

Breaking the Serial Engineering Cycle: Alternative Approaches to Floodplain Management in British Columbia

T. Lyle¹ and J.C. Day²

Abstract

British Columbia's current approach to flood damage reduction does not endorse natural flood control. In an effort to understand the reasons for this neglect, this paper examines pathways to implement natural approaches to flood damage reduction in British Columbia. Policymakers in this province face numerous obstacles in the implementation of non-structural approaches. However, numerous non-structural alternatives are available to overcome these obstacles. Legislative changes, the creation of basin-wide planning institutions, a shift in responsibility and liability, and citizen involvement are proposed as key actions to shift away from BC's reactive structural approach to floods.

We Are Going to Get Wet

There is little doubt that a major flood will affect the Lower Fraser Valley, BC. The problem lies in accurately predicting the timing and severity of such an event. Passivity by all levels of government, regarding floodplain management, has created a risk for millions of British Columbians; risks related to flood damage and potential loss of life. Given the current institutional arrangements for controlling floodplain occupancy, those at risk will continue to increase as a result of population growth.

Over fifty percent of the Lower Mainland's population currently reside behind flood control structures (BC MELP n.d.a); each is susceptible to structural failure during a large flood. Continued development in 'urban exempt areas' exacerbates the problem by directing development to floodplains, creating a cycle of 'serial engineering'. This process of building flood control structures then attracts further development that itself requires more structural protection. Not

only does this cycle degrade the natural environment, costs also spiral, as structures need to be continually maintained and rehabilitated. Structural maintenance and improvements cannot always keep pace with new development and the ever-changing hydrological characteristics of the river; thus the risk to residents 'protected' by structures increases steadily. This cycle must be broken if Fraser Valley residents are to become safe from flooding.

Federal, provincial, regional and municipal governments all contributed to the current situation. And, for the most part, landowners are ignorant of flood risk to their homes and lives. Both senior and local level governments are guilty of creating the current situation of British Columbia's densely populated floodplains (Day, 1999). With the full co-operation of senior governments, local governments permitted families and businesses to invade floodplains throughout the province for the last 100 years in full knowledge of the risk this creates for property owners. Thus, a concerted effort by all governments

¹ northwest hydraulic consultants, 30 Gostick Place, North Vancouver, BC V7M 3G2

² Professor Emeritus, School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC V5A 1S6

and private citizens is needed immediately if immense future flooding damage is to be avoided.

Structures, Structures Everywhere

Concerns regarding BC's dependence on structural flood control measures were originally voiced during the 1950s and 1960s (Sewell, 1965). Yet, structures continue to form the primary defense against floodwaters; over 600 km of dykes protect the Lower Mainland alone. Conversely, BC did not make full use of the federal *Flood Damage Reduction Program* funding to map the entire Fraser River floodplain, which remains poorly covered (BC MELP n.d.b). This policy contributed to the continuing dependence on structures and reduced the possibility of initiating non-structural measures for flood control.

Structural flood control measures can mitigate damages to floodplain development. However, there is overwhelming evidence that structures will not protect residents in the long term, will become increasingly expensive and will cause environmental degradation (Hunt, 1999). Structural flood control, although relatively successful to date, is not likely to prevent substantial damage when the next flood of record strikes (Fraser Basin Management Board, 1994). In the meantime, structures continue to exert an unnecessarily heavy demand on government coffers, and cause environmental degradation. British Columbia needs to take decisive action immediately to modify its reactive structural approach into a more proactive, non-structural strategy.

A Natural Approach to Flood Damage Reduction

An alternative strategy to reduce flood losses exists based on restoring hydrologic functions in a river system and reducing the number of people vulnerable to floods. Reinstatement of biological and hydrologic processes reduces the severity of flooding and decreases the number of vulnerable properties, thus reducing the cost of future flood events. The positive externalities of this approach are numerous: overall environmental quality is improved; agricultural

irrigation can be augmented; commercial and sport fisheries are enhanced; recreation and environmental education possibilities are increased; and local economies may be strengthened through community revitalisation (Lyle, 2001). However, the potential for flow control and additional benefits in the Fraser Valley are unknown at this time. Further research into hydrological best management practices for the Fraser River Valley, or similar watersheds, is required to ensure maximum benefits from the use of non-structural flood control approaches.

