Investigating Floodproofing Strategies for Historic Settlement Areas of the Fraser River Basin, BC

A Complementary Application of Multi Attribute Decision Making and Stated Choice Modelling

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Overview of Presentation

- Review management problem
- Overview of 2 methods used to address problem
- Discuss complementary methodology
- Implementation
- Results
- Conclusion

Flooding in British Columbia

Low lying areas near the Fraser River are highly susceptible to flooding.

Richmond
(LuLu Island)

Estimated Fraser River Floodplain in 1894 – Flooded areas shown in **white** (Source: Fraser Basin Council, 2003)

Significant historical flood events on the Lower Fraser River:

- 1894 (The largest flood on record)
- 1948
- 1972
- (1999)

Flood Prevention in the Lower Fraser Valley – Some Current Issues

- Most communities are protected by ***'provincial standard dykes'***, that are designed to prevent floods as large as those of 1894.

Concerns about dykes -

- There is a 1 in 10 chance that a major flood (greater than or equal to 1894) will occur in the next 20 years.
- If this happens, the dykes may be unable to prevent flooding, because they will be overtopped by water.
- Even during smaller flood events, dyke failure is a possibility.
- Susceptible to changes in river hydrology, sedimentation
- Vulnerable to earthquake damage.
- Effectiveness will be reduced if sea level rises (global warming).

Flood Prevention in the Lower Fraser Valley – Some Current Issues

- Since 1972, provincial regulations have required ‘floodproofing’ of individual homes in most *new* subdivisions;

Floodproofing *= physically altering buildings and/or land to reduce or eliminate flood damages to the structure.*

e.g. Elevation, Wet Floodpoofing, Dry Floodproofing.

- Many urban areas are exempt from floodproofing regulations because they are located in ‘Historic Settlement Areas’.

Historic Settlement Areas

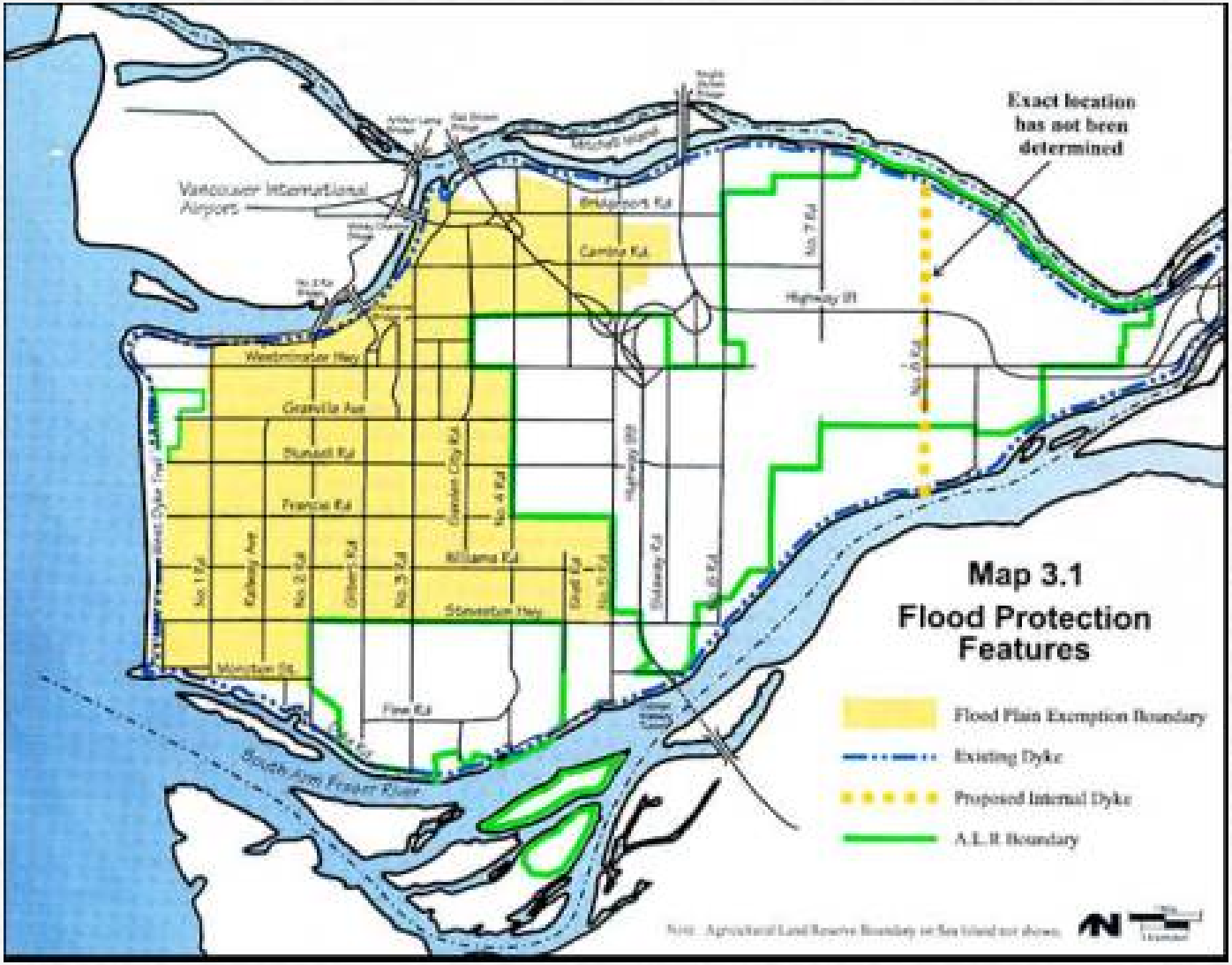
Definition:

Areas within the floodplain that have been developed through early settlement patterns that are committed to further development either through infill or redevelopment.

Issues -

- Totally reliant on existing dyking system for flood protection.
- Increasing urban density
- Non-uniform floodproofing standards
- Generally exempt from floodproofing regulations (Urban Exempt Areas)

Location of Urban Exempt Zone



Richmond, BC

Problem Identification

Research Question:

What can or should be done about current lack of floodproofing requirements for existing homes in HSA of the Fraser River Basin?

Fundamental Concerns -

- Multiple stakeholder interests (e.g. governments, developers, homeowners)
- Multiple objectives (e.g. costs, damages, aesthetics)

Research Objectives

1. To evaluate strategies that encourage ‘floodproofing’ of existing homes in residential areas in ‘Historic Settlement Areas’ of the Fraser River Basin, BC.
2. To investigate the benefits of a complementary application of multiple attribute decision analysis and stated preference discrete choice modelling.

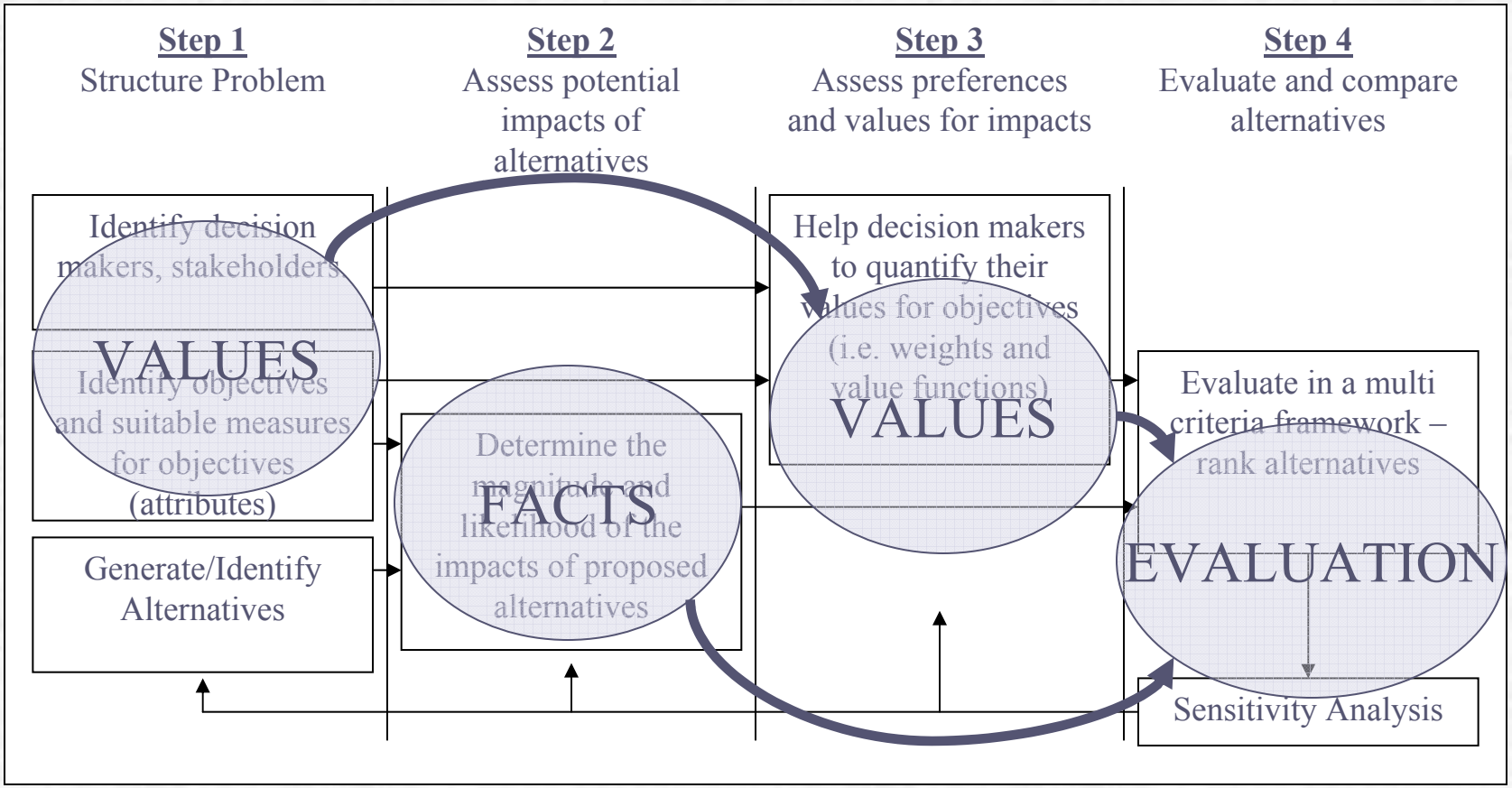
My Research Approach

- Use a complementary methodology that combines
  - Multiple Attribute Decision Analysis
  - Stated Preference Choice Modelling

Why?

- MADA is a quantitative decision tool traditionally used with one decision maker (or in small group environment).
  - Good problem structuring and analysis methods.
- SP methods are quantitative public preference modelling techniques.
  - Large samples, theory of errors.

Multiattribute Decision Analysis:
The 4 Step Process



What is Stated Preference Choice Modelling?

