

**LEARNING ABOUT WATER THROUGH THE  
AFRICAN CATCHMENT GAME: THE  
REFINEMENT OF A ROLE PLAYING  
SIMULATION GAME**

**THESIS**

**submitted in fulfilment of the requirements**

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**LINDA ANNE FRAENKEL**

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**SUPERVISORS**

**Professor R. Fox (Geography Department)**

**and**

**Doctor D. Wilmot (Education Department)**

## **ABSTRACT**

This research has undertaken two key mandates. One was to develop modifications to the African Catchment Game (ACG), a role playing simulation game, in order to simulate rainfall and water management processes representative of the southern African context. The other was to understand what, if any, learning associated with water management issues had taken place as a result of playing the ACG.

The modification process took the form of an action research process. The initial modifications were trialed with South African students as part of their undergraduate Geography course offered at Rhodes University, South Africa. Subsequent modifications were implemented over a five month period with three diverse participant groups, namely Finnish, American and South African participants.

An interpretive research orientation was employed in order to analyse both the qualitative and quantitative data that was generated. Pre- and Post-Game Questionnaires were used in order to identify the learning and understanding which the participants constructed as a result of playing the ACG. The Chi-Square Test was also applied to each of the pre- and post- questions to establish statistical significance. Subsequent analysis of these questions identified and traced patterns and trends associated with learning and understanding across the three game runs.

This research study draws on social constructivism and experiential learning as the dominant education theory that underpins it. Results revealed that for all three game runs learning took place. Participants identified dominant themes and environmental dimensions both before and after playing the ACG. The analysis of these responses indicated a deeper awareness of water as a contributing factor for sustainable economic development while the game runs enabled the researcher to adjust the water availability within each game run until rainfall and water management processes representative of a southern African context were successfully simulated in the last game run.

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# TABLE OF CONTENTS

<b>ABSTRACT</b> .....	<b>i</b>
<b>ACKNOWLEDGEMENTS</b> .....	<b>ii</b>
<b>LIST OF FIGURES</b> .....	<b>viii</b>
<b>LIST OF TABLES</b> .....	<b>xiii</b>
<b>CHAPTER ONE: INTRODUCTION</b> .....	<b>1</b>
1.2 Motivation .....	2
1.3 Research Objectives .....	4
1.4 Structure of the Research Report .....	4
<b>CHAPTER TWO: REVIEW OF THE LITERATURE</b> .....	<b>6</b>
2.1 Introduction .....	6
2.2. Constructivism & Experiential Learning .....	6
2.3 Models, Systems and Simulations.....	8
2.4 Pedagogical Use of Simulation Games .....	13
2.5 Playing the African Catchment Game .....	18
2.6 Resource Utilisation: Conflict, Competition and Collapse.....	22
2.8 Water, Agriculture & Food Security .....	27
2.9 Conclusion .....	33
<b>CHAPTER THREE: RESEARCH METHODOLOGY</b> .....	<b>34</b>
3.1 Introduction .....	34
3.2 The Research Orientation .....	34
3.3 Case Study Method .....	35
3.4 Research Goals .....	36
3.5 Data Generation .....	38
3.5.1 Questionnaire Design .....	38
3.5.2 Participant Observation.....	41
3.5.3 Focus Group Discussions.....	44
3.6 Summary of the Water Modification Process .....	44

