Climate Change Adaptation and Adaptive Environmental Management – An Integrated Process in the Design of Natural Channels

Presented by: Ian Jewell

.

August 1, 2013

AECOM

Introduction and Context

AECOM

Presentation Outline

- Define ‘Adaptive Environmental Management’ (the Ontario Canada application and interpretation of the ‘9 step’ process)
- Define Climate Change Adaptation (the interpretation of how adaptation of stream restoration can be applied)
- Where does Climate Change factor into the 9 step process?
- How does application of adaptive management respond to climate change initiatives
- Can adaptive management processes be used to satisfy climate change considerations; in terms of implemented design, in terms of risk management.

AECOM

Adaptive Management Approach

Based on a guide developed in 2001 in Ontario Canada to assist practitioners in restoring streams

What is Adaptive Management?

- Many interpretations are currently being used
- The understanding of the functions of a natural system and implementing a plan to deal with changes that are anticipated based on balanced objectives
- Provides a framework to consider long term natural processes in ultimate restored conditions. (allows the natural progression of regeneration and stability over time, vs. immediate restored conditions)

AEM - Adaptive Environmental Management

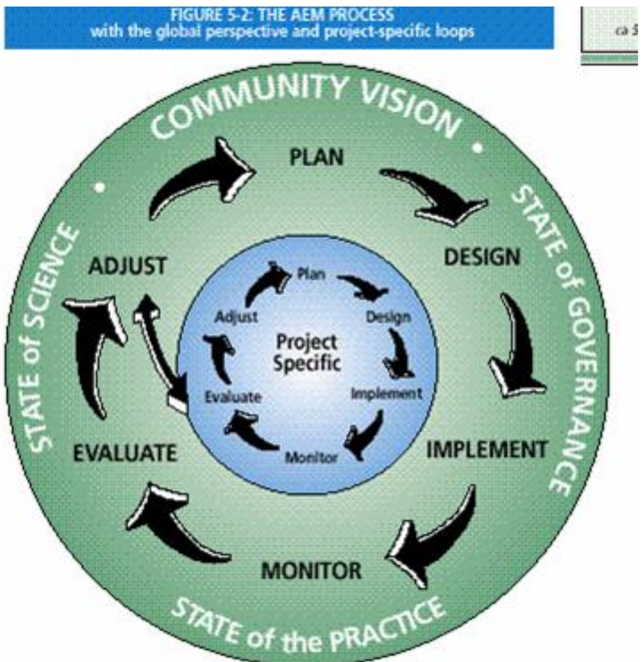


FIGURE 5-2: THE AEM PROCESS
with the global perspective and project-specific loops

