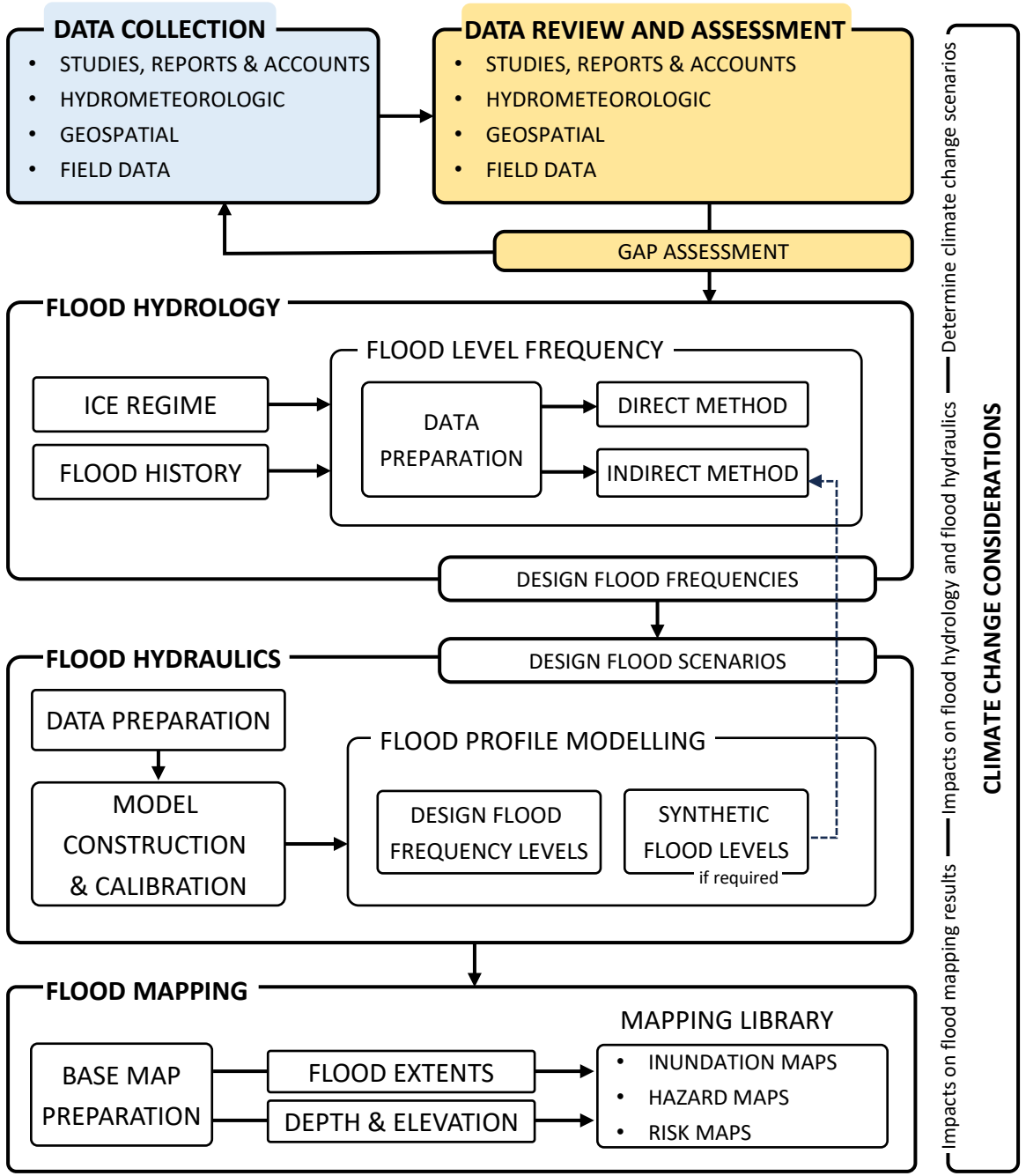
Methodology overview

- Data collection
- Data review and assessment
- Flood hydrology
- Flood hydraulics
- Flood mapping
- Climate change considerations