Purpose – to obtain multi-variate preference/ trade-off information from large samples.

Method – requires respondents to make choices between two or more profiles.

Key Products -

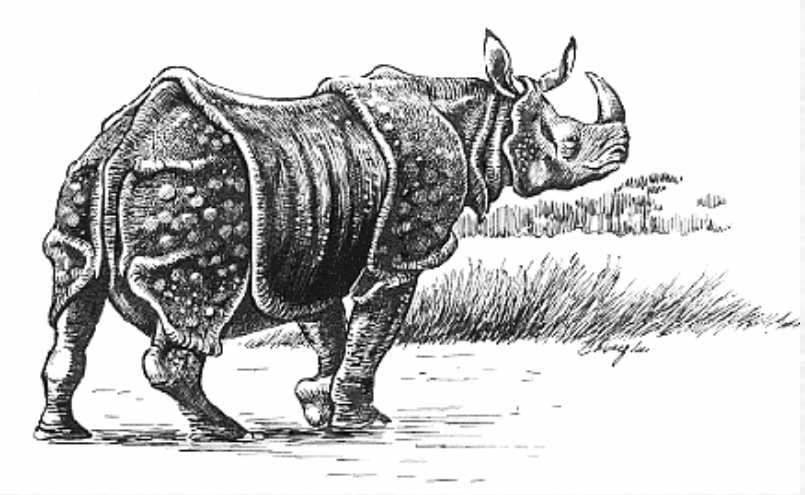
- Aggregate quantitative model of preference
- Part-worth utilities
- Decision Support Tools

Royal Chitwan National Park (Nepal)

Challenge: illiterate population

Issues:

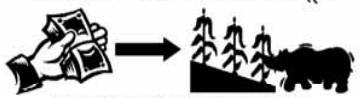
- Rhino conservation
- Tourism use
- Agriculture and crop damages
- Subsistence use
- Community development



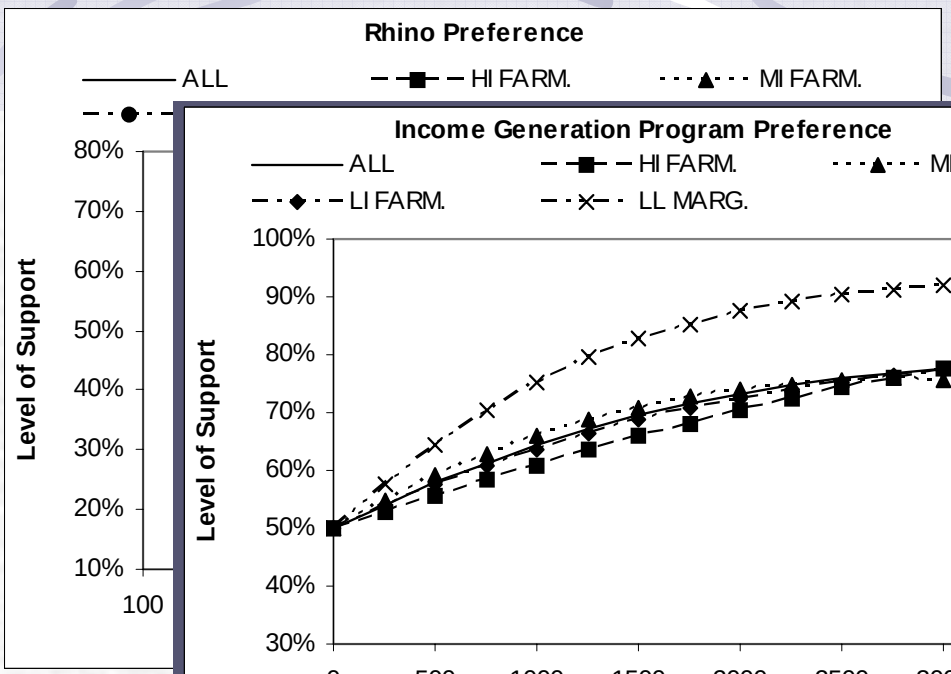
Rhinoceros unicornis

VERSION 1 CARD 1

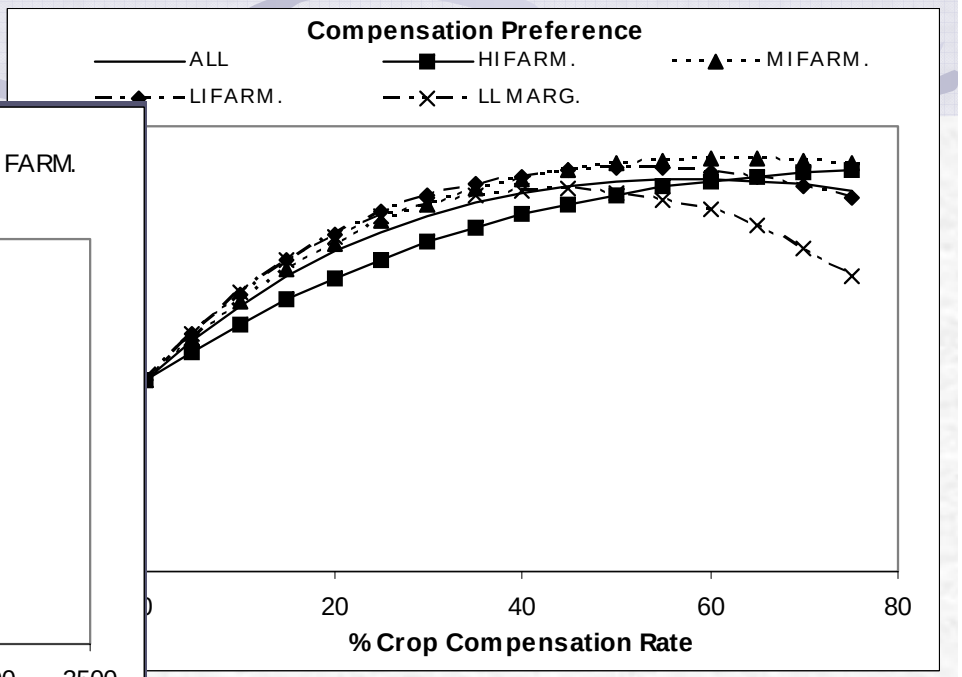
CARD - 1

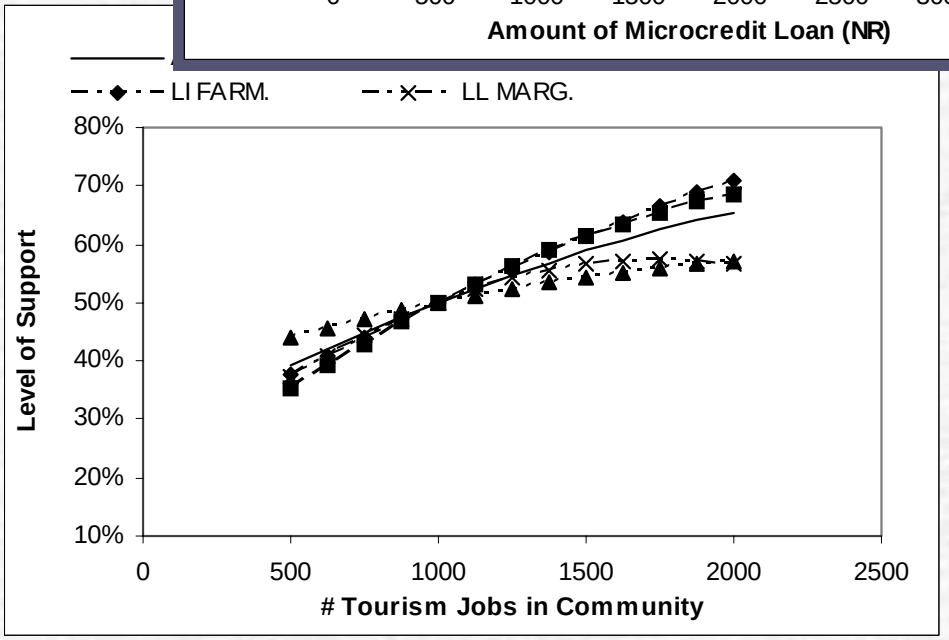
	विकल्प १	विकल्प २	अहिलेको अवस्था
राष्ट्रिय निकुञ्जमा भएका गैंडाको संख्या  Number of Rhino in the Chitwan Valley	१००० ० ८०० गैंडा 800 Rhino	१००० ० ४०० गैंडा 400 Rhino	१००० ० ६०० गैंडा 600 Rhino
बालीनाली नोक्सान बापत क्षतिपूर्ति  Compensation Rate for Crop Damages by Rhino	१००% ०% ५० % 0.5	१००% ०% ५० % 0.5	१००% ०% ० % 0
खरखडाई संकलनको लागी निकुञ्ज खुल्ला रहने अवधी  Length of Period to access Park Resources	१५ ० वर्षमा ३ दिन 3 days/year	१५ ० वर्षमा १० दिन 10 days/year	१५ ० वर्षमा ३ दिन 3 days / year
मध्यवर्ती क्षेत्रका बासिन्दाका लागी पर्यटन व्यवसायमा रोजगारीको अवसर  Tourism Employment available to Locals	२५०० ० ५०० रोजगारी 500 jobs	२५०० ० १५०० रोजगारी 1500 jobs	२५०० ० १००० रोजगारी 1000 jobs
आयमूलक कार्यको लागी आर्थिक सहयोग  Income Generation Program	रु ४००० रु ० रु १००० रु NR 1000	रु ४००० रु ० रु ३००० रु NR 3000	रु ४००० रु ० रु ० रु 0 NR

☐ विकल्प १ ☐ विकल्प २ ☐ अहिलेको अवस्था ☐ कुनैपनि विकल्प ठीक लागेन


Rhino Preference
ALL
HI FARM.
MI FARM.
LI FARM.
LL MARG.
Level of Support
80%
70%
60%
50%
40%
30%
20%
10%
100

Income Generation Program Preference
ALL
HI FARM.
MI FARM.
LI FARM.
LL MARG.
Level of Support
100%
90%
80%
70%
60%
50%
40%
30%
0
500
1000
1500
2000
2500
3000
3500
Amount of Microcredit Loan (NR)


Compensation Preference
ALL
HI FARM.
MI FARM.
LI FARM.
LL MARG.
20
40
60
80
% Crop Compensation Rate