3.7 Data Analysis.....	47
3.8 Issues associated with the Case Study Method.....	51
3.8.1 Quality and Rigour .....	51
3.8.2 Research Ethics.....	51
3.8.3 Particularity and Generalisations.....	52
3.8.4 Additional Limitations.....	52
3.9 Synthesis and Conclusion.....	53
<b>CHAPTER FOUR: ASSEGAAI TRIAL RUN.....</b>	<b>54</b>
4.1 Introduction .....	54
4.2 Changes and Modifications to the African Catchment Game.....	54
4.3 The Discussion and Findings of the Assegaaï Trial Run.....	55
4.4 Conclusion.....	57
<b>CHAPTER FIVE: TURKU GAME RUN .....</b>	<b>60</b>
5.1 Introduction .....	60
5.2 Profile of the Research Participants .....	60
5.3 Further Changes and Modifications to the African Catchment Game .....	60
5.4 Discussion and Findings of Turku Game Run.....	62
5.4.1 Rainfall and Water Allocation.....	62
5.4.2 Population Statistics .....	66
5.4.3 Productivity.....	67
5.4.4 Conclusion .....	69
5.5 Participants’ Learning: Southern African Context.....	69
5.5.1 Question 1: How is water used in a southern African context?.....	69
5.5.2 Question 2: Who controls water?.....	70
5.5.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in a southern African context. ....	71
5.5.4 Question 4: Why do you think these issues and challenges have emerged?.....	72
5.5.5 Question 5: How has the game helped you to gain a better understanding of water management?.....	73
5.6 Participants’ Learning: Their Own Context.....	73
5.6.1 Question 1: How is water used in your local environment?.....	73
5.6.2 Question 2: Who controls water? .....	74

5.6.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in your local context. ....	75
5.6.4 Question 4: Why do you think these issues and challenges have emerged?.....	76
5.6.5 Question 5: How has the game helped you to gain a better understanding of water management in a southern African context?.....	77
5.6.6 Question 6: Do you think that you would be able to use insights from your game experience and if yes where? .....	78
5.6.7 Question 7: Do you have any recommendations for changes or improvements? .....	80
5.7 Reflecting on Modifications Implemented .....	84
5.8 Conclusion .....	84
<b>CHAPTER 6: TAMMELA GAME RUN .....</b>	<b>85</b>
6.1 Introduction .....	85
6.2 Profile of the Research Participants .....	85
6.3 Further Changes and Modifications to the African Catchment Game .....	85
6.4 Discussion and Findings of Tammela Game Run .....	86
6.4.1 Rainfall and Water Allocation.....	86
6.4.2 Population Statistics .....	90
6.4.3 Productivity.....	92
6.4.4 Conclusion .....	93
6.5 Participants' Learning: Southern African Context.....	94
6.5.1 Question 1: How is water used in a southern African context? .....	94
6.5.2 Question 2: Who controls water? .....	95
6.5.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in a southern African context. ....	96
6.5.4 Question 4: Why do you think these issues and challenges have emerged?.....	97
6.5.5 Question 5: How has the game helped you to gain a better understanding of water management in a southern African context?.....	97
6.6 Participants' Learning: Their Own Context.....	98
6.6.1 Question 1: How is water used in your local environment? .....	98
6.6.2 Question 2: Who controls water? .....	99
6.6.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in your local context. ....	100
6.6.4 Question 4: Why do you think these issues and challenges have emerged?.....	101
6.6.5 Question 5: How has the game helped you to gain a better understanding of water management in a southern African context?.....	102

6.6.6 Question 6: Do you think that you would be able to use insights from your game experience and if yes where? .....	103
6.6.7 Question 7: Now that you have played the ACG and discussed it as a group, do you have any recommendations for changes or improvements? .....	104
6.7 Reflecting on Modifications Implemented .....	107
6.8 Conclusion .....	107
<b>CHAPTER 7: AMAKHALA GAME RUN .....</b>	<b>108</b>
7.1 Introduction .....	108
7.2 Profile of the Research Participants .....	108
7.3 Further Changes and Modifications to the African Catchment Game .....	108
7.4 Discussion and Findings of Amakhala Game Run.....	109
7.4.1 Rainfall and Water Allocation.....	109
7.4.2 Population Statistics .....	113
7.4.3 Productivity.....	115
7.4.4 Conclusion .....	117
7.5 Participants' Learning: Southern African Context.....	117
7.5.1 Question 1: How is water used in a southern African context?.....	117
7.5.2 Question 2: Who controls water? .....	118
7.5.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in a southern African context. ....	119
7.5.4 Question 4: Why do you think these issues and challenges have emerged?.....	120
7.5.5 Question 5: How has the game helped you to gain a better understanding of water management in a southern African context?.....	121
7.6 Participants' Learning: Their Own Context.....	123
7.6.1 Question 1: How is water used in your local environment?.....	124
7.6.2 Question 2: Who controls water? .....	124
7.6.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in your local context. ....	125
7.6.4 Question 4: Why do you think these issues and challenges have emerged?.....	126
7.6.5 Question 5: How has the game helped you to gain a better understanding of water management?.....	127
7.6.6 Question 6: Do you think that you would be able to use insights from your game experience and if yes where? .....	128
7.6.7 Question 7: Now that you have played the ACG and discussed it as a group, do you have any recommendations for changes or improvements? .....	128