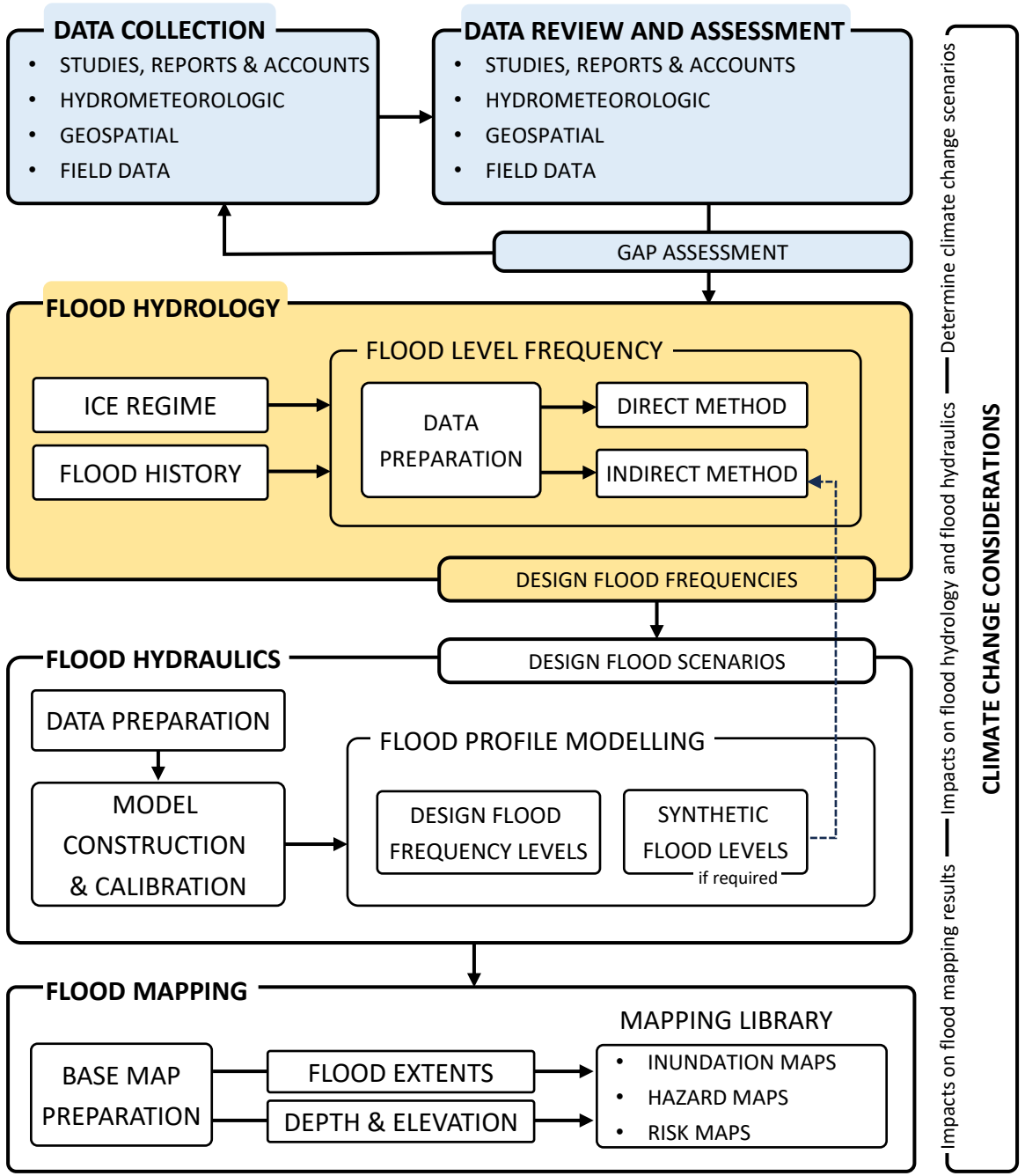
Data Collection

- Studies, reports, and accounts
- Hydrometeorologic
- Geospatial
  - Including Lidar acquisition
- Field data
  - Including survey program