LI FARM.
LL MARG.
Level of Support
80%
70%
60%
50%
40%
30%
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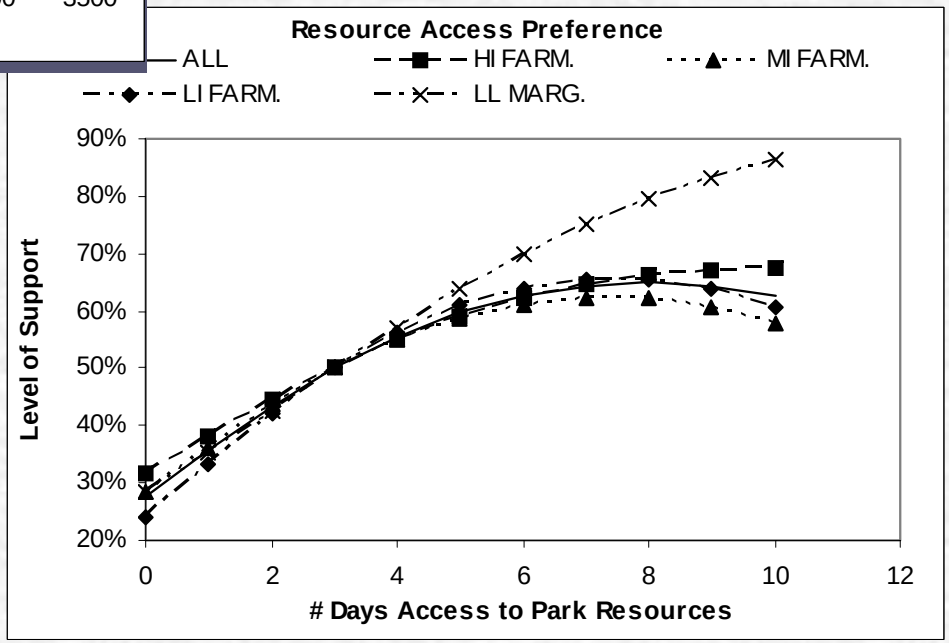
10%
0
500
1000
1500
2000
2500
Tourism Jobs in Community


Resource Access Preference
ALL
HI FARM.
MI FARM.
LI FARM.
LL MARG.
Level of Support
90%
80%
70%
60%
50%
40%
30%
20%
0
2
4
6
8
10
12
Days Access to Park Resources

A Complementary Methodological Approach

1. Structure the problem ('MADA')
   - Objectives, indicators and potential alternatives
   - Workshops with "experts" = flood managers/ planners
2. Determine the effects of alternatives
   - Use indicators to describe the overall performance of each alternative in terms of fundamental objectives.
3. Elicit Preferences for Objectives
   - Managers/decision makers – Swing Weighting (DA)
   - Public (homeowners) - 'DCE' and 'MDC'
4. Evaluate Alternatives ('MADA' or 'DCE')
   - Combine preference information with performance indicators to get an overall evaluation of each alternative.

Step 1 - Problem Structuring

Objectives Hierarchy

Nine Indicators for Each Objective

Step 1 – Problem Structuring
Alternative Floodproofing Strategies

Policy Lever	ALTERNATIVES								
	(A) Do Nothing	**(B)** Carrot – Positive Incentives I	**(C)** Stick – Negative incentives I	**(D)** Carrot & Stick – Wealth transfer I	**(E)** Reduced Liability	**(F)** Strict Regulations only	**(G)** Wealth Transfer II	**(H)** Negative Incentives II	**(I)** Positive Incentives II
Compliance	Voluntary	Voluntary	Voluntary	Voluntary	Voluntary	Mandatory	Voluntary	Voluntary	Voluntary
Trigger	N/A	N/A	N/A	N/A	N/A	Redevelop-ment or major renovation[1]	N/A	N/A	N/A
Restrictions	Height, set back	Height, set back	Height, set back	Height, set back	Height, set back	Height, set back	Height, set back	Height, set back	Height, set back
Support	None	Property tax break	None	Property tax break	None	None	One time grant	None	One time grant
Penalties	None	None	Set levy paid yearly to local government	Set levy paid yearly to local government	None	None	Set levy paid yearly to local government	Set levy paid yearly to local government	None
Liability	Unchanged from current policy.[2]	Unchanged from current policy.	Unchanged from current policy.	Unchanged from current policy.	Limit % damages covered by province if home not floodproofed	Unchanged from current policy.	Unchanged from current policy.	Limit % damages covered by province home not floodproofed	Unchanged from current policy.
Standard	FCL	FCL	FCL	FCL	FCL	FCL	FCL	FCL	FCL

Step 2 – Impacts of Alternatives

Multiattribute assessment of floodproofing strategies

- Technique – simulation modelling
- Used difference equations of the form

$$State_{t+1} - State_t = (system\ transfers\ in - system\ transfers\ out) = \Delta\ State$$

- Time step – 1 year
- Simulation length – 20 years

Step 2 – Impacts of Alternatives

Example

Homeowner Costs

$$HC_t = HC_{t-1} - HE*\Delta t - HF*\Delta t + HS*\Delta t$$

- Recalculate HC_t for each time period...20 yrs
- Result for Alternative B (Positive Incentives I) ~ $25,000

Step 3 - Preference Elicitation (Public)

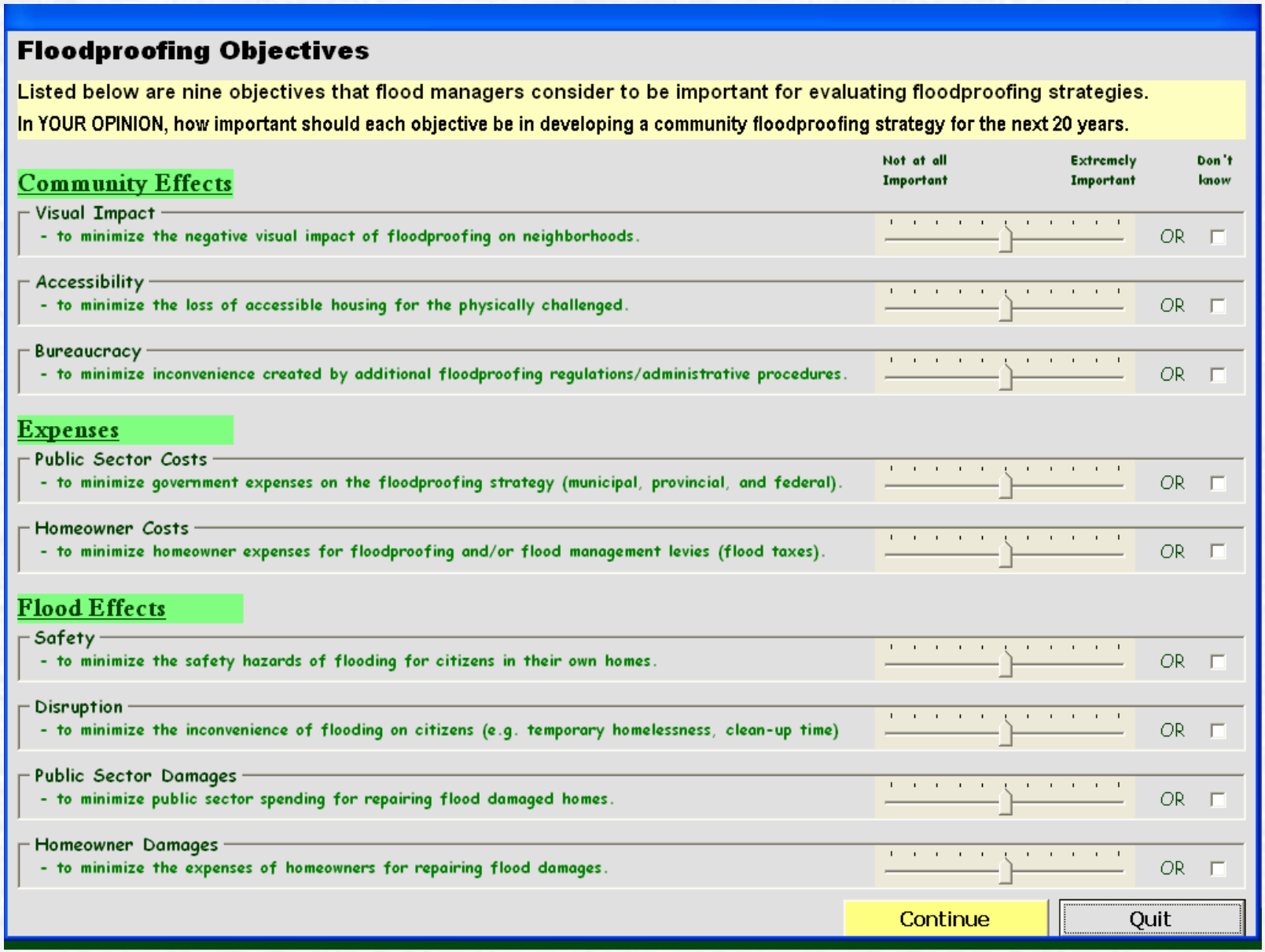
The Stated Preference Survey

- Computerized response task
- Programmed in Visual Basic
- Target audience – Homeowners in Richmond

Primary Tasks:

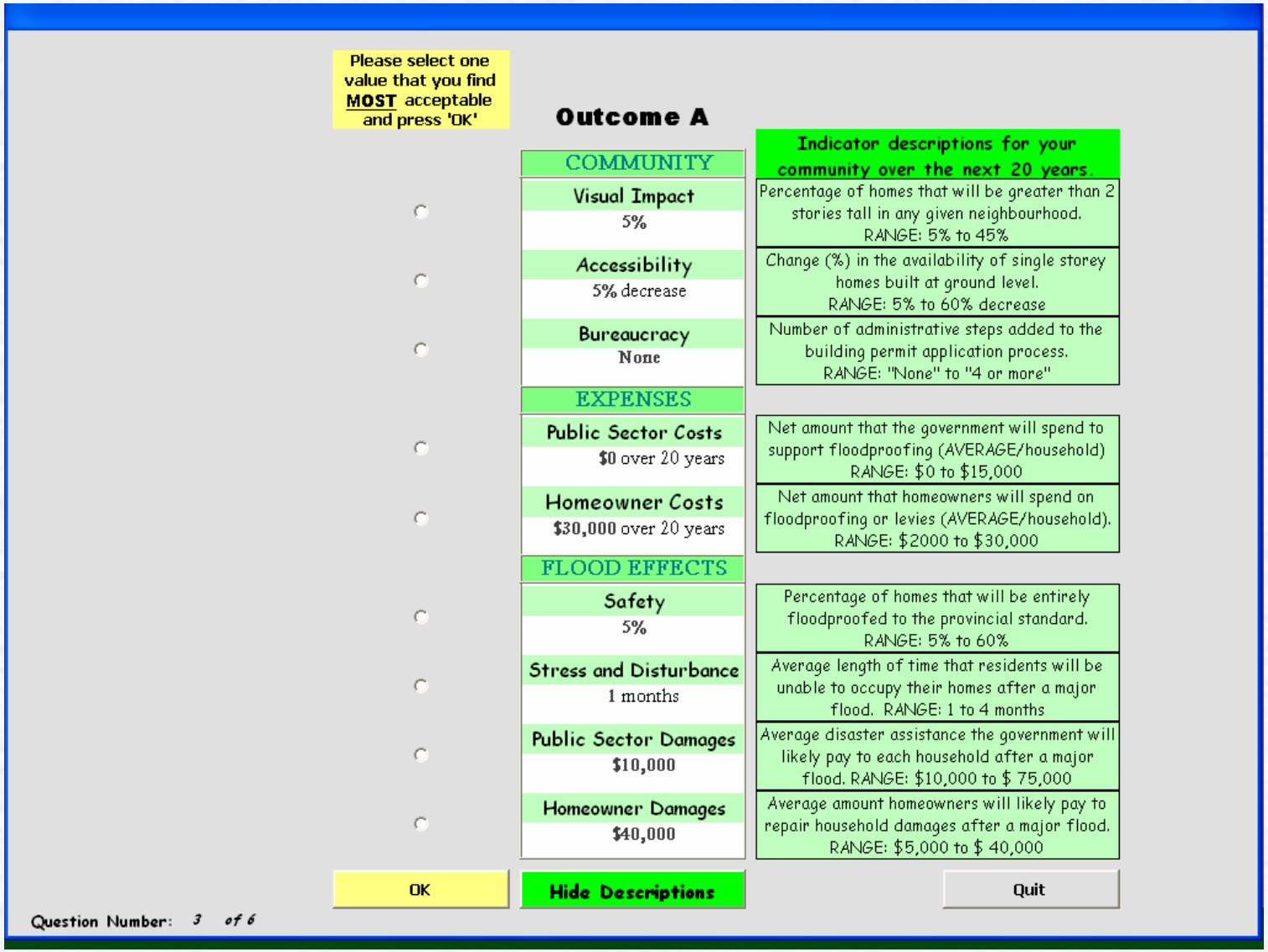
1. Community Outcomes Stated Preference
   - Maximum Difference Conjoint
   - Discrete Choice Experiment
2. Personal Floodproofing Choice (DCE)