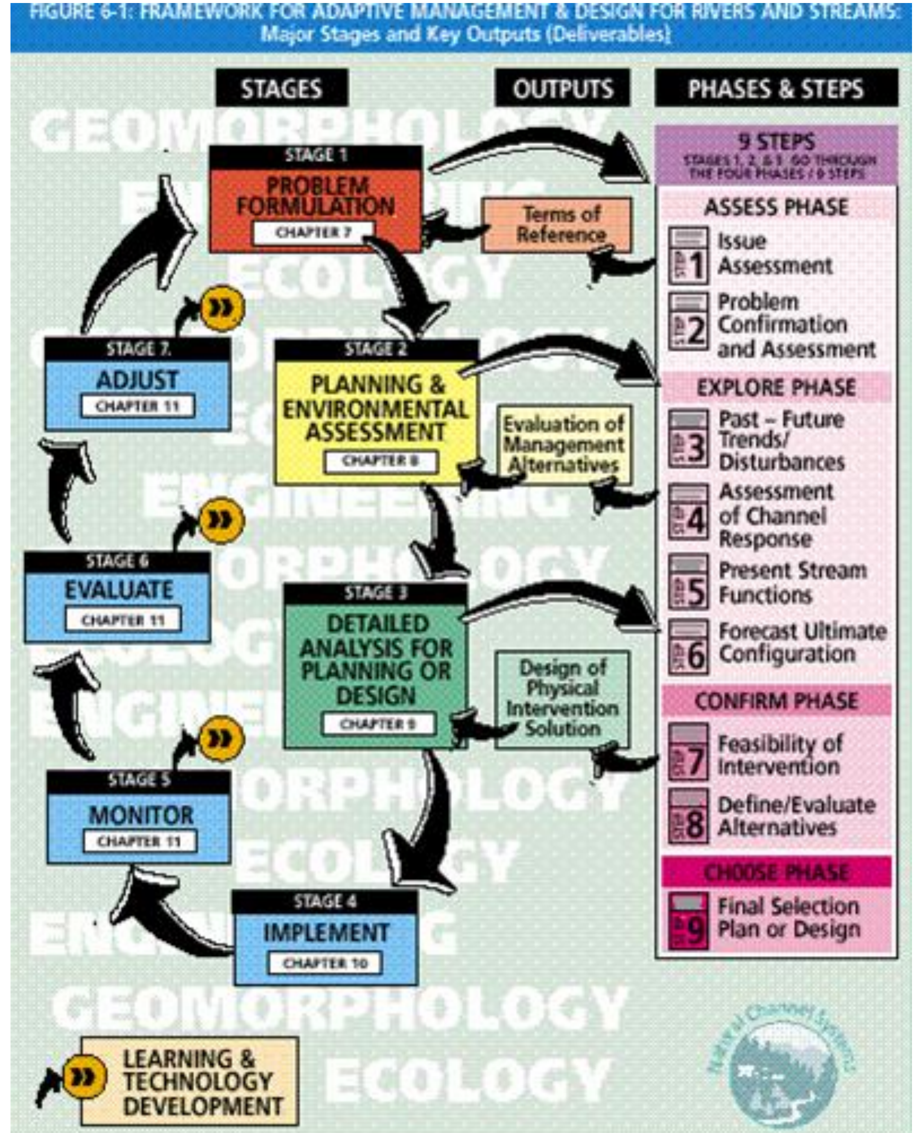


FIGURE 6-1: FRAMEWORK FOR ADAPTIVE MANAGEMENT & DESIGN FOR RIVERS AND STREAMS:
Major Stages and Key Outputs (Deliverables)

AECOM

Geomorphology-Ecology-Engineering

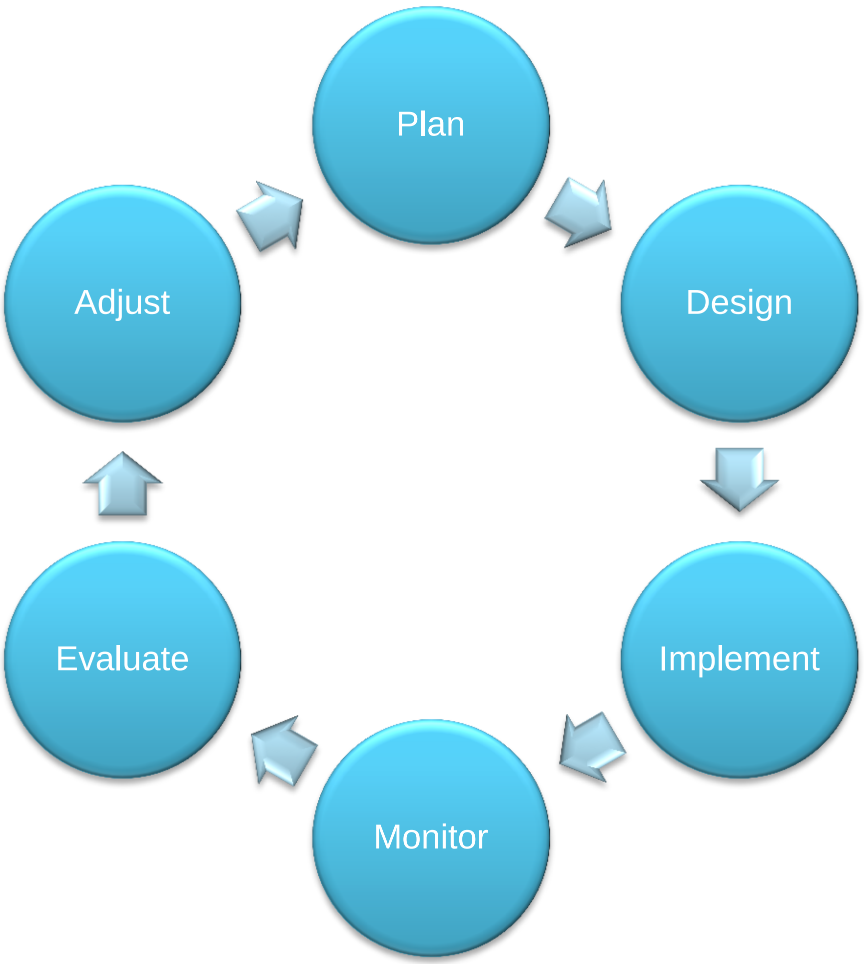
The Nine steps:

- Step 1 — Issue Assessment
- Step 2 — Problem Confirmation and Assessment
- Step 3 — Past - Future trends and Disturbances
- Step 4 — Assessment of Channel Response
- Step 5 — Present Stream Functions
- Step 6 — Forecast Ultimate Configuration
- Step 7 — Feasibility of Intervention
- Step 8 — Define and Evaluate Alternatives
- Step 9 — Final Selection, Plan and Design

AECOM

Long Term Adaptive Management

- *Iterative process*
- *Seeks to create dynamic stability in stream systems*
- *Requires a long term commitment, but allows for development of staged intervention*



AECOM

What is Climate Change?