7.7 Summary of Three Game Runs: Dominant Themes and Dimensions.....	132
7.8 Reflecting on Modifications Implemented .....	134
7.9 Conclusion.....	134
<b>CHAPTER EIGHT: COMPARATIVE ANALYSIS OF THREE GAME RUNS.....</b>	<b>135</b>
8.1 Chi-Square Test: Analysis and Findings .....	135
8.2 Analysis of the Most Statistically Significant Questions .....	137
8.2.1 Your Context, Question 1: How is water used in your environment?.....	137
8.2.2 Southern African Context, Question 3: Please identify and explain what issues and challenges, if any, are associated with water management. ....	142
8.2.3 Southern African Context, Question 1: How is water used in a southern African Context? .....	149
8.2.4 Southern Africa, Question 2: Who controls water? .....	154
8.2.5 Annotated Environmental Dimension Diagram .....	160
8.2.6 Synthesis of the Findings .....	163
8.3 Conclusion.....	164
<b>CHAPTER 9: CONCLUSION AND RECOMMENDATION.....</b>	<b>165</b>
9.1 Introduction .....	165
9.2 Synthesis of Findings and Recommendations .....	165
9.2.1 Synthesis of Modifications.....	165
9.2.2 Synthesis of Participants Learning .....	167
9.3 Conclusion.....	168
<b>REFERENCE LIST .....</b>	<b>170</b>
<b>APPENDICES .....</b>	<b>174</b>
Appendix A: Chapter 5: Turku Game Run.....	174
Biographical Data: Figures A.1 to A.7.....	174
Pre- and Post-Questionnaires: Tables A.1 to A.18.....	178
Appendix B: Chapter 6: Tammela Game Run.....	196
Biographical Data: Figure B.1 to B.7 .....	196
Pre- and Post-Questionnaires: Tables 6.1 to 6.19 .....	199
Appendix C: Chapter 7: Amakhala Game Run .....	218
Biographical Data: Figures C.1 to C.7 .....	218
Pre- and Post-Questionnaires: Tables C.1 to C.19.....	221
Appendix D: Chapter 8 .....	240

## LIST OF FIGURES

Figure 1.1 – Water In A Multi-Dimensional Environment .....	3
Figure 2.1: Kolb’s Learning Cycle.....	8
Figure 2.2 - Interacting Components Within A System .....	10
Figure 2.3 - Adaptation Of The Aristotelian Decision Making Model .....	10
Figure 2.4 Chronology Of Research Process Employed .....	12
Figure 2.5 – The Acg Positioned In Terms Of Its Complexity And Duration .....	17
Figure 2.6 – Potential Mobility And Communication Between Different Roles.....	19
Figure 2.7 - Rural And Urban Cycles In The Acg .....	22
Figure 2.8 - Common Causal Chain For Contested Natural Resources And Environmental Problems.....	24
Figure 2.9- Map Showing The Projected Water Scarcity For Southern Africa: Water And People, 2025 .....	26
Figure 2.10 - Rainfall Partitioning: Green And Blue Water Flows .....	28
Figure 2.11: The Predominant Sources Of Green Or Blue Water To Produce Grain Foods (Map Produced For Publishing In 2004) .....	29
Figure 3.1 Use Of The Case Study Method Outlined .....	35
Figure 3.2 –Summary Of The Pre- And Post-Game Questions .....	40
Figure 3.3 - Rural Sector After Modification. Source: Fox (2008).....	42
Figure 3.4 - Urban Sector After Modification. Source: Fox (2008) .....	43
Figure 3.5 Timeline Of Game Run Modifications And Workshops .....	45
Figure 3.6 – V-Diagram: Summary Of The Analysis Process .....	49
Figure 4.1 –Assegaitrial Run: Annual Rainfall .....	56
Figure 4.2 – Assegai Trial Run: Government Issued Water Per Annum .....	56
Figure 4.3 –Assegai Trial Run: Comparison Of Annual Rainfall And Government Issued Water.....	57
Figure 4.4 – Assegai Trial Run: Dam Levels Over Four Year Game Period. ....	59