Step 3 – Survey (Learning Concepts)

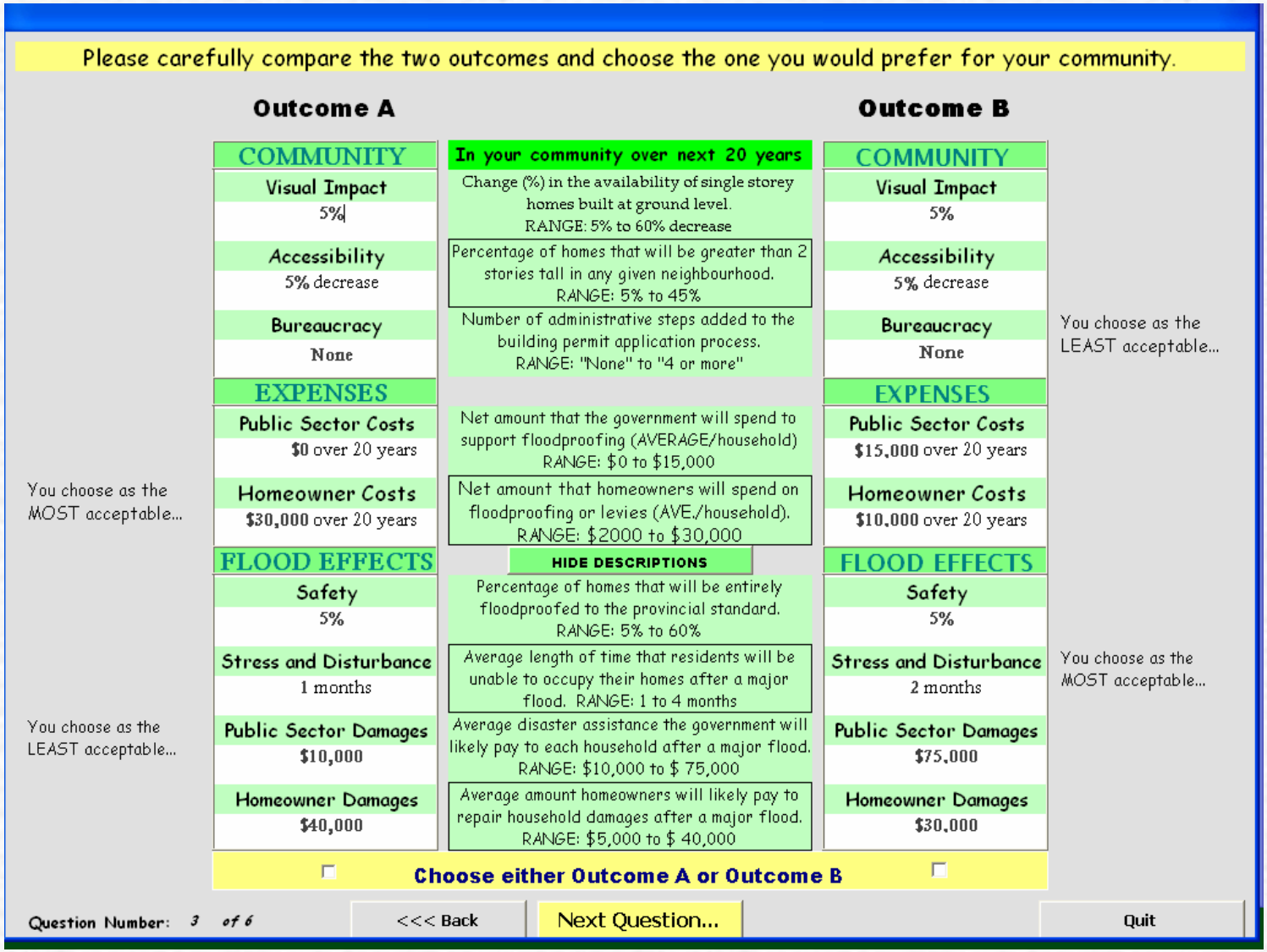


Step 3 - Preference Elicitation (Public, Homeowners)

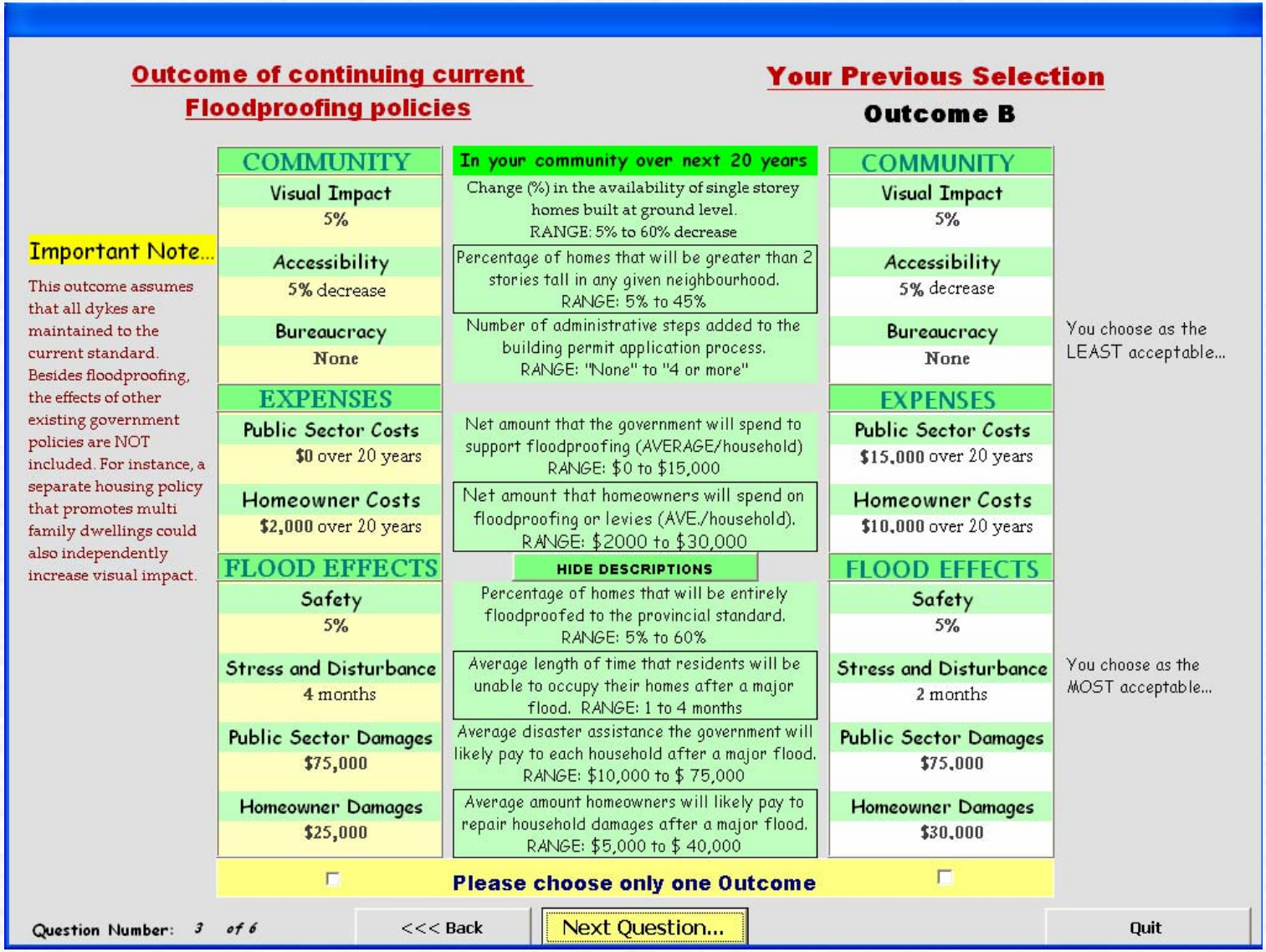
Maximum Difference Conjoint Task



Step 3 – Preference Elicitation (Public, Homeowners)
Community Outcomes – Forced Choice