Has many interpretations:

'Periodic modification of Earth's climate brought about as a result of changes in the atmosphere as well as interactions between the atmosphere and various other geologic, chemical, biological, and geographic factors within the Earth system' *Encyclopedia Britannica*

In terms of natural channel restoration:

- Extremes in rainfall and drought that affect the viability of a system.
- Some municipalities changing IDF curves for hydrological estimate

Recent studies focus on predicting increases or decreases in *risk* to elements of the community

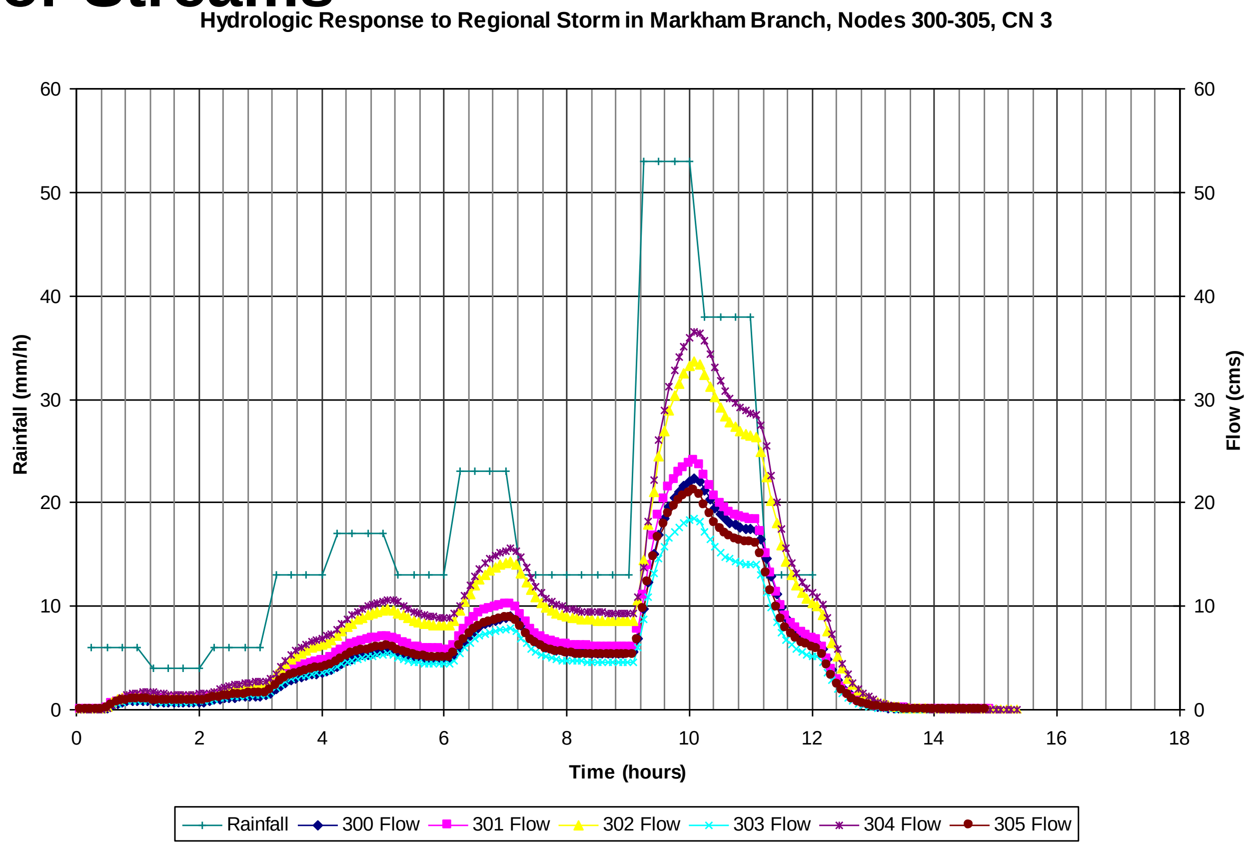
Risk is often quantified in terms of insurance

AECOM

Climate Change for Streams

Stream restoration

- Primary challenge with climate change is related to watershed conditions.
- In Ontario- change in rainfall patterns.