Figure 5.1 – Turku Game Run: Annual Rainfall.....	63
Figure 5.2 – Turku Game Run: Government Issued Water Per Annum .....	63
Figure 5.3 – Turku Game Run: Comparison Of Annual Rainfall & Government Issued Water.....	63
Figure 5.4 – Turku Game Run: Water Levels Over A Four Year Period.....	65
Figure 5.5 - Turku Game Run: Rural Population Statistics.....	66
Figure 5.6 – Turku Game Run: Urban Population Statistics .....	66
Figure 5.7 – Total Population Statistics.....	67
Figure 5.8 – Turku Game Run: Total Yield, Consumption And Surplus.....	67
Figure 5.9 – Turku Game Run: Imports, Exports And Trading Balance .....	68
Figure 5.10 – Turku Post-Game Questionnaire: Now That You Have Played The Acg And Discussed It As A Group Do You Have Any Recommendations For Changes Or Improvements? .....	82
Figure 6.1 – Tammela Game Run: Annual Rainfall .....	87
Figure 6.2 – Tammela Game Run: Government Issued Water Per Annum .....	87
Figure 6.3 – Tammela Game Run: Comparison Of Annual Rainfall & Government Issued Water.....	88
Figure 6.4 – Tammela Game Run: Water Levels Over A 5 Year Period.....	89
Figure 6.5 – Tammela Game Run: Rural Population Statistics .....	90
Figure 6.6 – Tammela Game Run: Urban Population Statistics .....	90
Figure 6.7 – Tammela Game Run: Total Population Statistics .....	91
Figure 6.8 – Tammela Game Run: Total Yield, Consumption And Surplus .....	92
Figure 6.9 – Tammela Game Run: Imports, Exports And Trading Balance .....	93
Figure 6.10 – Tammela Game Run: Participant Responses Per Category .....	103
Figure 7.1 – Amakhala Game Run: Annual Rainfall .....	110
Figure 7.2 – Amakhala Game Run: Government Issued Water Per Annum.....	111
Figure 7.3 – Amakhala Game Run: Comparison Of Annual Rainfall & Government Issued Water.....	111
Figure 7.4 – Amakhala Dam Data: Water Levels Over A 5-Year Period.....	112

Figure 7.5 – Amakhala Game Run: Rural Population Statistics .....	113
Figure 7.6 – Amakhala Game Run: Urban Population Statistics .....	113
Figure 7.7 – Amakhala Game Run: Total Population Statistics .....	114
Figure 7.8 – Amakhala Game Run: Total Rice Yield, Consumption And Surplus .....	115
Figure 7.9 – Urban Sector: Imports, Exports And Trading Balance .....	116
Figure 7.10 – Amakhala Post Game Questionnaire : Participant Responses Per Environmental Dimension .....	122
Figure 7.11 – Amakhala Game Run: Nationality Ratios Per Environmental Dimension	123
Figure 7.12 - Now That You Have Played The Acg And Discussed It As A Group Do You Have Any Recommendations For Changes Or Improvements?.....	130
Figure 8.1 – Turku Game Run : Comparison Of Pre- And Post- Environmental Dimensions.....	138
Figure 8.2 – Tammela Game Run: Comparison Of Pre- And Post- Game Environmental Dimensions.....	138
Figure 8.3 – Amakhala Game Run: Comparison Of Pre- And Post- Game Environmental Dimensions.....	138
Figure 8.4 – Turku Game Run: Comparison Of Pre- And Post- Game Themes .....	141
Figure 8.5 – Tammela Game Run: Comparison Of Pre- And Post- Game Themes .....	141
Figure 8.6 – Amakhala Game Run: Comparison Of Pre- And Post- Game Themes .....	141
Figure 8.7 – Turku Game Run: Comparison Of Pre- And Post- Game Activity Response; Rates Per Environmental Dimension.....	143
Figure 8.8 – Tammela Game Run: Comparison Of Pre- And Post- Game Activity Response; Rates Per Environmental Dimension .....	143
Figure 8.9 – Amakhala Game Run: Comparison Of Pre- And Post- Game Activity Response; Rates Per Environmental Dimension .....	144
Figure 8.10 – Turku Game Run: Comparison Of Pre- And Post- Game Themes .....	146
Figure 8.11 – Tammela Game Run: Comparison Of Pre- And Post- Game Themes .....	147
Figure 8.12 – Amakhala Game Run: Comparison Of Pre- And Post- Game Themes ....	148
Figure 8.13 – Turku Game Run: Comparison Of Pre- And Post- Game Environmental Dimension .....	150