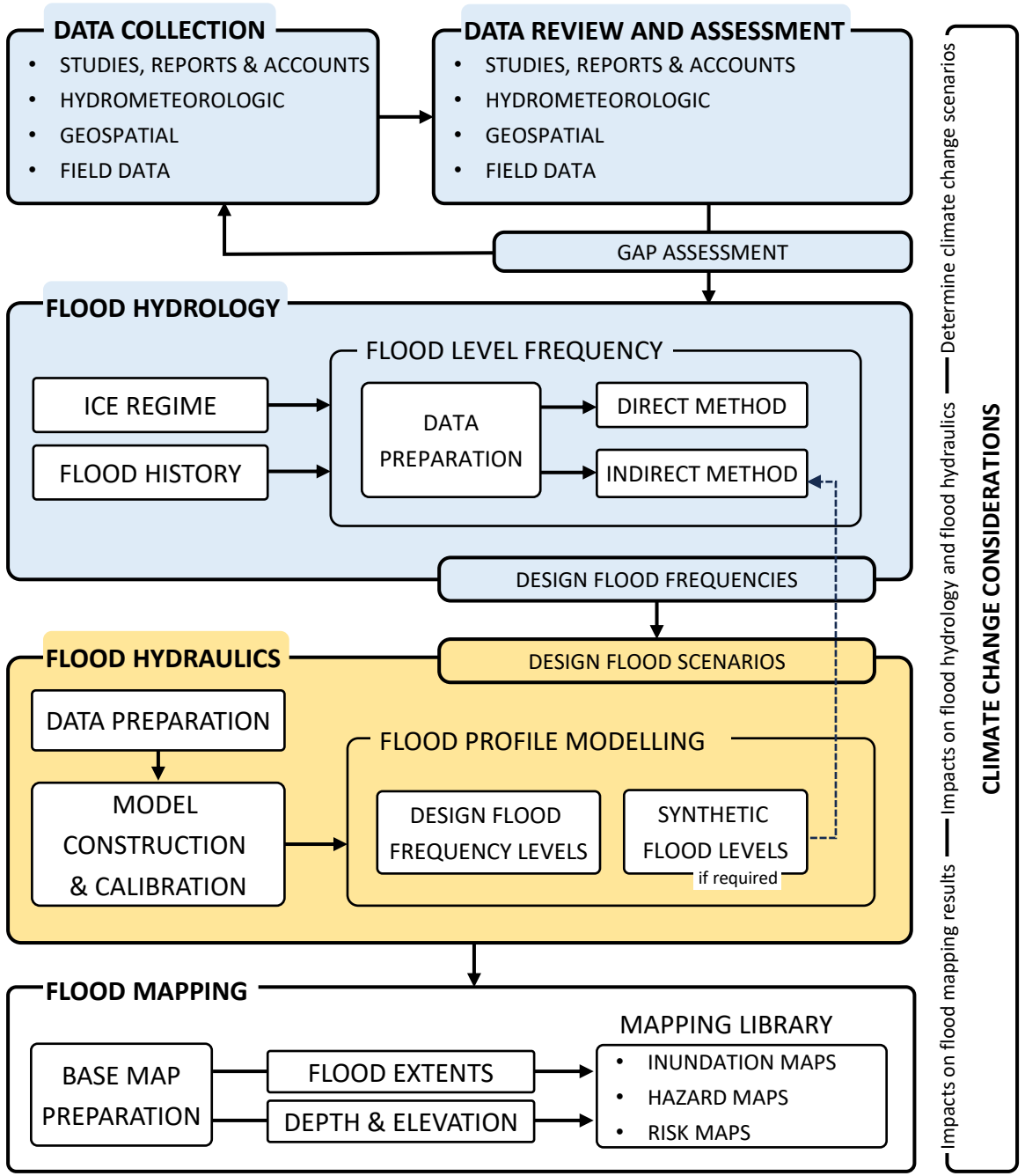
Data Review and Assessment

- Review and assess studies, reports, accounts, hydrometric, geospatial, and field data.
- GAP ASSESSMENT
  - Assess adequacy of data to fulfill project requirements
  - Evaluate need to collect additional data
  - Develop methods for working with limited data