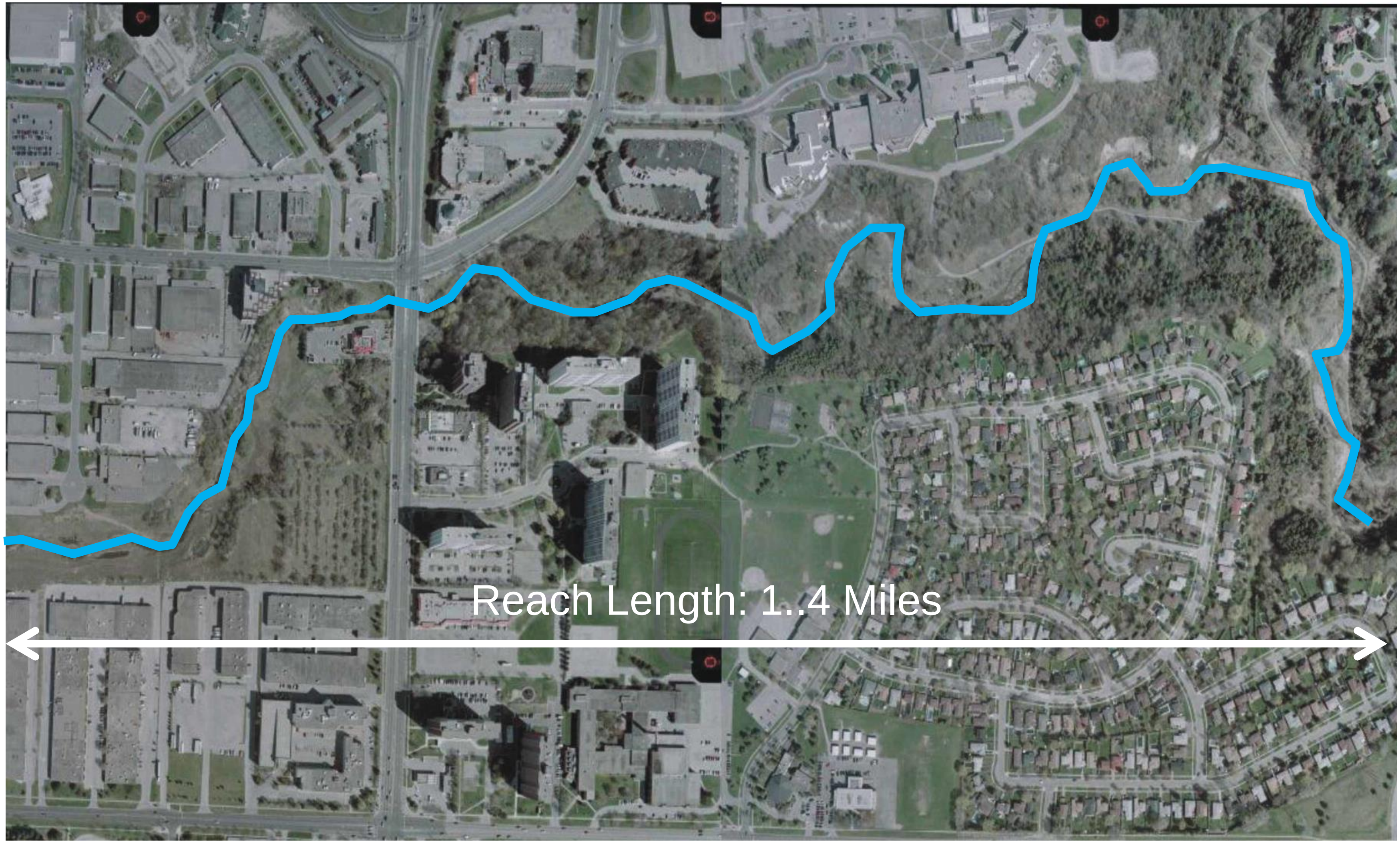


Specific climate change studies have found:
- **frequency** at which the rain falls is changing
- **intensity** at which it falls is changing