Figure 8.14 – Tammela Game Run: Comparison Of Pre- And Post- Game Environmental Dimensions.....	150
Figure 8.15 – Amakhala Game Run: Comparison Of Pre- And- Post- Game Environmental Dimensions .....	150
Figure 8.16 - Turku Game Run: Comparison Of Pre- And Post- Game Themes .....	152
Figure 8.17 - Tammela Game Run: Comparison Of Pre- And Post- Game Themes .....	153
Figure 8.18 - Amakhala Game Run: Comparison Of Pre- And Post- Game Themes....	154
Figure 8.19 – Turku: Comparison Of Pre- And Post- Game Activity Response Rates Per Environmental Dimension .....	155
Figure 8.20 – Comparison Of Pre- And Post- Game Activity Response Rates Per Environmental Dimension .....	155
Figure 8.21 – Comparison Of Pre- And Post- Game Activity Response Rates Per Environmental Dimension .....	156
Figure 8.22– Turku Game Run: Comparison Of Pre- And Post- Game Themes .....	158
Figure 8.23 – Tammela Game Run: Comparison Of Pre- And Post- Game Themes .....	159
Figure 8.24 – Amakhala Game Run: Comparison Of Pre- And Post- Game Themes....	160
Figure 8.25 – Turku Game Run: Annotations Made To Environmental Dimension Diagram.....	161
Figure 8.26 – Amkhala Game Run: Annotations Made To Environmental Dimension Diagram.....	162
Figure A.1 – Turku Game Run: Nationality Of Participants .....	174
Figure A.2 – Turku Game Run: Gender Of Participants .....	174
Figure A.3 – Turku Game Run: Language Of Participants .....	175
Figure A.4 – Turku Game Run: Highest Qualification Of Participants .....	175
Figure A.5 – Turku Game Run: Types Of Participants’ Occupation .....	176
Figure A.6 – Turku Game Run: Present Occupation Of Participants .....	176
Figure A.7 – Turku Game Run: Ages Of Participants .....	177
Figure B.2 - Tammela Game Run: Gender Of Participants.....	196
Figure B.3 – Tammela Game Run: Language Of Participants .....	197

Figure B.4 – Turku Game Run: Highest Qualification Of Participants .....	197
Figure B.5 - Tammella Game Run: Types Of Participants’ Occupation .....	197
Figure B.6 - Tammella Game Run: Present Occupation Of Participants .....	198
Figure B.7 - Tammella Game Run: Ages Of Participants .....	198
Figure C.1 – Amakhala Game Run: Nationality Of Participants.....	218
Figure C.2 – Amakhala Game Run: Gender Of Participants.....	218
Figure C.3 – Amakhala Game Run: Language Of Participants.....	219
Figure C.4 – Amakhala Game Run: Highest Qualification Of Participants .....	219
Figure C.5 – Amakhala Game Run: Types Of Participants’ Occupation.....	219
Figure C.6 – Amakhala Game Run: Present Occupation Of Participants .....	220
Figure C.7 – Amakhala Game Run: Age Of Participants.....	220