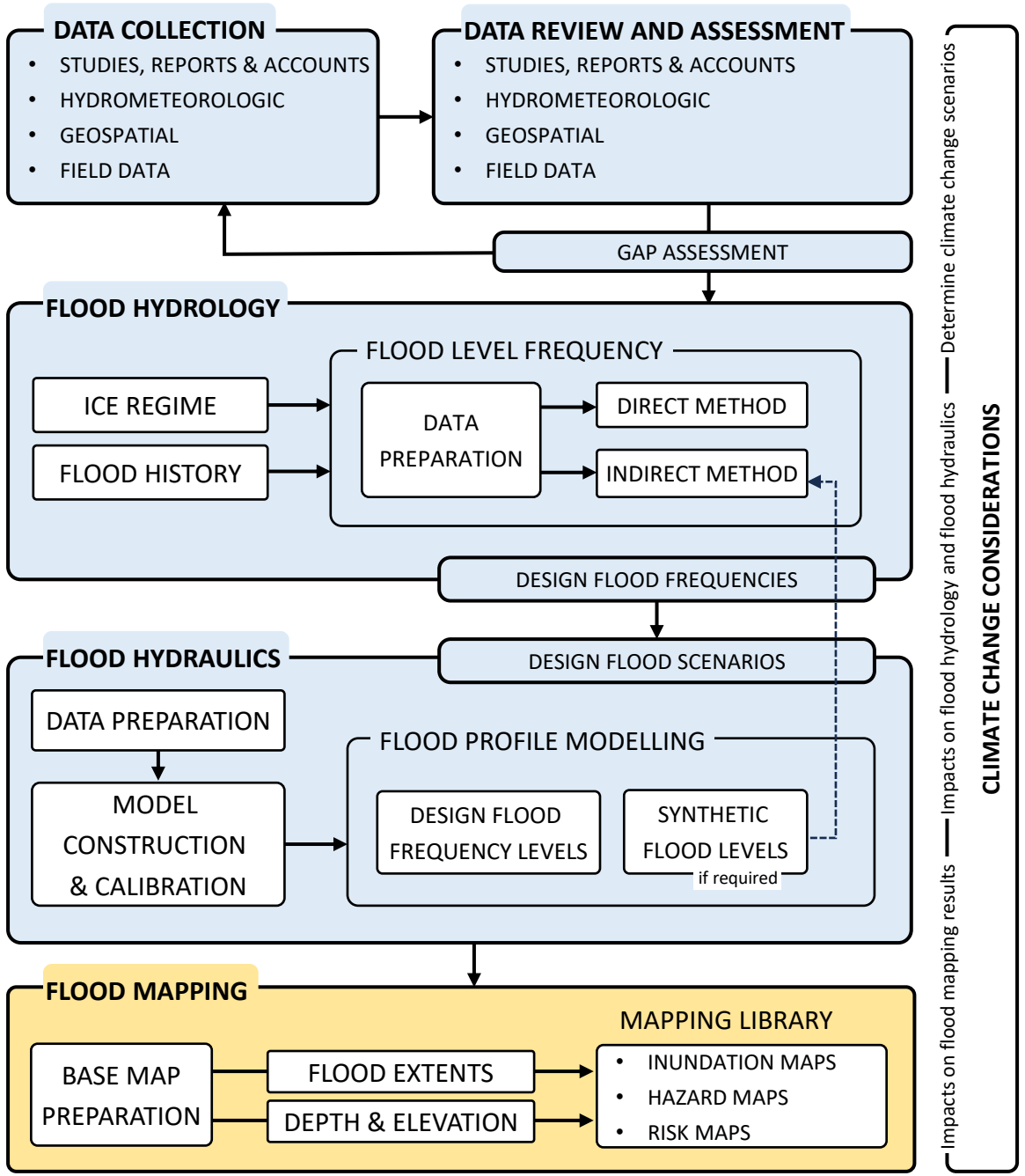
Flood Hydrology

- Ice regime
- Flood history
- Flood level frequency
  - Data preparation
  - DIRECT or INDIRECT METHODS
- Design flood frequencies



