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# Challenging Perspectives

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*An Interdisciplinary Exploration of Urban Stormwater  
Management*

**Ines Winz**

*A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of  
Philosophy, The University of Auckland, 2009.*



# **Abstract**

Urban stormwater management must address multiple social-ecological concerns as it adapts to present challenges and transitions towards sustainability. Concerns for physical stormwater infrastructure must be investigated and resolved in relation to diverse stakeholder perspectives. This research explored perspectives and barriers in urban stormwater management and their roles in the transition to sustainability.

A dynamic simulation was developed to understand the systemic influence of environmentally friendly solutions on water quality in receiving environments in Project Twin Streams Catchment, West Auckland, New Zealand. Results showed that environmentally friendly solutions can reduce but not fully internalise the environmental impact of stormwater even in a catchment-wide implementation. Failure to integrate social-ecological variables in the modelling process limits the usefulness of the model and the insights that can be gained. To address this, a qualitative modelling approach was undertaken that sought to understand pluralist perspectives in stormwater management and barriers that restrict the uptake of alternative solutions.

Cognitive mapping was used to elicit and capture perceptions on problems and solutions in urban stormwater management. Three core perspectives were found to underlie contemporary stormwater management: conventional fixes, low impact solutions, and community development. These perspectives were diverse and conflicting. Conventional stormwater management created feedback loops that promoted the continuous construction of infrastructure to the detriment of environmental systems. Low impact solutions did not break this feedback loop. Community development failed to address urgent issues due to systemic delays. Importantly, none of the perspectives by themselves will lead to sustainable

outcomes. This highlighted the need for integration of these different perspectives and approaches.

Uptake of low impact solutions and community development was found to be hindered by physical, institutional, logistical and internal barriers. These barriers were caused by, and at the same time increased, the complexity inherent in stormwater management. Interactions between barriers were investigated and potential policy interventions suggested guiding managers in the development of effective policies that support the transition of urban stormwater management towards sustainability.

Keywords: urban stormwater management, stormwater quality, Project Twin Streams, low impact design, community-based resource management, barriers to implementation, behaviour change, sustainability, cognitive mapping, systems thinking, system dynamics

# **Dedication**

*For my family – young and old, close by and far away, nuclear and extended.*

*Für meine Familie – jung und alt, nah und fern, klein und groß.*



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# Table of Contents

Abstract.....	iii
Dedication.....	v
Acknowledgements.....	vii
List of Figures.....	xiii
List of Tables.....	xv
List of Boxes.....	xvii
Glossary.....	xix
Chapter 1: Introduction and Overview.....	1
1.1. Stormwater and Its Management.....	1
1.2. Scope of the Research.....	4
1.3. Objectives and Research Questions.....	6
1.4. Research Design.....	7
1.5. Overview of the Thesis.....	10
1.6. Publications from this Thesis.....	11
Chapter 2: Sustainability and Stormwater Management.....	13
2.1. Sustainability and Sustainable Development.....	13
2.2. Sustainable Urban Development.....	16
2.3. Sustainable Urban Water Management.....	16
2.4. Urban Stormwater Management.....	20
2.4.1. The ‘Urban Stream Syndrome’.....	20
2.4.2. Discourses in Urban Stormwater Management.....	25
2.4.3. Conventional Stormwater Management.....	26
2.4.4. Low Impact or Water Sensitive Stormwater Management.....	27
2.4.5. Community-based Resource Management.....	29

2.5. Description of the Case Study Area .....	30
2.5.1. Geographic Description .....	30
2.5.2. Social and Cultural Determinants .....	36
2.5.3. Institutional Determinants.....	38
2.5.4. Project Twin Streams .....	44
2.6. Summary of Chapter 2 .....	45
Chapter 3: Understanding Stormwater Management Using Systems Theory .....	47
3.1. Literature Review.....	47
3.1.1. The Transformation from the Mechanistic to the Holistic Paradigm .....	47
3.1.2. Complexity and Post-Normal Science .....	49
3.1.3. Enter Systems Science .....	52
3.1.4. On the Purpose of Modelling and Simulation.....	59
3.1.5. Systems Thinking and System Dynamics.....	61
3.1.6. Mathematical Modelling of Stormwater Processes.....	63
3.2. Application of Systems Theory to Stormwater Management .....	65
3.2.1. Conceptualisation of Physical Stormwater Processes .....	65
3.2.2. The System Archetype of Stormwater Pollution .....	68
3.2.3. A Simulation of Water Quality Dynamics.....	69
3.3. Summary of Chapter 3 .....	86
Chapter 4: Perspectives in Urban Stormwater Management.....	89
4.1. Literature Review.....	90
4.1.1. Relationships between Scientists, Policy Makers and the Public .....	90
4.1.2. Public Participation .....	91
4.1.3. Theories of Behaviour Change .....	102
4.2. Setting up the Research .....	120
4.2.1. Adopted Research Paradigm.....	120
4.2.2. Positionality.....	121
4.2.3. Selection of Research Participants.....	122
4.3. Data Collection.....	125
4.3.1. Interview Process.....	125
4.3.2. Cognitive Mapping .....	126
4.3.3. Questionnaire .....	127
4.4. Data Analysis.....	130
4.4.1. Overview .....	130