## LIST OF TABLES

Table 2.1 – Classification of models .....	14
Table 2.2 – The ACG’s position in the Rhodes Geography Syllabus .....	17
Table 2.3 - Urban and rural roles .....	18
Table 2.4 - Projected Water Scarcity in Southern Africa in 2025 .....	27
Table 2.5 - The evolution of thinking about agriculture: 1950s – 1990s .....	31
Table 2.6 - Summary of theories: population change and the environment .....	32
Table 5.1 – Turku Post-Game Questionnaire: Do you think that you would be able to use insights from your game experience? .....	79
Table 5.2 – Turku Post-Game Questionnaire: Now that you have played the ACG and discussed it as a group do you have any recommendations for changes or improvements? .....	81
Table 5.3 – Turku Post-Game Questionnaire: Implementing Suggested Game Rules .....	83
Table 6.1 – Tammela Post- Game Questionnaire: Now that you have played the ACG and discussed it as a group do you have any recommendations for changes or improvements? .....	105
Table 6.2 – Tammela Post- Game Questionnaire: Implementing Suggested Game Rules .....	106
Table 7.1 – Amakhala Post- Game Questionnaire: Now that you have played the ACG and discussed it as a group do you have any recommendations for changes or improvements? .....	129
Table 7.2 – Amakhala Game Run: Implementing Suggested Game Rules .....	131
Table 7.3 – Summary of Three Game Runs: Dominant Patterns and Trends .....	133
Table 8.1 – Example: Sum of response rates for Question 1: Southern Africa .....	136
Table 8.2 – Questions ranked according to the Chi-Square Test Results.....	136

Table A.1 - Turku Pre-Game Questionnaire: How is water used in a southern African context?.....	178
Table A.2 – Turku Post-Game Questionnaire: How is water used in a southern African context?.....	179
Table A.3 – Turku Pre-Game Questionnaire: Who controls water?.....	180
Table A.4 – Turku Post Game Questionnaire: Who controls Water?.....	181
Table A.5 – Turku Pre-Game Questionnaire: Issues and challenges associated with water management .....	182
Table A.6 – Turku Post-Game Questionnaire: Issues and challenges associated with water management .....	183
Table A.7 – Turku Pre-Game Questionnaire: Why do you think these issues and challenges have emerged?.....	184
Table A.8 – Turku Post-Game Questionnaire: Why have these issues and challenges emerged?.....	185
Table A.9 – Turku Post Game Questionnaire: How has the game helped you to gain a better understanding of water management?.....	186
Table A.10 – Turku Pre-Game Questionnaire: How is water used in your local environment?.....	187
Table A.11 – Turku Post-Game Questionnaire: How is water used in your local context? .....	188
Table A.12 – Turku Pre-Game Questionnaire: Who controls water?.....	189
Table A.13 – Turku Post-Game Questionnaire: Who controls water?.....	190
Table A.14 – Turku Pre-Game Questionnaire: Issues and challenges associated with water management .....	191
Table A.15 – Turku Post-Game Questionnaire: Issues and challenges associated with water management .....	192
Table A.16 – Turku Post-Game Questionnaire: Why do you think these issues and challenges have emerged?.....	193
Table A.17 – Turku Post-Game Questionnaire: Issues and challenges associated with water management .....	194