Examples of successful natural flood control projects are found across Ontario, Europe and the United States (Brown *et al.*, 1997; U.S. Army Corps of Engineers and Napa County Flood Control and Water Conservation District, n.d.). Despite the proven advantages of such an approach, and the disadvantages associated with the heavy dependence on structures for flood control, British Columbia continues to rely on structural measures as its first defence against flooding.

Steps to a Solution

Canadian and British Columbian policies do not currently reflect the long-term advantages of a non-structural approach to flood damage reduction. British Columbians need to adjust flood management policy based on two sets of actions. First, the obstacles to a non-structural approach to flood damage reduction must be overcome, and then non-structural policy alternatives must be implemented.

Obstacles to a Non-Structural Approach to Flood Damage Reduction

Flood policy is a difficult area; the inherent uncertainty of natural disasters requires that decisions be made without fully understanding the consequences. Further, momentum favouring structural flood control has been created by precedents established by all levels of government over the past century. This momentum has created obstacles (Table 1) that must be overcome if a natural approach to flood damage reduction is to be gradually adopted in the Lower Fraser Valley, based on appropriate public flood policy.

Table 1. Summary of obstacles to non-structural approaches to flood control.

Obstacle	Problem
High floodplain land values from historic development	<ul style="list-style-type: none"> • Raises land values, thereby increasing the cost of land acquisition for non-structural flood control projects
Private property rights versus common property resources	<ul style="list-style-type: none"> • Many floodplains are in private hands; owners do not value water retention as a common property resource
Inter-Jurisdictional Complexity	<ul style="list-style-type: none"> • Jurisdictional boundaries rarely coincide with watershed boundaries • Upstream and downstream communities conflict due to flooding issues
Responsibility	<ul style="list-style-type: none"> • Lack of inter-governmental and intra-governmental cooperation • Costs of floodplain habitation are borne by the wider community, province and nation
Lack of Information	<ul style="list-style-type: none"> • Public knowledge of flood risk and associated cost is low • Low understanding of flood control issues for public and policymakers
Current Analysis Frameworks	<ul style="list-style-type: none"> • Benefit-costs calculations rarely favour non-structural approaches as time horizon is short, and non-monetized externalities are excluded
Social Costs	<ul style="list-style-type: none"> • Acquisition and relocation of families, businesses and communities can disrupt social networks in the short term
Policy-Making Uncertainty	<ul style="list-style-type: none"> • Flood management spending complicated by uncertainty of flood events

Adjustments Suitable for a Non-Structural Approach to Flood Damage Reduction

Historically, British Columbia has relied on two forms of adjustments. These include structural flood control, and post-disaster payments to affected areas, neither of which is likely to reduce future flood losses. Structural flood control, although mostly successful to date, is unlikely to protect Fraser Valley residents as the region continues to grow, structures age, and the hydrology of the Fraser River evolves. As a result of this continued dependence on structures for flood

control, post-disaster payments to flood victims will continue to increase, ultimately overburdening the ability of Canadian taxpayers to pay.

A series of adjustments that promote non-structural flood damage reduction are available to policymakers (Table 2). Each adjustment plays a role in flood control depending on local conditions. Thus flood management decisions must be made, in part, locally to ensure local buy-in. The full range of flood adjustments creates a large toolbox, from which local policymakers can choose appropriate measures.

Table 2. Summary of policy alternatives to achieve a non-structural approach to flood control.