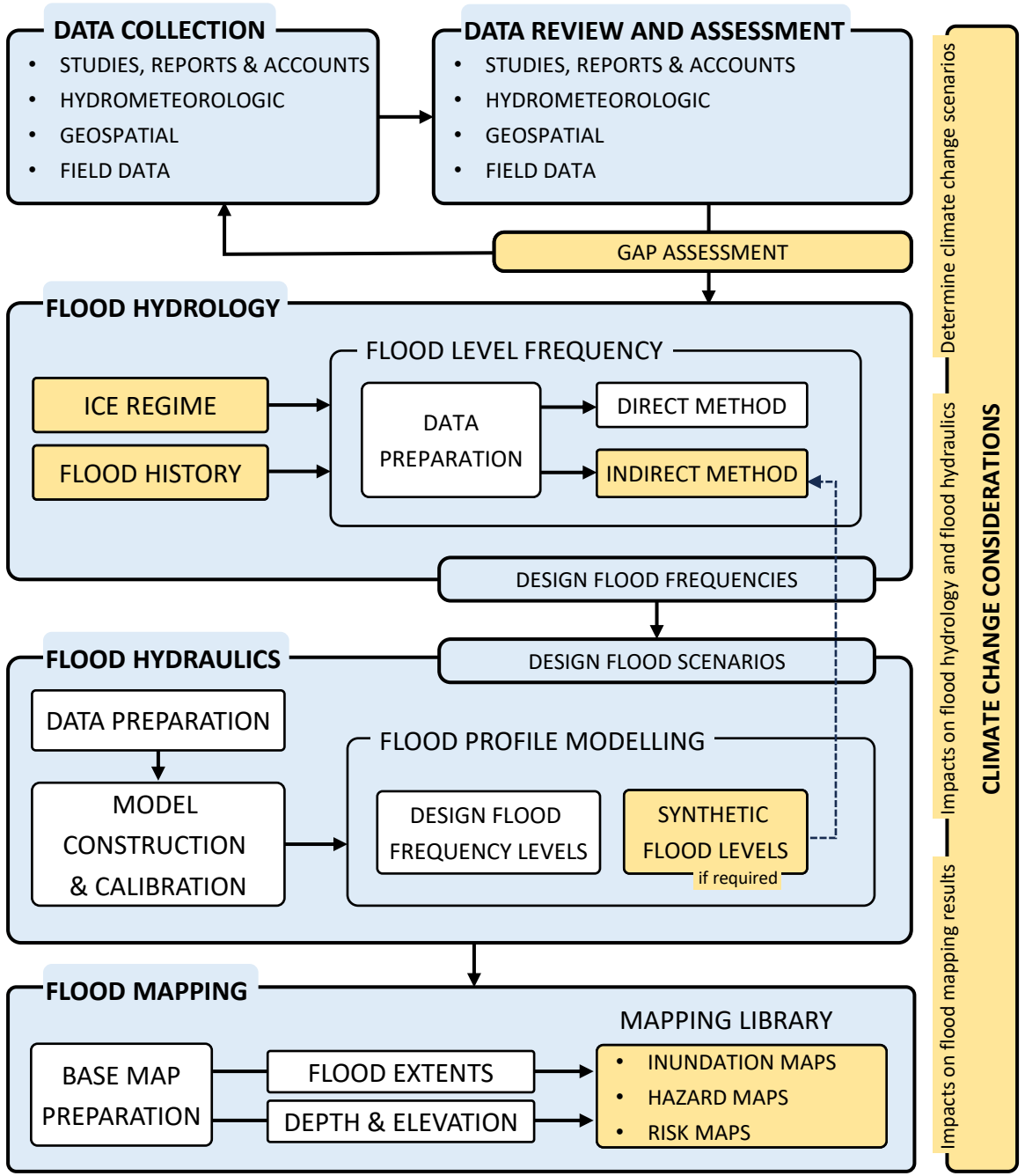
Flood Hydraulics

- Design scenarios
- Data preparation
- Model development
- Model implementation
- (Feedback to flood hydrology)
- Design flood levels feed into the mapping



Flood Mapping

- Base mapping
- Flood extents, depth, and elevation
  - Flood elevation surface
  - Flood elevation grid
  - Flood depth grid
  - Inundation extent
- Manual edits
- Map library
  - Inundation, hazard, risk maps



Climate Change Considerations

Government of Northwest Territories

nhc

- Integrated throughout the workflow
  - Climate scenarios
  - Impacts on hydrology and hydraulics
  - Impacts on flood mapping
- Assessment is informed by the various study components

It is a guideline

- A guide to inform the project management team and technical experts
- As with any flood study you require a team with specialist expertise
  - Survey and geomatics
  - Flood hydrology
  - Flood hydraulics
  - Flood mapping
  - **River ice**

Thank you

Government of Canada

Natural Resources Canada (NRCan)

Environment and Climate Change Canada (ECCC)

Government of Northwest Territories

nhc

Methodology – Companion Tables
DATA COLLECTION

DATA COLLECTION			
STUDIES, REPORTS & ACCOUNTS	HYDROMETEOROLOGIC	GEOSPATIAL	FIELD DATA
• Documented events • Prior flood studies • Planning studies • Design reports • Regional studies • Hydrologic and hydraulic models • Indigenous Knowledge • Local accounts • Media accounts • Climate change studies • Guidelines	• Stream flow • Stream level • Direct discharge measurements • Rating curves • Meteorologic • Water temperature • River ice	• Base maps • DEM / LiDAR • Aerial imagery • Radar satellite imagery • Optical satellite imagery • Local mapping • Previous flood mapping • Datums and projections	• Survey plan • Survey control • River geometry • Highwater marks and ice scars • Hydraulic structures • Field notes, photos, and video • Ice jam observational information