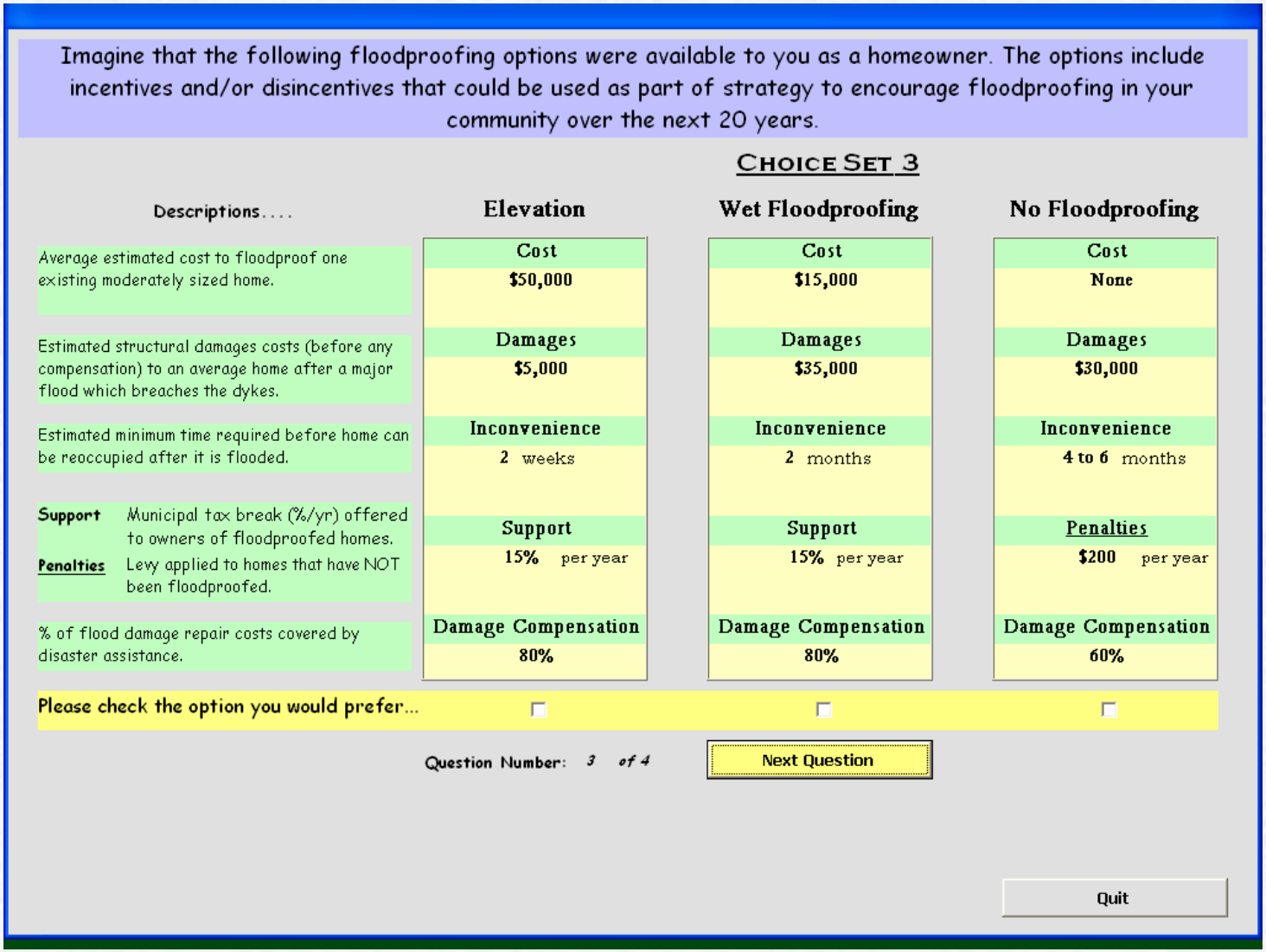


Step 3 – Preference Elicitation (Public, Homeowners)
Community Outcomes - Choice with Base



Step 3 - Preference Elicitation (Public, Homeowners)

Personal Floodproofing Choice



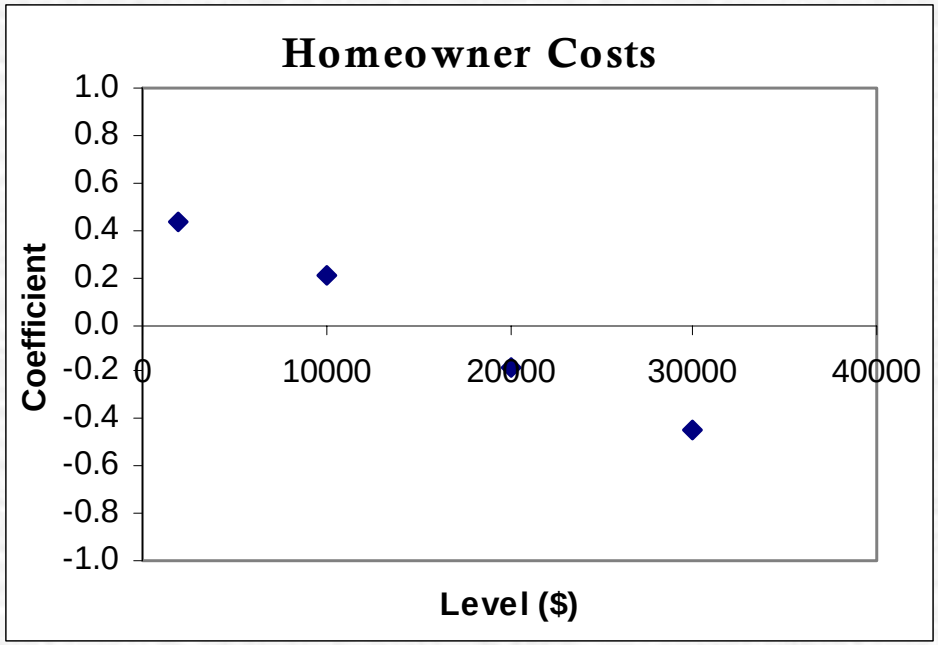
Step 3

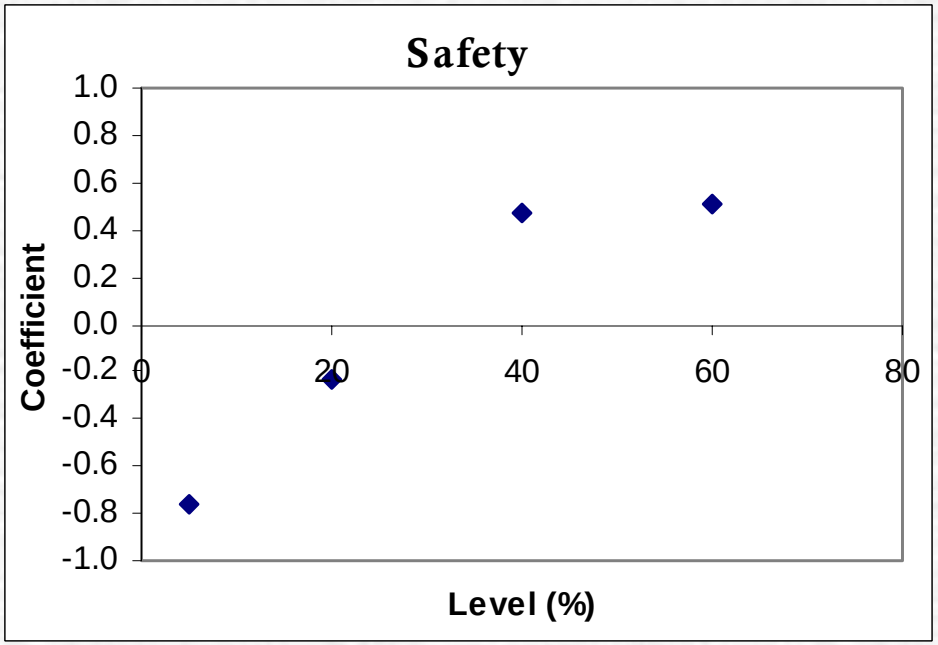
Results – Managers' Swing Weighting Task

Attribute	Average	Min	Max
Aesthetics	**0.03**	0.02	0.05
Accessibility	**0.04**	0.02	0.06
Bureaucracy	**0.07**	0.06	0.08
Public Sector Costs	**0.13**	0.10	0.18
Homeowner Costs	**0.11**	0.09	0.14
Safety	**0.16**	0.11	0.20
Stress and Disturbance	**0.15**	0.14	0.16
Public Sector Damages	**0.16**	0.13	0.18
Homeowner Damages	**0.15**	0.12	0.17