Alternative	Description
Technical Tools	
Floodplain Mapping	<ul style="list-style-type: none"> Delineate flood prone areas, normally using the 200-year flood (Brown <i>et al.</i>, 1997)
Policy Objectives	
Impede Development	<ul style="list-style-type: none"> Bar further floodplain development
Change Development	<ul style="list-style-type: none"> Change development rules to allow non-structural flood control options (U.S. National Parks Service, 1996)
Policy Instruments	
Regulation	<ul style="list-style-type: none"> Strict government control of floodplain land use (Kreutzwiser <i>et al.</i>, 1994)
Economic Incentives	<ul style="list-style-type: none"> Monetary incentives to promote non-structural flood damage reduction by floodplain residents
Voluntary (Education)	<ul style="list-style-type: none"> Increased public awareness of flood risk—possible adjustments to floods (de Loë and Shrubsole, 1999)
Insurance Action	<ul style="list-style-type: none"> Private insurance for floodplain dwellers, limiting liability to those at risk (Platt, 1999)
Policy Paradigms	
Acquisition and Relocation	<ul style="list-style-type: none"> Public purchase of vulnerable floodplain properties/relocate residents
Water Retention as a Common Property Resource	<ul style="list-style-type: none"> Change in public attitude towards to the use of private land for water retention during floods (Environmental Review, 1996)
Best Practices	
Ecological Restoration	<ul style="list-style-type: none"> Environmental/ecological changes to improve floodplain water retention (American Rivers, 1997)
Open Space	<ul style="list-style-type: none"> Minimize buildings and maximize open space on floodplains (U.S. National Park Service and Rivers, Trails and Conservation Assistance Program, 1996)
‘Flood-Friendly’ Uses	<ul style="list-style-type: none"> Use floodplains for sports fields, parks, and golf courses that can withstand occasional inundation
‘Flood-Friendly’ Agriculture	<ul style="list-style-type: none"> The agricultural use of floodplains using special crops and techniques that can withstand occasional inundation (U.S. Department of Agriculture, 1997)
Flood-Proofing	<ul style="list-style-type: none"> Flood-proofing buildings through construction techniques (Williams, 1978)

To overcome obstacles and implement policy alternatives, governments must pursue the following actions:

- enable appropriate legislation and remove legislative barriers,
- create basin-wide planning institutions,

- shift responsibility and liability to floodplain dwellers, and

- involve relevant stakeholders in the planning process.

Figure 1 summarizes the steps to engaging non-structural approaches to flood damage reduction, including the above actions.

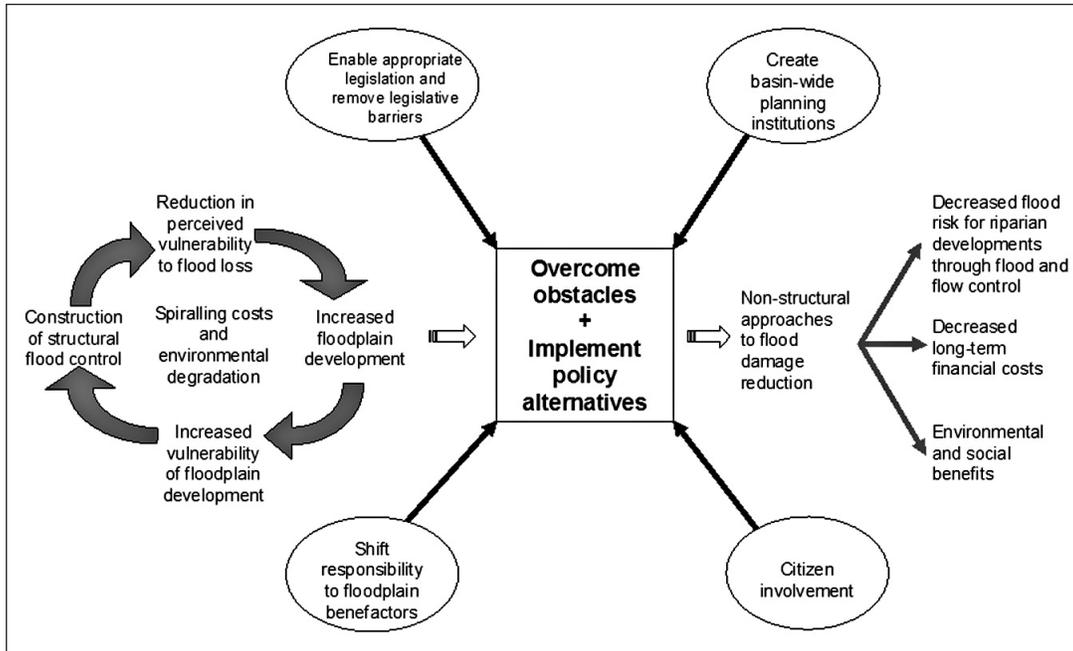


Figure 1. Steps to Non-Structural Flood Management.