Methodology – Companion Tables
DATA REVIEW & ASSESMENT

DATA REVIEW & ASSESSMENT			
STUDIES, REPORTS & ACCOUNTS • Data extraction and collation • Dominant ice jam processes • Confirm ice jam is dominant flood mechanism (over open water)	HYDROMETEOROLOGIC • Data quality • Periods of record • Representative events • Representative of study reach	GEOSPATIAL • Coverage • Survey data comparison • Conventions and symbology • Preliminary base maps and geodatabase	FIELD DATA • Survey control • QA/QC • Bathymetry / bed survey • Hydraulic structures • Flood control structures • Field notes, photos, and video

GAP ASSESSMENT

- Assess adequacy of data collected for hydrology, hydraulics, and mapping.
- Assess the need to pursue collection of additional data that was identified during the data review (e.g., other published work, work in progress, additional local knowledge).
- Assess the need to collect additional monitoring, observational, or survey data.
- Develop methodology to rely on limited data.

Methodology – Companion Tables
FLOOD HYDROLOGY

Government of Northwest Territories

nhc

FLOOD HYDROLOGY

FLOOD HISTORY

- Overview of ice jam flood history and locations prone to flooding.
- Tabulated historical and observed ice-affected floods (dates, location, magnitude, and impacts).
- Detailed summary of major documented events with supporting information including:
- Sequence of events leading to the evolution of the ice jam flood event.
- Description of the ice jam development, the maximum flood condition, and ice jam recession.
- Information collected during the event including survey data and ground observations (e.g., water level profiles, photos, ice conditions), and aerial observations by plane, helicopter, and/or drone (e.g., river reach extent and nature of ice conditions).
- Post event information including survey data (e.g., highwater mark profiles, ice scars, shear walls), monitoring data (e.g., water levels), post processed data (satellite data, aerial imagery, ice mapping).

Methodology – Companion Tables
FLOOD HYDROLOGY

FLOOD HYDROLOGY

ICE REGIME

- Identify hydro-climatic conditions characteristic to the study reach.
- Examine river morphology and identify locations of interest with respect to ice processes including hydraulic controls, steep sections, deep pools, sharp bends, geomorphic features, river encroachments.
- Characterize various ice processes in relation to the study reach.
- Determine causal factors for ice jam severity.
- Determine typical ice characteristics (thickness, roughness, type).

FLOOD LEVEL FREQUENCY

DATA PREPARATION	DIRECT METHODS	INDIRECT METHODS
• Hydrometric records • Measured data (highwater marks, trees scars) • Model input data (where synthesized data is included)	• Extreme value statistics • Frequency analysis	• Determine dominant causal factors • Modelling and data synthesis • Frequency analysis

Methodology – Companion Tables
FLOOD HYDRAULICS

FLOOD HYDRAULICS			
DATA PREPARATION • River geometry • Physical jam characteristics • Calibration data • Boundary conditions	MODEL CONSTRUCTION & CALIBRATION • Model geometry • Jam stability parameters • Roughness • Calibration	**FLOOD PROFILE MODELLING**	
		SYNTHETIC FLOOD LEVELS • Calculate flood levels to support frequency analysis (if required)	FLOOD FREQUENCY LEVELS • Calculate design flood frequency profiles

Methodology – Companion Tables
FLOOD MAPPING

FLOOD MAPPING			
BASE MAP PREPARATION • Layout and scale • Base data • Model information • Annotation • Symbology	FLOOD EXTENTS (VECTOR DATA) • Flood extents derived from flood profiles • Refinements / adjustments	DEPTH AND ELEVATION (RASTERIZED DATA) • Create water surface elevation and depth grids	MAP LIBRARY CREATION • Inundation maps • Hazard maps • Risk maps

Methodology – Companion Tables
CLIMATE CHANGE CONSIDERATIONS

CLIMATE CHANGE CONSIDERATIONS
• Determine climate change scenarios.
• Assess potential impacts of climate change scenarios on flood hydrology and flood hydraulics.
• Assess potential impacts of climate change scenarios on flood mapping results.