Table A.18 – Turku Post Game Questionnaire: How has the game helped you to gain a better understanding of water management in a southern African context?.....	195
Table B.1 - Tammela Pre- Game Questionnaire: How is water used in a southern African context?.....	199
Table B.2 – Tammela Post- Game Questionnaire: How is water used in a southern African context? .....	200
Table B.3 – Tammela Pre- Game Questionnaire: Who controls water?.....	201
Table B.4 – Tammela Post- Game Questionnaire: Who controls Water?.....	202
Table B.5 – Tammela Pre- Game Questionnaire: Issues and challenges associated with water management .....	203
Table B.6 – Tammela Post- Game Questionnaire: Issues and challenges associated with water management .....	204
Table B.7 – Tammela Pre- Game Questionnaire: Issues and challenges associated with water management .....	205
Table B.8 – Tammela Post- Game Questionnaire: Why have these issues and challenges emerged.....	206
Table B.9 – Tammela Post- Game Questionnaire: How has the game helped you to gain a better understanding of water management?.....	207
Table B.10 – Tammela Pre- Game Questionnaire: How is water used? .....	208
Table B.11 – Tammela Post- Game Questionnaire: How is water used?.....	209
Table B.12 – Tammela Pre- Game Questionnaire: Who controls water? .....	210
Table B.13 – Tammela Post- Game Questionnaire: Who controls water?.....	211
Table B.14 – Tammela Pre- Game Questionnaire: Issues and challenges associated with water management .....	212
Table B.15 – Tammela Post- Game Questionnaire: Issues and challenges associated with water management .....	213
Table B.16 – Tammela Pre- Game Questionnaire: How have these issues and challenges emerged? .....	214
Table B.17 – Tammela Post- Game Questionnaire: How have these issues and challenges emerged? .....	215

Table B.18 – Tammela Post- Game Questionnaire: How has the game helped you to gain a better understanding of water management? .....	216
Table B.19 – Tammela Post- Game Questionnaire: Do you think that you would be able to use insights from your game experience? .....	217
Table C.1 - Amakhala Pre- Game Questionnaire: How is water used in a southern African context? .....	221
Table C.2 – Amakhala Post-Game Questionnaire: How is water used in a southern African context? .....	222
Table C.3 – Amakhala Pre- Game Questionnaire: Who controls water? .....	223
Table C.4 – Amakhala Post Game Questionnaire: Who controls Water? .....	224
Table C.5 – Amakhala Pre- Game Questionnaire: Issues and challenges associated with water management .....	225
Table C.6 – Amakhala Post- Game Questionnaire: Issues and challenges associated with water management .....	226
Table C.7 – Amakhala Pre- Game Questionnaire: Issues and challenges associated with water management .....	227
Table C.8 – Amakhala Post-Game Questionnaire: Issues and challenges associated with water management .....	228
Table C.9 – Amakhala Post- Game Questionnaire: How has the game helped you to gain a better understanding of water management in a southern African context? .....	229
Table C.10 – Amakhala Pre- Game Questionnaire: How is water used in your local environment? .....	230
Table C.11 – Amakhala Post-Game Questionnaire: How is water used in your local environment? .....	231
Table C.12 – Amakhala Pre- Game Questionnaire: Who controls water? .....	232
Table C.13 – Amakhala Post- Game Questionnaire: Who controls Water .....	233
Table C.14 – Amakhala Pre- Game Questionnaire: Issues and challenges associated with water management .....	234
Table C.15 – Amakhala Post-Game Questionnaire: Issues and challenges associated with water management .....	235

Table C.16 – Amakhala Pre- Game Questionnaire: Issues and challenges associated with water management .....	236
Table C.17 – Amakhala Post- Game Questionnaire: Issues and challenges associated with water management .....	237
Table C.18 – Amakhala Post- Game Questionnaire: How has the game helped you to gain a better understanding of water management? .....	238
Table C.19 – Amakhala Post- Game Questionnaire: Do you think that you would be able to use insights from your game experience? .....	239