Legislation

Generally, flood legislation in BC includes opportunities to promote non-structural flood control (Lyle, 2001), especially if legislation were used imaginatively to realize flood control benefits. However, often legislative barriers need to be removed and legislation improved. Unfortunately, existing legislation is seldom used in this way; policy-making defaults to structural and reactive measures to combat potential flooding. This situation must be reversed to avoid potentially heavy losses of life and property in future.

Authorities in Ontario have shown that intelligent and effective floodplain management decisions can be made when communication channels are open (Fraser Basin Council, 2000; Brown *et al.*, 1997). Continued funding and support for these, and other innovative institutions is vital to the promotion of a non-structural approach to flood damage reduction. Co-ordination and co-operation amongst different issue groups will provide impetus to initiate publicly supported, multi-purpose projects, which can provide an array of flood control benefits.

The Need for Basin-Wide Planning

Institutions

Co-ordination and co-operation between and within governments is cited as an obstacle to non-structural flood control. Watershed institutions such as the Fraser Basin Council in BC and some Conservation

Shifting Responsibility and Liability

There must be local control of floodplain management to implement a non-structural approach to flood damage reduction. However, this level of control also needs to come with responsibility. Given that local solutions to flood management are required, how can senior governments support local government

given the current institutional arrangements? In fact, there are several opportunities for senior government involvement in the management of local floodplains.

First, there is a need to gradually shift financial responsibility for flood losses as well as land use control to floodplain residents and their local governing bodies. At present, local government enjoys benefits without assuming responsibilities, whereas senior governments are liable without control. If local governments, and by extension residents, were responsible for post-disaster costs, the numerous non-structural adjustments to flood control would become more attractive. This shift could occur in two instances. First, if the federal and provincial governments were to discontinue post-disaster payments. The *Canada Water Act* states that no funding will be given in cases where buildings on designated floodplains are damaged. However, funds continue to be handed out; in effect, floodplain property owners are currently subsidized by the entire nation, in the form of post-disaster payments, to compensate for predictable flood losses. Second, senior level governments need to provide incentives to insurance companies to insure at-risk properties, or to create government sponsored insurance as the United States government has done since the 1960s (Platt, 1999). Overland flood insurance would require that floodplain owners assume financial responsibility for the risk of flood damage. Thus, non-floodplain owners would no longer be responsible for damages experienced by those living on floodplains. The National Flood Insurance Program in the United States is an excellent example of how such a federally-aided program could create a more rational flood control policy in Canada. It is time that senior level governments stop disbursing disaster funds, and instead create an opportunity for floodplain residents to insure themselves. If this does not occur, floodplain residents will continue to exploit the current post-disaster payment system by over developing floodplains. Control and responsibility for floodplain flood management must be shifted to local government to achieve this goal.

Citizen Involvement

Grassroots buy-in to floodplain management programs is crucial for the success of non-structural approaches to flood damage reduction. Currently, many floodplain residents are oblivious to the risk to themselves and their property. Additionally, there is a false sense of security created by senior governments through the existence of Disaster Financial Assistance arrangements. Private citizens will be awarded post-disaster payments regardless of the level of risk they have assumed by living, or doing business, on floodplains. A further deterrent to non-structural approaches to flood damage reduction is the appearance of structural reliability. Flood control structures are easy to understand, whereas alternative adjustments to flood damage reduction require a greater understanding of complex riparian processes. Thus, private citizens are unlikely to support non-structural flood damage reduction measures because they believe that governments will protect their families and assets through structures and post-disaster payments.