- But overall end quantity is not changing

AECOM

Application of Design Change in Toronto Example



AECOM

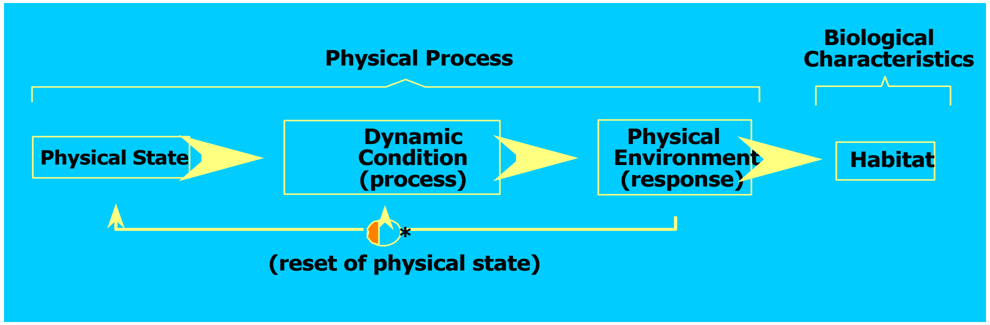
Channel Condition

A highly urbanized stream channel in constant state of change:

Entire erosion control systems established in the 1980's have failed reach wide through changes in watershed land use and development

Climate Change Influence to Implementation Design

- Specific watershed-based climate change study completed suggests low peak storm events increasing in frequency (6mm to 10mm events)
- Fish inventories suggest fish are present, but monitoring shows spawning habitat is short lived
- Solution requires flow velocities to be halved (4.0m/s to 2.0 m/s max habitat threshold)
- Design channel cross section to convey large flow events, but maintain low flow channel
- Create pools to provide local backwater for fish habitat



AECOM

Design Approach

Challenges:

- Urban setting (**75% impervious**, one of the most urbanized watersheds in the Toronto area)
- Location on the watershed profile, (steep slope)
- Highly incised valley setting (minimal floodplain access)

Approach using AEM:

- Prediction of channel shape (geomorphology),
- Channel conveyance and structural stability (engineering)
- Improvement of aquatic/terrestrial resources (ecology)

Hydrological study done to identify and plan for future climate change impact on stream channel

AECOM

Solution: Convergence of objectives in AEM and Climate Change adaptation

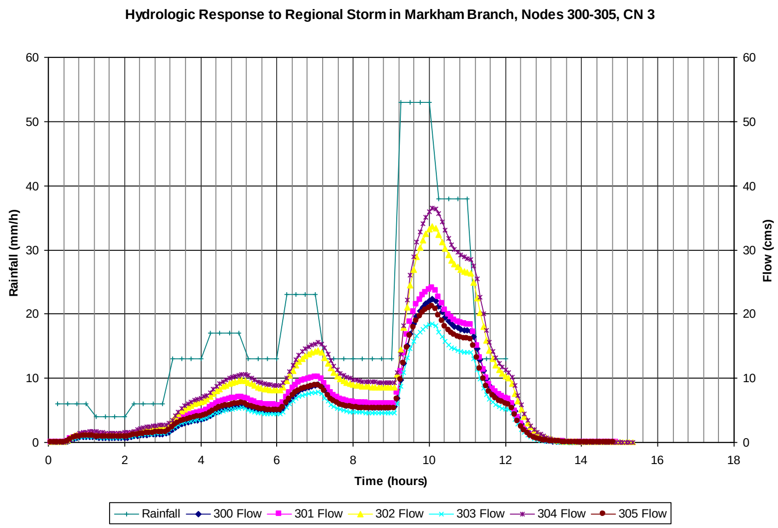
- **Reduction in flow velocity** necessary for low peak events
- Use hard stabilization measures to protect critical infrastructure, **But** create enough backwater to allow fish passage and energy reduction (achieve sub-critical flow condition)
- **Valley retaining structures** to reduce forest loss from channel section enlargement
- **In-stream structures** to direct flow in new plan form and to adapt to range of flow volumes as flood levels increase
- Ensure channel stability is achieved without reliance on sediment source

AECOM

What did we learn?

Climate Change

- That low peak events in an urban system can have dramatic impacts on habitat viability
- That flow velocities need to be reduced to sustain long term fishery resources and channel self-regeneration
- That design redundancy can provide risk reduction, but at a high cost



AECOM

What did we learn?

Adaptive Management

- That climate change is an integral part of determining long term viability of a system
- That staged implementation is possible based on acceptance of risk identified through hydrologic variability of streams
- That Climate Change Adaptation should be intrinsically integrated with natural channel design initiatives.

Thank You