4.4.2. Structural Map Analysis .....	130
4.4.3. Coding and Clustering .....	131
4.4.4. Stakeholder Analysis .....	131
4.5. Findings: Perspectives in Urban Stormwater Management .....	133
4.5.1. Findings: Structural Analysis .....	133
4.5.2. Perspectives on Urban Stormwater Management in PTS Catchment .....	135
4.5.3. Mental Models in Stormwater Management .....	145
4.5.4. Findings: Stakeholder Analysis .....	147
4.6. Discussion of Findings .....	149
4.6.1. Differences in Perspectives .....	149
4.6.2. Integration of Efforts – Transition Culture .....	154
4.6.3. Implications for Urban Stormwater Management .....	157
4.7. Strengths and Limitations of the Study .....	162
4.8. Summary of Chapter 4 .....	163
Chapter 5: Barriers to Implementing Alternative Stormwater Solutions .....	167
5.1. Literature Review .....	168
5.1.1. Barriers as Manifestations of Systemic Resistance to Change .....	168
5.1.2. Barriers in Stormwater Management .....	169
5.1.3. International Evidence .....	169
5.1.4. National Evidence .....	172
5.1.5. Identification of the Research Gap .....	173
5.2. Purpose .....	175
5.3. Methods .....	176
5.4. Findings: Barriers to Implementation .....	176
5.4.1. Physical Barriers .....	178
5.4.2. Institutional Barriers .....	180
5.4.3. Logistical Barriers .....	186
5.4.4. Internal Barriers .....	190
5.5. Discussion of Findings .....	194
5.5.1. Initial Observations .....	194
5.5.2. Comparison of Results to Literature Review .....	194
5.5.3. Seeing Positives in Negatives – The Broader Picture .....	197
5.6. Conceptualising Interactions between Barriers .....	199
5.6.1. A Method to Determine Significant Interactions between Barrier Categories .....	199

5.6.2. A Method to Determine Appropriate Policy Entry Barriers.....	207
5.7. Recommendations – Facilitating Change.....	209
5.8. Summary of Chapter 5 .....	229
Chapter 6: Discussion: The Big Picture .....	233
6.1. Research Journey .....	234
6.2. The Role of Path Dependency.....	238
6.3. Physical Modelling and the Role of Systems Science .....	240
6.4. The Sustainability Potential of LID .....	242
6.5. Institutional Change.....	244
6.6. Pathways to Sustainability for Urban Environments .....	246
6.7. Bring It On: Paradigm Change.....	248
Chapter 7: Conclusions .....	253
7.1. Research Questions Answered .....	253
7.2. Main Insights and Contributions.....	255
7.2.1. Research Objective 1 – The Systemic Nature of Stormwater Management .....	255
7.2.2. Research Objective 2 – Perspectives on Urban Stormwater Management .....	256
7.2.3. Research Objectives 3 and 4 – Barriers to Implementing Alternative Solutions.....	256
7.3. Opportunities for Further Research.....	257
7.3.1. Simulation of Water Quality Dynamics.....	257
7.3.2. Perspectives on Urban Stormwater Management .....	258
7.3.3. Barriers to the Implementation of Alternative Solutions .....	258
References .....	261
Appendix A – Model Equations.....	309
Appendix B – Contaminant Load Model .....	315
Appendix C – Area Division Process.....	317
Appendix D – Research Participant Profiles.....	323
Appendix E – Interview Guide.....	329
Appendix F – Stakeholder Analysis Questionnaire .....	331
Appendix G – Concept Listing .....	333
Appendix H – Barrier Interactions – Pair-wise Comparisons.....	359
Appendix I – Barrier Ranking (Strong).....	397