Citizen support for non-structural flood damage reduction measures will only arise from policy changes by all levels of government. Through media campaigns, governments could foster greater level of understanding amongst the public and create the opportunity to explore alternatives to structural flood control. More persuasive would be to shift the cost of flood protection to private citizens who are individually at risk, and away from Canadian taxpayers as a whole. Senior governments need to desist from paying for post-disaster costs; floodplain dwellers should pay for their own predictable risk privately. However, given that senior level governments promoted the current situation of densely populated floodplains, without properly informing property owners of the flood risk, society is partly liable to create and fund a solution. Thus it is only fair that senior governments help the insurance industry to create a suitable program to fund disaster costs. Further research into creating an appropriate program is needed.

Table 3. Summary of recommendations.

Summary of Recommendations
General
<ol style="list-style-type: none"> 1. Break the cycle of ‘serial engineering’ by ceasing to build structural flood control 2. Implement alternative policy adjustments and target to local situations 3. Reform the benefit-cost analysis framework to include non-monetary externalities
Legislation
<ol style="list-style-type: none"> 1. Remove legislative barriers to non-structural flood control 2. Create and enable appropriate legislation
Basin-Wide Institutions
<ol style="list-style-type: none"> 1. Create watershed institutions to facilitate communication, education, co-ordination and co-operation amongst all levels of government and stakeholders
Responsibility Shift
<ol style="list-style-type: none"> 1. Rectify the current situation of local governments who enjoy benefits without responsibility and of senior level governments who experience liability without control 2. Gradually discontinue post-disaster assistance payments 3. Encourage the insurance industry, with the help of senior level governments, to create overland flood insurance programs to replace post-disaster assistance payments
Citizen Involvement
<ol style="list-style-type: none"> 1. Create public awareness programs to encourage voluntary efforts to adopt non-structural approaches to flood damage reduction 2. Create economic incentives to encourage private citizens to increase flood awareness, and to flood-proof homes and businesses
Additional Research
<ol style="list-style-type: none"> 1. Study the potential to initiate wetland storage in the Fraser Basin, with specific interest in the best location for wetlands to temporarily store excess flow during floods 2. Conduct detailed economic analysis of the costs and benefits of a non-structural flood control approach in the Lower Fraser Valley

The Probability of Success

Progress in flood hazard management has been slow in Canada. Although research into non-structural flood management adjustments began in the 1930s in the United States, little advancement has been made since in BC with the exception of ecological concerns. Future progress will occur in one of two ways: either, through gradual, steady changes to policy resulting from enlightened governance, or through rapid change after large flood events. For example, many changes to flood management in the Mississippi Valley resulted directly from the disastrous flood of 1993. Non-structural policy knowledge coincided with this large flood event and public support for change briefly opened a

policy window, which allowed for proactive non-structural flood management to be instituted. The Lower Fraser Valley could also be induced to change its approach to flood control through similar catastrophic flooding, although a planned transition to a non-structural system would be less costly monetarily and in human suffering.

Progress in the Lower Fraser Valley

Floodplain management is a difficult game. It requires that “the risk associated with the floodplain [is balanced] against the desire to make use of floodplain lands” (Boyd *et al.*, 1999). Numerous obstacles to non-structural adjustments increase

the difficulty of effective and efficient floodplain management. However, some progress has been made in overcoming obstacles and to move towards non-structural adjustments along the Fraser River Valley. The creation of the Joint Program Committee for Integrated Flood Hazard Management by the Fraser Basin Council facilitated communication amongst floodplain stakeholders. This initiative offers the greatest potential for progress in adopting non-structural flood control options in the Lower Fraser.

A non-structural approach to flood damage reduction needs to take centre stage in flood management policy in British Columbia if the province is to avoid exponential flood damages in future. Tools are available to promote such an approach to flood damage reduction although BC has not taken advantage of these instruments to date. Indeed, the province lacks leadership and commitment to flood management issues; decisions tend to be temporary, reactive, and most often are taken in the face of potentially large floods. Longer-term solutions in the Lower Fraser Valley are necessary to ensure safety for residents and improvements. Forward thinking politicians and policymakers must begin to make changes immediately to floodplain management in BC to achieve this goal.