Step 3

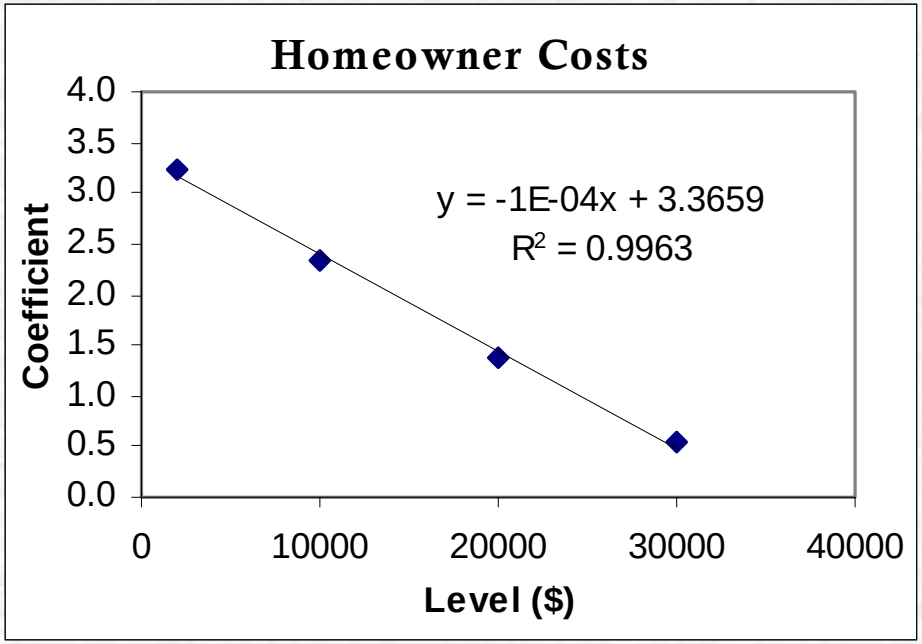
Results - Community Outcomes DCE

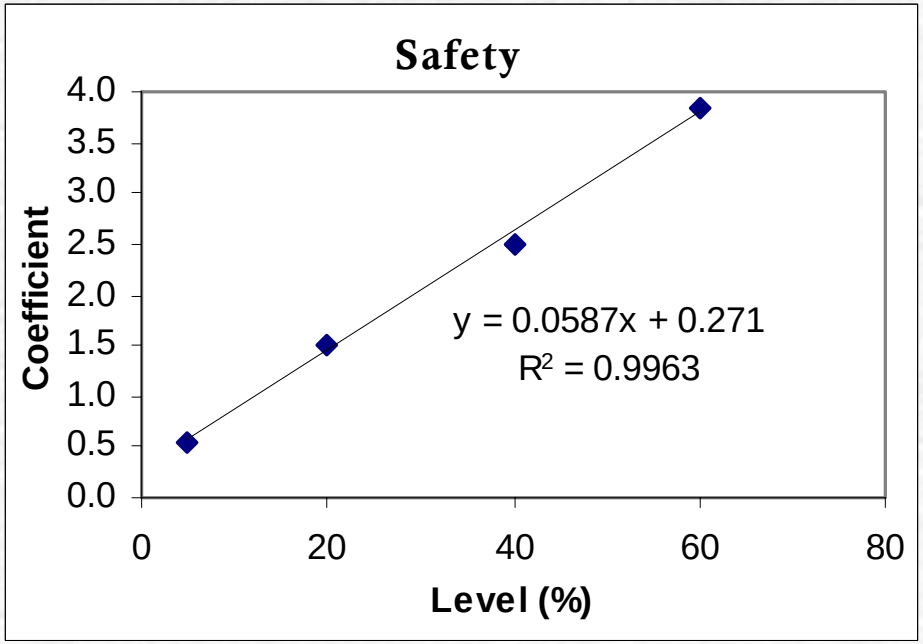




Step 3

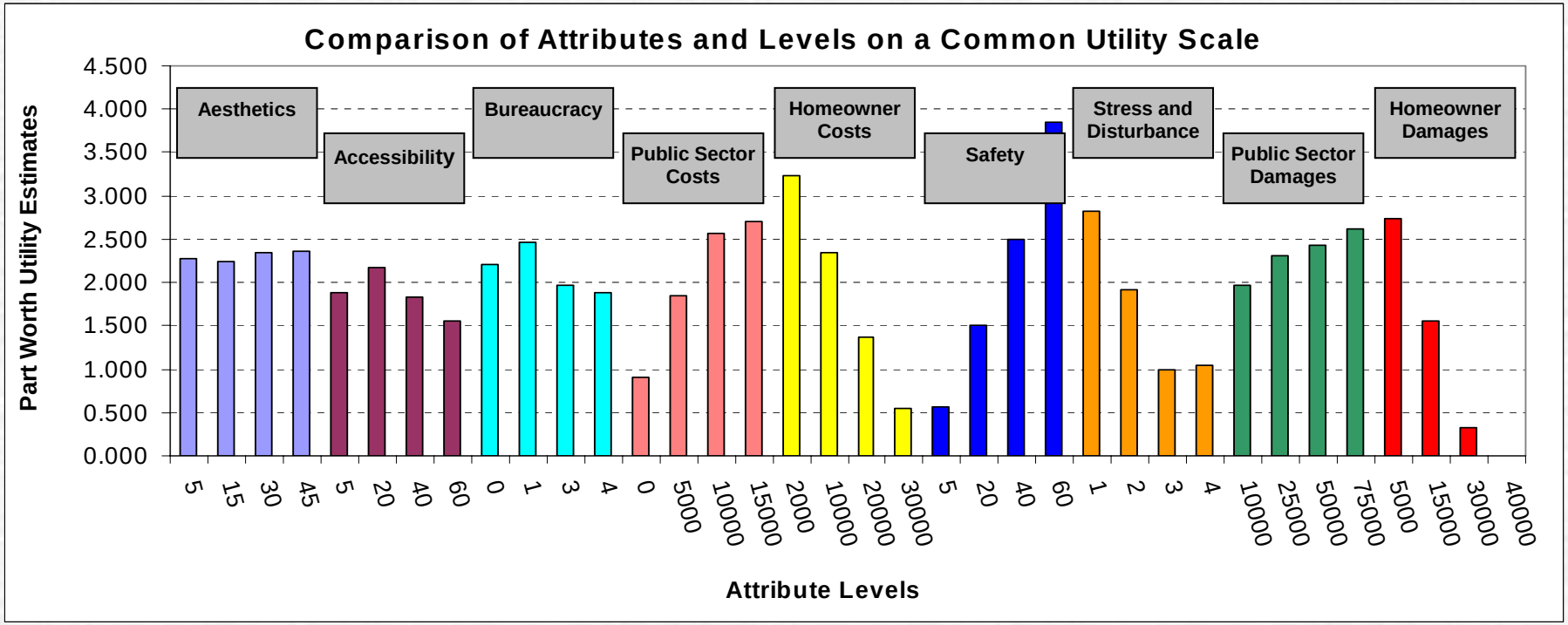
Results - Community Outcomes MDC





Step 3

Results – Community Outcomes MDC (Common Scale)



Step 3

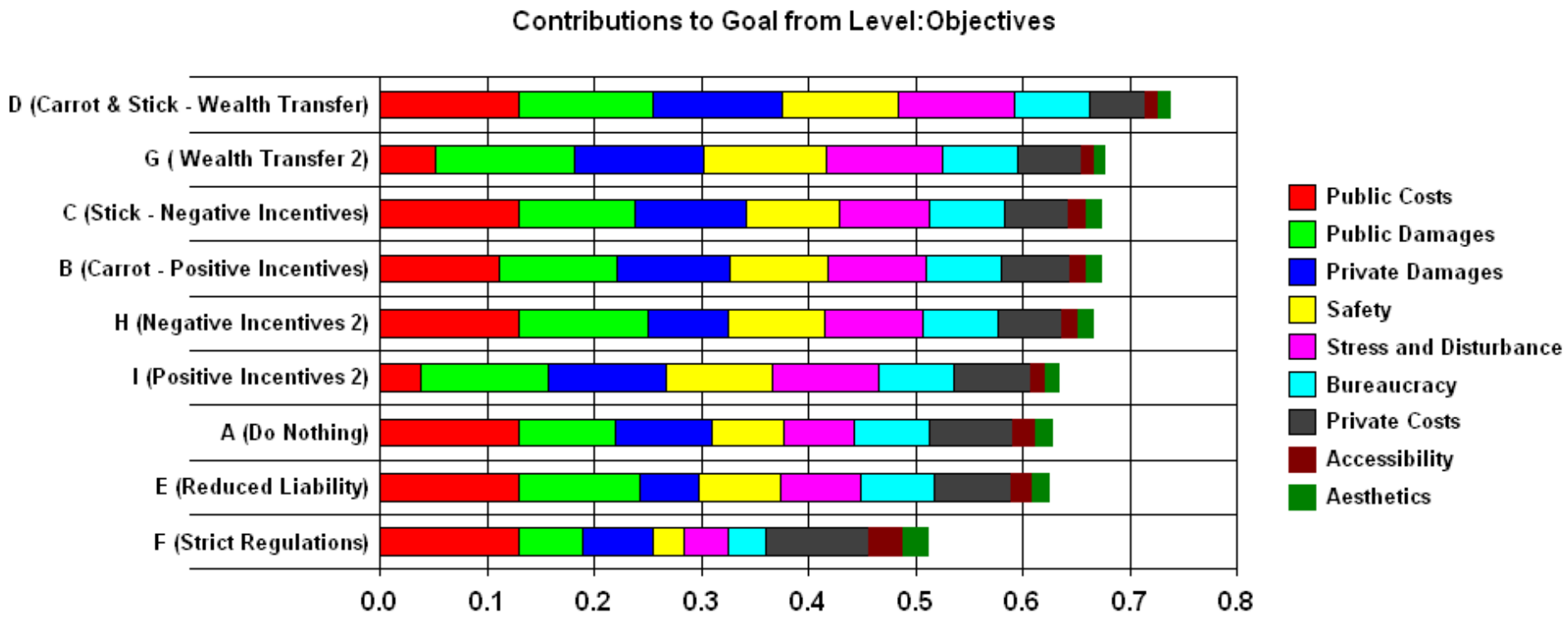
Results – Comparison of Objective Weights

Attribute	MDC Weight	Rank	Managers' Weight	Rank
Aesthetics	0.01	9	0.03	9
Accessibility	0.03	8	0.04	8
Bureaucracy	0.03	7	0.07	7
Public Sector Costs	0.13	5	0.13	5
Homeowner Costs	0.19	3	0.11	6
Safety	0.23	1	0.16	1
Stress and Disturbance	0.13	4	0.15	4
Public Sector Damages	0.05	6	0.16	2
Homeowner Damages	0.20	2	0.15	3

Step 4

Results - Evaluating Alternatives Using Decision Analysis

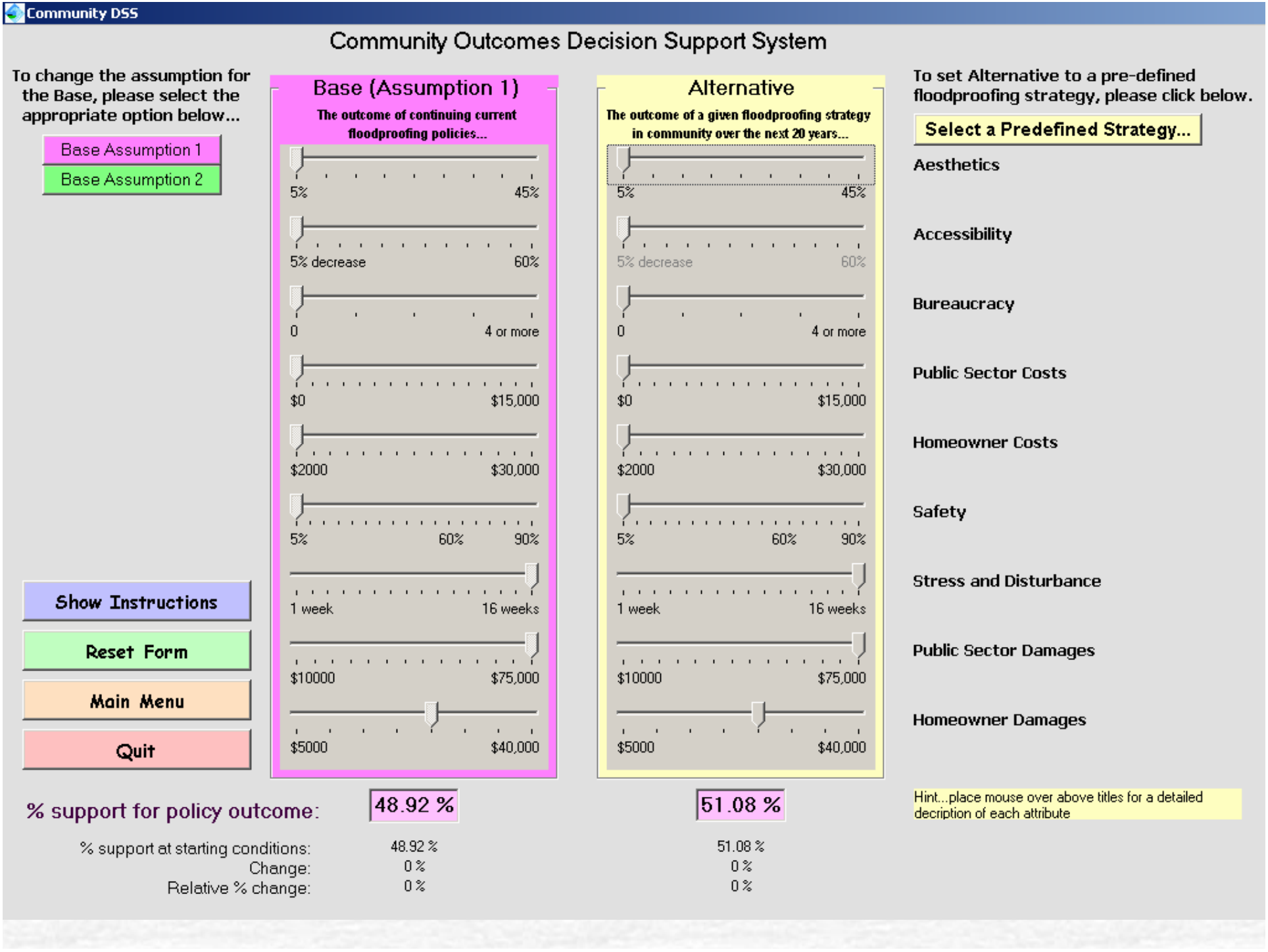
Example - Expert Preferences



Step 4

Results – Comparison, Ranking of Alternatives

	Decision Model		
Alternative	***Public 1***	***Public 2***	***Expert***
A (Do Nothing)	7	6	7
B (Carrot - Positive Incentives I)	3	4	4
C (Stick - Negative Incentives I)	4	5	3
D (Carrot & Stick – Wealth Trans I)	1	3	1
E (Reduced Liability)	8	8	8
F (Strict Regulations)	9	9	9
G (Wealth Transfer II)	2	2	2
H (Negative Incentives II)	5	7	5
I (Positive Incentives II)	6	1	6