## List of Figures

Figure 1.1 Urban stormwater management explored from multiple areas of inquiry.....	5
Figure 2.1: Basic interactions in the urban water system.....	17
Figure 2.2: Transition in urban water management.....	19
Figure 2.3: International discourse on water management.....	19
Figure 2.4: Conceptual model of linkages between drivers, pressures and impacts.....	21
Figure 2.5: Comparison of stream behaviour according to development stage.....	22
Figure 2.6: Changes in stream channel shape at different stages of urbanisation.....	23
Figure 2.7: Change in management discourses in the 20 <sup>th</sup> century.....	25
Figure 2.8: Map of Project Twin Streams catchment showing the four subcatchments Opanuku, Oratia, Henderson and Waikumete (from left).....	31
Figure 2.9: The imperviousness of Project Twin Streams catchment in 2004.....	32
Figure 2.10: Current and predicted ecological impact of stormwater in the Auckland region.....	33
Figure 2.11: Zinc concentrations in the Auckland region.....	34
Figure 2.12: Ethnic groups in Waitakere City in comparison with New Zealand, 2006 census.....	37
Figure 2.13: Organisational chart showing the institutional structure of Waitakere City Council.....	39
Figure 3.1: The four dimensions of systemic thinking.....	54
Figure 3.2: Common feedback interactions.....	55
Figure 3.3: The resilience of a system shown as the difference between the system's state and its carrying capacity.....	56
Figure 3.4: Oscillations are caused by time-delayed negative feedback cycles within the system in interaction with external limits.....	57
Figure 3.5: Causal loop diagram notation adopted in this thesis.....	62
Figure 3.6: Feedback loop notation adopted.....	62
Figure 3.7: Stock-and-flow notation adopted.....	63
Figure 3.8: Physical stormwater processes with focus on quantity.....	66
Figure 3.9: Physical stormwater processes with focus on water quality.....	67
Figure 3.10: Contaminant transport processes.....	67
Figure 3.11: Tragedy of the commons archetype for stormwater pollution.....	68
Figure 3.12: Historic zinc concentration and future predicted increase in the Waitemata harbour ...	71
Figure 3.13: Dynamic hypothesis.....	72
Figure 3.14: Stock-and-flow model of the PTS stormwater simulation.....	75
Figure 3.15: The graphical user interface with scenario 3 results.....	76

Figure 3.16: Area divisions, final source areas and CLM yields .....	77
Figure 3.17: Comparison of results of adjusted (red) and original (black) impervious area .....	78
Figure 3.18: Comparison between results of negative growth test (red 20% decline, black 50% decline).....	79
Figure 3.19: Graphical user interface with extreme condition test result for zero road stock in 201080	
Figure 3.20: Comparison between results of scenario 1 (red), 2 (black) and 6 (blue).....	81
Figure 4.1: Categorising methods according to process goals.....	95
Figure 4.2: A diagram of the Theory of Planned Behaviour.....	104
Figure 4.3: Action-centred model of environmental education .....	107
Figure 4.4: The action research process .....	112
Figure 4.5: Organisational development phases relevant to the implementation of LID .....	114
Figure 4.6: Organisational structure at the integrated stage of change .....	115
Figure 4.7: A feedback perspective on human behaviour and public policy .....	119
Figure 4.8: Map of stakeholders identified.....	122
Figure 4.9: Example cognitive map .....	128
Figure 4.10: Example of a smaller cognitive map showing two feedback loops .....	129
Figure 4.11: Example of cluster mapping on a white board.....	132
Figure 4.12: A typology of stakeholders according to characteristics of power, legitimacy and urgency .....	133
Figure 4.13: The 'conventional fixes' CLD .....	136
Figure 4.14: The 'low impact solutions' CLD .....	139
Figure 4.15: The 'community development' CLD .....	143
Figure 4.16: Integrating community engagement and LID serves multiple objectives and creates change at different levels and timescales.....	156
Figure 5.1: Influence strength between barrier categories for PTS catchment data .....	205
Figure 5.2: Strong feedback between legal, structural and communication barriers .....	206
Figure 5.3: Information feedback loop in adaptive management .....	216
Figure 5.4: The responsive policy cycle.....	219