References

- American Rivers. 1997. *Floodplains*. At <<http://www.amrivers.org/floodsummary.html>>. 4 April 2000.
- Boyd, Dwight, Anthony Smith and Barbara Veale. 1999. Flood Management on the Grand River, Ontario, Canada: A Watershed Conservation Perspective. *Environments*, 27(1): 23-47.
- BC MELP 1999a. *More Flood Control Projects Approved: Provincial Funding Nears \$7 Million*. At <<http://www.env.gov.bc.ca/main/newsrel/fisc9900/may/nrPEP.htm>>. 25 May 1999.
- BC MELP, Water Management Branch. n.d.a. *Flood Hazard Management Homepage*. At <<http://www.env.gov.bc.ca/wat/flood>>. 1 December 1998.
- BC MELP. Water Management Branch. n.d.b. *Index of Designated Floodplain Areas by Region*. At <<http://www.elp.gov.bc.ca/rib/wat/fpm/regfpmmin.html#fpmreg2>>. 22 June 2001.
- Brown, Douglas W., Syed M.A. Moin and Michelle L. Nicolson. 1997. "A Comparison of Flooding in Michigan and Ontario: 'Soft' Data to Support 'Soft' Water Management Approaches." *Canadian Water Resources Journal*, 22(2): 125-139.
- Day, J.C. 1999. "Adjusting to Floods in the Lower Fraser Basin, British Columbia: Towards an Integrated Approach." *Environments*, 27(1): 49-66.
- de Loë, Rob and Dan Shrubsole. 1999. "An Assessment of a Proposed Floodplain Management Evaluation Methodology: A Case Study of the Credit River Watershed." *Scientific/Technical Report for Emergency Preparedness Canada*. At <http://www.epc-pcc.gc.ca/research/scie_tech/ef_floodmg/floodplain/index.html>. 17 May 2001.
- Environmental Review. 1996. "Wetlands and Flood Control in the Mississippi Watershed: A Conversation with Donald Hey." *Environmental Review*, 3(8).
- Fraser Basin Council. 2000. *Summary of Initiatives: Flood Hazard Management*. At <<http://www.fraserbasin.bc.ca/summary8.html>>. 1 May 2001.
- Fraser Basin Management Board. 1994. *Getting Ready for the BIG ONE*. Vancouver, BC.
- Hunt, C. 1999. "A Twenty-First Century Approach to Managing Floods." *Environments*, 27(1): 97-114.
- Kreutzwiser, Reid, Ian Woodley and Dan Shrubsole. 1994. "Perceptions of Flood Hazard and Floodplain Development Regulations in Glen Williams, Ontario." *Canadian Water Resources Journal*, 19(2): 115-124.
- Lyle, T. 2001. *Non-Structural Flood Management Solutions for the Lower Fraser Valley, British Columbia*. M.R.M. Thesis. School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC. August 2001.

Platt, Rutherford H. 1999. "From Flood Control to Flood Insurance: Changing Approaches to Floods in the United States." *Environments*, 27(1): 67-78.

Sewell, W.R. Derrick. 1965. *Water Management and Floods in the Fraser River Basin*. Department of Geography Research Paper 100. Chicago: University of Chicago, Department of Geography.

U.S. Army Corps of Engineers and Napa County Flood Control and Water Conservation District. n.d. *A Citizen's Guide to the City of Napa, Napa River & Napa Creek Flood Protection Project*. Berkeley, California: Moore Iacofano Goltsman, Inc.

U.S. Department of Agriculture. 1997. Government Efforts to Restore the Everglades. *Agricultural Outlook*. September 1997.

U.S. National Park Service and Rivers, Trails and Conservation Assistance Program. 1996. *Floods, Floodplains and Folks: A Casebook in Managing Rivers for Multiple Uses*. Washington DC: National Park Service.

Williams, G.P. 1978. Flood-Proofing of Buildings. *Canadian Building Digest*. Ottawa: National Resources Council Canada.