Community DSS
Community Outcomes Decision Support System
To change the assumption for the Base, please select the appropriate option below...
Base Assumption 1
Base Assumption 2
Base (Assumption 1)
The outcome of continuing current floodproofing policies...
Alternative
The outcome of a given floodproofing strategy in community over the next 20 years...
To set Alternative to a pre-defined floodproofing strategy, please click below.
Select a Predefined Strategy...
Aesthetics
5% 45%
Accessibility
5% decrease 60%
Bureaucracy
0 4 or more
Public Sector Costs
$0 $15,000
Homeowner Costs
$2000 $30,000
Safety
5% 60% 90%
Stress and Disturbance
1 week 16 weeks
Public Sector Damages
$10000 $75,000
Homeowner Damages
$5000 $40,000
Show Instructions
Reset Form
Main Menu
Quit
% support for policy outcome:
48.92 %
51.08 %
Hint...place mouse over above titles for a detailed decription of each attribute
% support at starting conditions: 48.92 % 51.08 %
Change: 0 % 0 %
Relative % change: 0 % 0 %

Step 4

Results – Comparison of Alternative Evaluations, Community Outcomes DCE and Decision Analysis

	Community Outcomes DSS		Decision Analysis - PPM2	
Floodproofing Strategy	**Market Shares (%)**	**Rank**	**Score (%)***	**Rank**
G (Wealth Transfer II)	24.53%	1	13.52 %	2
I (Positive Incentives II)	19.36%	2	13.57 %	1
D (Carrot & Stick – Wealth transfer)	14.91%	3	11.52 %	3
B (Carrot - pos. Incentives)	11.68%	4	11.44 %	4
C (Stick - neg. incentives)	8.71%	5	10.66 %	5
H (Negative Incentives II)	6.90%	6	10.22 %	7
A (Do Nothing – Current)	5.99%	7	10.29 %	6
E (Reduced Liability)	5.06%	8	9.71 %	8
F (Strict Regulations Only)	2.85%	9	9.07 %	9

Results – A Simple DSS

Enter values in UNSHADED boxes or select strategy below

Attribute	1. Elevation	2. Wet Flood Proofing	3. No Flood Proofing
Costs ($)	$60,000.00	$18,000.00	$0
Damages ($)	$4,400.00	$40,000.00	$87,000.00
Inconvenience (weeks/months)	2 weeks	2 months	4 months min
Grant or Tax Break	1	1	None
Support (Taxbreak 1=No,2=Yes	1	1	None
Penalties (1=No,2=Yes)	None	None	1
Compensation (%)	80	80	80
Choice %	**29.60%**	**15.91%**	**54.49%**

Available Strategies:

Do Nothing	Reduced Liability	Wealth Transfer (+/- Combo
Positive Incentives	Negative Incentives	Wealth Transfer (+/- Combo2
Positive Incentives 2	Negative Incentives 2	

Step 4

Results - Sensitivity Analysis

- Change direction of preference
- Sensitivity to changes in weights
- Analysis of uncertainty in model parameters
- Considered different rates of floodproofing adoption

Conclusions – Methodological

- Stated preference models can successfully complement a MADA
  1. Integrated approach
  2. Comparative approach
- General Benefits
  - DA structuring and preference theories improve survey.
  - Stated preference approaches are efficient.
  - Large scale surveys can provide statistically significant results.
  - Inclusion of public interest in decision making process
  - Survey environment reduces opportunity for analyst to influence results.

Conclusions – Implications for Floodplain Management

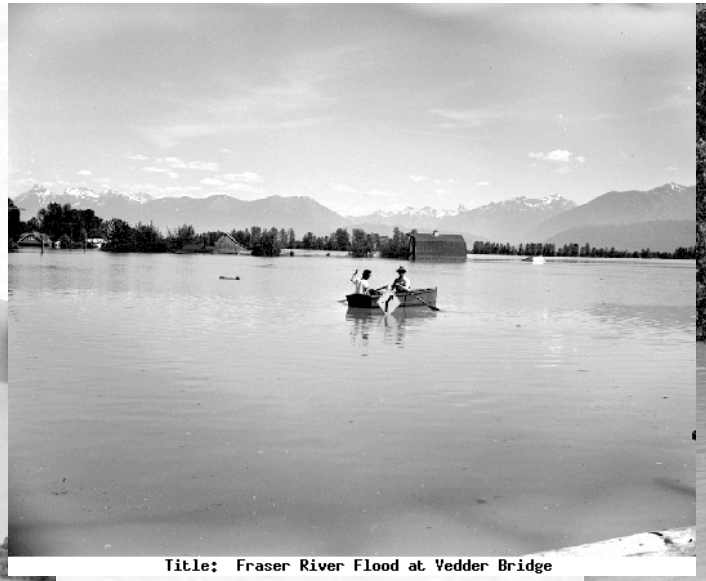
City of Richmond:

- Large urban population and recent growth a concern.
- Evidence of misperceptions about flood hazard and denial.
- Education is needed.
- Residents showed a strong overall desire for floodproofing but they want governments to share responsibility for costs and provide leadership.
- Supportive of the effects that floodproofing will have in community.

The End...

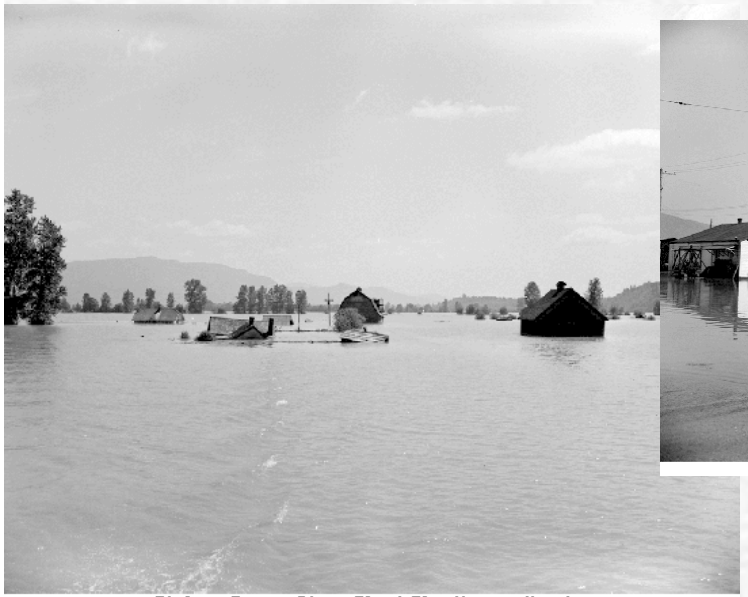
The Fraser in Flood…1948

Title: Fraser River Flood Hatzic Dyke Break



Title: Fraser River Flood at Vedder Bridge

Title: Fraser River Flood Flooding in Hatz



Title: Fraser River Flood Flooding at Hatzic

Title: Fraser River Flood Flooding at Mission

Title: Fraser River Flood Flooding in Matsqui

Supplement - Caveats and Extensions...

Limitations:

- May not be possible to use same attribute set in survey and DA.
- SP experimental design process can produce unrealistic alternatives.
- Simple DA model used.

Extensions:

- More complicated DA methods.
- Incorporation of uncertainty.
  - Preference survey
  - Impact models
- Use swing weighting to derive public weight sets and compare to SP.

Supplement - Caveats and Extensions...

Limitations:

- Representativeness of sample
- Model complexity
- Uncertainty in flood data

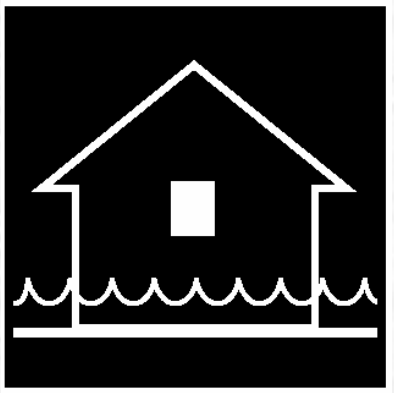
Extensions:

- Alternative floodproofing strategies
- Extended sensitivity analysis
  - Values for policy levers
- Reduced FCL (Richmond specific)
- Model refinement and expansion

Supplemental – Floodproofing Individual Homes

- **Elevation**
  - add a basement or crawl space to prevent water from entering the main living quarters.

- **Wet Floodproofing**
  - use special building materials and techniques that allow water to enter the home, but resist significant damage.



Other – dry floodproofing, relocation, floodwalls etc.

Supplemental – Problem Structuring, Objectives and Indicators

		Objective	Description	Indicator
Economic Impacts	Prevention	Public Sector Costs of floodproofing	To minimize the costs to public interests of implementing a floodproofing strategy	Net amount that the government will spend to support floodproofing (AVERAGE $ per household).
		Homeowner Costs of floodproofing	To minimize the costs to homeowners of implementing a floodproofing strategy	Net amount that homeowners will spend on floodproofing or levies (AVERAGE $ per household).
	Flood Damages	Public Sector Damages of future floods	To minimize future flood damage costs to public interests	Average flood disaster assistance that the government will likely have to pay to each household after a major flood ($).
		Homeowner Damages of future floods	To minimize future flood damage costs to private interests	Average amount that homeowners will pay to repair damages to their homes after a major flood ($).
Social Impacts…	of Floodproofing	Aesthetics	To minimize the negative aesthetic impact of floodproofing building techniques.	% of homes that will be greater than two stories tall in any given neighbourhood.
		Bureaucracy	To minimize the inconvenience created by any new floodproofing requirements	Number of administrative steps added to the building permit application process.
		Accessibility	To minimize the loss of accessible housing for the physically challenged	% decrease in the availability of single storey homes built at ground level.
	of Flooding	Protection of Community Members (Safety)	To minimize the flood related safety hazards in the community	% of homes that will be floodproofed to the provincial standard.
		Flood Related Stress and Disturbance	To minimize the flood related stress and disturbance on community members	Average time that residents will be unable to occupy their homes after a major flood (weeks).