## List of Tables

Table 1.1 Research design and methods used to address different research objectives.....	8
Table 2.1 Government documents that contain a mandate for sustainability.....	15
Table 2.2: Conventional and integrated approaches to water management.....	18
Table 2.3: Overview of urbanisation effects on receiving environments.....	20
Table 2.4: Symptoms of the ‘urban stream syndrome’ .....	21
Table 2.5: Summary of findings from water quality, sediment quality and stream ecology monitoring in Project Twin Streams catchment in 2005-2006.....	35
Table 2.6: Policies affecting stormwater management .....	41
Table 3.1: Summary of reality perceptions and shared values under mechanistic and holistic paradigms.....	49
Table 3.2: Characteristics of post-normal science .....	51
Table 3.3: Leverage points within a system.....	58
Table 3.4: A Typology of models, collated from Zoppou (2001).....	64
Table 3.5: Input and output variables of the PTS stormwater stock-and-flow model .....	73
Table 3.6: Annual roof material growth rates .....	77
Table 3.7: Comparison between original and adjusted impervious area values.....	78
Table 3.8: Extreme condition tests with high negative growth factors.....	79
Table 3.9: Parameters and results for simulation runs.....	81
Table 4.1: Differences in the knowledge-generation between scientists, policy makers and the public .....	90
Table 4.2: Overview of costs associated with participatory practice .....	94
Table 4.3: Participation purpose and corresponding suggested methods .....	97
Table 4.4: Acceptance and process criteria that evaluate the effectiveness of participatory methods .....	98
Table 4.5: Suggested participatory methods for different stages in a system dynamics project.....	101
Table 4.6: Policy instrument categories.....	116
Table 4.7: Types of policy instruments .....	117
Table 4.8: Contrasting assumptions of the two main research paradigms .....	120
Table 4.9: Stakeholder groups and their identified stakes .....	123
Table 4.10: List of stakeholders who participated in the research.....	124
Table 4.11: Statistics of structural analysis of individual maps .....	133



Table 4.12: Results of the domain analysis for concepts with more than five ingoing and outgoing links .....	134
Table 4.13: Supporting and preventing mindsets.....	146
Table 4.14: Averages and standard deviation of questionnaire results .....	147
Table 4.15: Classification of stakeholders.....	148
Table 4.16: Overview of the main differences between the three perspectives in stormwater management.....	153
Table 5.1: Overview of international and national barrier studies.....	175
Table 5.2: Barrier categories and definitions.....	177
Table 5.3: Barriers to the implementation of LID and CBRM .....	196
Table 5.4: Positive aspects of barriers .....	199
Table 5.5: Percentages of ‘weak and strong’ pair-wise influences between categories.....	202
Table 5.6: Ranking of category pair interactions in decreasing strength .....	202
Table 5.7: Absolute differences between the ‘strong only’ and ‘weak and strong’ rankings .....	203
Table 5.8: Barriers in descending order of the difference between incoming and outgoing interactions .....	208
Table 5.9: Barriers that reinforce the existence of short election time frames .....	212
Table 5.10: Barriers that reinforce LID costs.....	216
Table 5.11: Characteristics of adaptive management organisations.....	218
Table 5.12: Barriers that reinforce the uncertainty and complexity associated with LID implementation .....	220
Table 5.13: Barriers that reinforce conventional approaches in education .....	222
Table 5.14: Barriers that reinforce poor public participation.....	223
Table 5.15: Barriers that reinforce communication problems .....	226
Table 5.16: Barriers that reinforce knowledge-power problems .....	227
Table 5.17: Barriers that reinforce the perception that a crisis is required before people start to act .....	228
Table 5.18: Barriers that reinforce administrative inertia .....	229
Table 6.1: Supporting strategies for individual transition stages .....	251
Table 7.1: Succinct answers to the research questions.....	255

## List of Boxes

Box 3.1: Equations underlying Mike Timperley’s Contaminant Load Model.....	70
Box 5.1: Calculation of the Spearman rank correlation coefficient based on average ranks.....	203
Box 5.2: Process steps of Method 1 that determines significant interactions between barrier categories.....	231
Box 5.3: Process steps of Method 2 that determines appropriate policy entry barriers .....	232



## Glossary

The following definitions are provided firstly to avoid ambiguity in terminology and lengthy discussions in the thesis. Secondly, as this thesis is interdisciplinary in nature a further objective is to explain terms that the reader may be unfamiliar with. The glossary gives the meanings that have been adopted here.

**Androcentricity** – dominated by or emphasizing masculine interests or points of view

**Anthropogenic** – caused by human activities

**ANZECC Guidelines** – Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand 2000)

**Attitude** – a cognitive and affective evaluation that predisposes a person to act in a certain way; by behavioural scientists thought to consist of three components: cognition (thoughts), affect (feelings) and behaviour

**Belief system** – larger structures that link attitudes with one another

**BMP** – best management practice, i.e. a technique, method, process, activity, incentive or reward that is believed to be more effective at delivering a particular outcome than any other technique, method, process, etc.

**Bounded rationality** – the fact that the rationality of all individuals is limited by existing information, cognitive limitations of the human mind and a restricted amount of time available to make decisions

**Brownfield** – land area that has previously been developed and used for industrial or commercial uses

**Carrying capacity** – a species' population size that can be sustained indefinitely by a given land area

**Catchment** – land area from which rain water or snow melt drains downhill into a water body, such as a river, lake, reservoir, estuary, wetland, sea or ocean

**Checksum** – a calculated value that allows one to check the validity of other data or calculations

**CLD** – Causal Loop Diagram

**Cognitive dissonance** – a condition in which two attitudes or a behaviour and an attitude conflict

**Commitment** – loyalty to and heavy involvement in a project or organisation

**Culture** – distinctive spiritual, material, intellectual and emotional features of society or a social group (UNESCO 2002)

**Ecological footprint** – land area necessary to sustain levels of resource consumption and waste discharge of a given population; an indicator of long-term resilience and sustainability

**Effective imperviousness** - the impervious surfaces area that is directly connected to receiving water bodies in a catchment

**Ex post** – Latin phrase meaning 'after the event'

**Greenfield** – land in an urban or rural area previously undeveloped which is currently used for agriculture, landscape design, or left to nature

**Imperviousness** - Impervious surfaces are built areas, including roads, sidewalks, driveways, parking lots and roofs), that are covered by impenetrable materials such as asphalt, concrete, brick, stone, and various types of roofing materials. This imperviousness prevents any exchange of water and air between the soil and the atmosphere. Soils compacted by urban development are also highly impervious.

**Institution** – structures and mechanisms of social order and cooperation governing the behaviour of a group of individuals; they exhibit a social purpose and permanence, and establish and enforce rules for cooperative human behaviour that are designed to provide for and protect private and public goods

**Iwi** – Maori tribe or tribes

**Kaitiakitanga** – the guardianship of a land area by people

**Leverage** – small change in one part of the system can produce dramatic changes in other parts of the system

**LID** – Low Impact Design or Low Impact Development

**LIUDD** – Low Impact Urban Design and Development

**Mauri** – life force of an object including water

**Mental Model/ Worldview/ Perspective** – one's 'point of view'; the choice of a context for opinions, beliefs and experiences; recurring patterns of thought which are continuously held by individuals and societies; to choose a perspective is to choose a value system and, unavoidably, an associated belief system

**Paradigm** – recurring pervasive worldviews in a scientific discipline or other epistemological context

**Path dependency** – the tendency of past or traditional practices or preferences to continue even if better alternatives are available; usually technology-related

**Perception** – how people understand and make sense of external or internal stimuli according to their frame of reference and worldview

**Personality** – a set of characteristics that underlie a relatively stable pattern of behaviour of a person in response to ideas, objects or people in the environment

**Perspective** – the choice of a context or a reference from which to sense, categorize, measure or codify experience. In this process a coherent belief system is formed and often used for making comparisons. Choosing a perspective implies choosing a value system and, unavoidably, an associated belief system (Wikipedia 2009).

## **PTS** – Project Twin Streams

**Restoration vs. rehabilitation** – Environmental restoration is the process of returning to a previous state of ecosystem function while rehabilitation is the improvement towards a defined level of ecosystem function. It has been observed that due to the destruction of ecosystems the restoration of a past ecosystem state is often impossible. Despite this, restoration is still used to some extent in the scientific realm (e.g. refer to publications by the Society for Ecological Restoration), and also used entirely in the non-academic domain. Therefore, I use restoration throughout this thesis without taking sides in a debate or making a scientific judgement on whether proper restoration is possible or even desirable in the area under study.

**Stakeholder** – any person or group who can affect or is affected by the decisions or policies set in place by the institution, in this case the local council

**Sustainability** – a socially constructed term usually implying at least a small level of environmental concern and an objective to sustain a certain function, activity or reality over a longer time frame

**Transdisciplinarity vs. interdisciplinarity** – crossing traditional boundaries between academic disciplines or schools of thought; both terms are used interchangeably and do not imply a judgement on the exact interactions of disciplines; these terms are also ambiguous and can polarise – therefore they are avoided.

**Urbanisation** – the dynamic extension/growth of urban areas with parallel transformation of rural areas as a result of population immigration and land use change

**Worldview** – from the German *Weltanschauung*, the fundamental perception of philosophy, norms, values, emotions and ethics through which an individual interprets the world