Step 3 - Preference Elicitation

Two sources of preference information:

- Experts – Flood managers
- Public – Homeowners

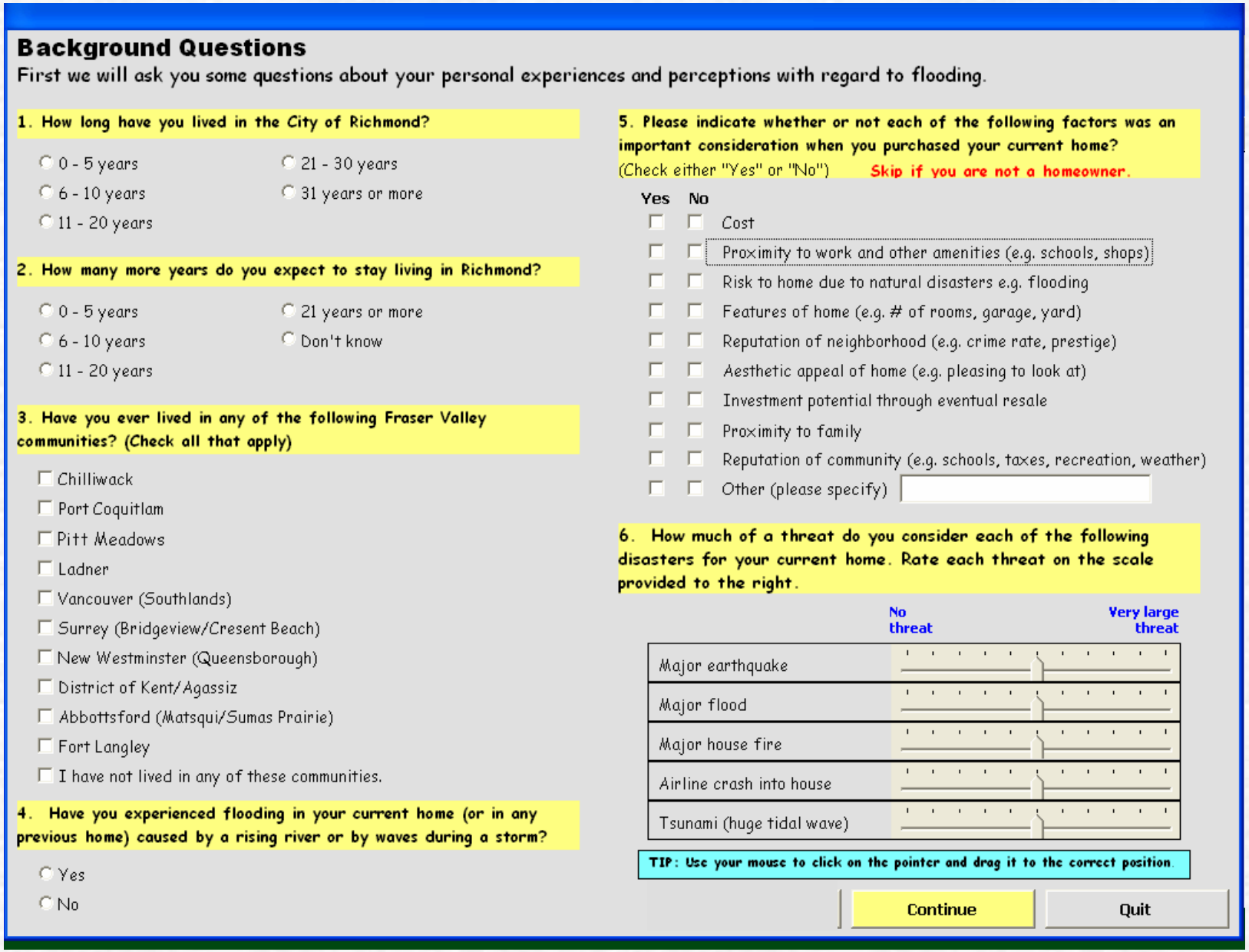
Tools:

- Expert – Swing Weighting Task
- Public – Stated Preference Survey

Supplemental - Managers' Swing Weighting Task

Objective	Indicator Description (for your community over 20 years time…)	Units	Estimated Range	Step 1 Your ranking	Step 2 Your rating
Visual Impact	Percentage of homes that will be greater than 2 stories tall in any given neighbourhood.	%	RANGE: 0% to 45%		
Accessibility	Decrease (%) in the availability of single storey homes built at ground level.	% decrease	RANGE: 0% to 60% decrease		
Bureaucracy	Number of new regulations/ administrative steps added to the building permit application process.	# steps	RANGE: "None" to "4 or more"		
Public Costs	Net amount that the government will spend to support floodproofing (AVERAGE/ household)	$	RANGE: $0 to $15,000		
Homeowner Costs	Net amount that homeowners will spend on floodproofing or levies (AVERAGE/ household).	$	RANGE: $0 to $30,000		
Safety	Percentage of homes that will be entirely floodproofed to the provincial standard.	%	RANGE: 0% to 60%		
Inconvenience	Average length of time that residents will be unable to occupy their homes after a major flood.	months	RANGE: 1 to 4 months		
Public Damages	Average disaster assistance the government will likely pay to each household after a major flood.	$	RANGE: $10,000 to $75,000		
Homeowner Damages	Average amount homeowners will likely pay to repair household damages after a major flood.	$	RANGE: $5,000 to $40,000		

Supplemental – Warm-up Questions



Background Questions

First we will ask you some questions about your personal experiences and perceptions with regard to flooding.

1. How long have you lived in the City of Richmond?

- ○ 0 - 5 years
- ○ 6 - 10 years
- ○ 11 - 20 years
- ○ 21 - 30 years
- ○ 31 years or more

2. How many more years do you expect to stay living in Richmond?

- ○ 0 - 5 years
- ○ 6 - 10 years
- ○ 11 - 20 years
- ○ 21 years or more
- ○ Don't know

3. Have you ever lived in any of the following Fraser Valley communities? (Check all that apply)

- ☐ Chilliwack
- ☐ Port Coquitlam
- ☐ Pitt Meadows
- ☐ Ladner
- ☐ Vancouver (Southlands)
- ☐ Surrey (Bridgeview/Cresent Beach)
- ☐ New Westminster (Queensborough)
- ☐ District of Kent/Agassiz
- ☐ Abbottsford (Matsqui/Sumas Prairie)
- ☐ Fort Langley
- ☐ I have not lived in any of these communities.

4. Have you experienced flooding in your current home (or in any previous home) caused by a rising river or by waves during a storm?

- ○ Yes
- ○ No

5. Please indicate whether or not each of the following factors was an important consideration when you purchased your current home?

(Check either "Yes" or "No") **Skip if you are not a homeowner.**

Yes	No	
☐	☐	Cost
☐	☐	Proximity to work and other amenities (e.g. schools, shops)
☐	☐	Risk to home due to natural disasters e.g. flooding
☐	☐	Features of home (e.g. # of rooms, garage, yard)
☐	☐	Reputation of neighborhood (e.g. crime rate, prestige)
☐	☐	Aesthetic appeal of home (e.g. pleasing to look at)
☐	☐	Investment potential through eventual resale
☐	☐	Proximity to family
☐	☐	Reputation of community (e.g. schools, taxes, recreation, weather)
☐	☐	Other (please specify)

6. How much of a threat do you consider each of the following disasters for your current home. Rate each threat on the scale provided to the right.

	No threat ... Very large threat
Major earthquake	
Major flood	
Major house fire	
Airline crash into house	
Tsunami (huge tidal wave)	

TIP: Use your mouse to click on the pointer and drag it to the correct position.

Continue Quit

Supplemental Results – Objective Rating Task

Attribute	Mean Rating
Safety	7.90
Homeowner Damages	7.83
Stress and Disturbance	7.57
Homeowner Costs	7.29
Public Sector Damages	7.14
Accessibility	6.54
Public Sector Costs	6.15
Bureaucracy	6.01
Aesthetics	5.82

Supplemental Example – Sensitivity Analysis

Supplemental Example – Sensitivity Analysis

Top Scoring Alternative: H (Wealth Transfer II)				
Attribute	**Relative Weight**	**Transition Point**	**% Change**	**Preferred Alternative After Transition**
Homeowner Costs	0.11	0.41	272 %	A (Do Nothing)
Public Damages	0.16	0.72	350 %	G (Wealth Transfer II)
Public Costs	0.13	0.04	-69 %	G (Wealth Transfer II)
Aesthetics	0.03	0.31	933 %	A (Do Nothing)
Accessibility	0.04	0.29	625 %	A (Do Nothing)
Safety	0.16	0.60	275 %	G (Wealth Transfer II)

Supplemental – Objectives by Alternatives Matrix

Attribute	Description	A *Do nothing*	B *Positive Incentives*	C *Negative Incentives I*	D *Wealth Transfer I*	E *Reduced Liability*	F *Strict Regulations Only*	G *Wealth Transfer II*	H *Negative Incentives II*	I *Positive Incentives II*
Public Costs	Net amount that the government will spend to support floodproofing (AVERAGE $ per household).	$0.00	$1,513.00	$0.00	$0.00	$0.00	$0.00	$6,070.00	$0.00	$7,100.00
Homeowner Costs	Homeowner spending on floodproofing or levies (AVERAGE $ per household, NET of financial aid).	$18,399.54	$24,486.35	$26,970.39	$31,627.22	$21,199.47	$7,477.23	$26,729.18	$28,107.36	$21,299.29
Public Damages	Average flood disaster assistance that the government will likely have to pay to each household after a major flood ($).	$43,840.26	$30,626.85	$33,408.62	$21,586.10	$30,484.95	$62,830.34	$18,804.33	$24,991.19	$26,454.20
Homeowner Damages	Average amount that homeowners will have to pay to repair damages to their homes after a major flood ($).	$11,960.06	$8,656.71	$9,352.16	$6,396.52	$19,230.25	$16,707.58	$5,701.08	$15,161.68	$7,613.55
Aesthetics	% of homes greater than 2 stories tall in any given neighbourhood.	27	34	33	38	30	15	39	34	36
Bureaucracy	Number of new regulations added to the building permit application process.	None	None	None	None	None	1 or more	None	None	None
Accessibility	% decrease in the availability of single storey homes built at ground level.	37	48	46	55	42	17	57	48	51
Safety	% of homes that are floodproofed to the provincial standard.	50	69	65	82	57	22	86	68	75
Stress and Disturbance	Average length of time that residents will be unable to occupy their homes after a major flood (weeks).	10	7	8	5	9	13	5	7	6