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## CHAPTER ONE

### INTRODUCTION

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#### **1.1 Introduction**

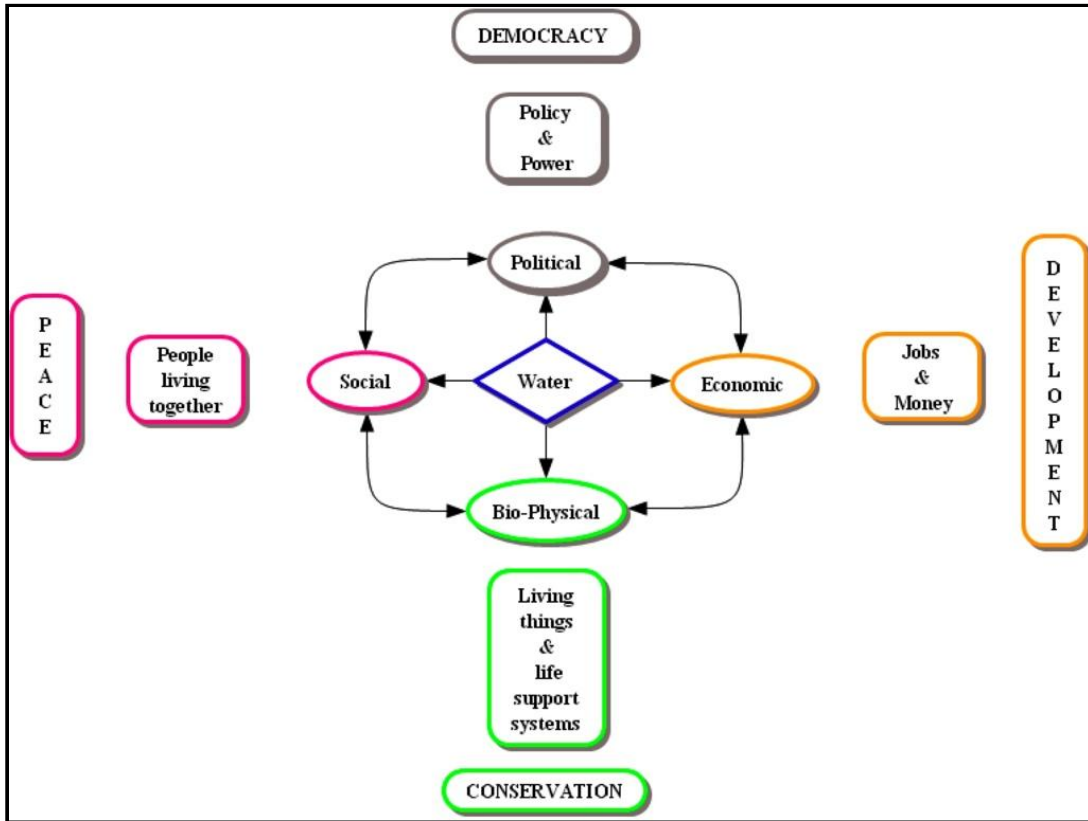
The aim of this research is to facilitate the learning associated with water management and consumption through the inclusion of new water processes into the structure of the African Catchment Game (ACG), a role playing simulation game of “a real imaginary developing country” (Chapman 1989: unpagged) in southern Africa.

The research was conducted in three stages. Stage one involved the development of the new water processes for inclusion in the ACG. Stage two consisted of a trial run in which the new water processes were implemented. In stage three the modified ACG was played with three different educational and cultural groups. Pre- and post-game questionnaires, participant observation and focus group debriefings were used to capture what, if any, learning had occurred. Spreadsheets were designed for the Dam Manager while the existing spreadsheets of the Rural and Urban Managers were modified to include the new water processes. The information collected from these methods was subsequently analysed and interpreted to provide an overview of the dynamics of each game run.

The pre- and post-game questionnaires were used to compare and unpack the participants’ understanding of water processes in both their own and the southern African context. These water processes were identified within various aspects of the environment, namely biophysical, economic, social and political. Application of the Chi-Square Test on the pre- and post-game questionnaires facilitated the identification of statistically significant question(s) for an in-depth analysis of the understanding of water issues that had taken place.

## **1.2 Motivation**

Water and food, together with territory, raw materials and sources of energy are considered the five most prized natural resources (Gleditsch 1998). Today water is considered both a scarce and vulnerable resource in Africa and the world over, while agriculture is the largest sector dependent on this resource (Hirji and Molapo 2004; Appelgren 2004). There is a need to balance these two partly incompatible pressures: human welfare and the protection of the resource base on which that human welfare depends (Falkenmark and Rockstrom 2004). Environmental educators such as O'Donoghue (cited in Lotz-Sisitka and Raven 2001) argue for the conceptual understanding of the interrelated and interdependent aspects of our environment so that students gain a comprehensive understanding of the environment. Their framework for understanding the environment as multi-dimensional is displayed in Figure 1.1. The need to conserve our natural resources requires an understanding of the linkages between the social, political, economic and biophysical. It is the development of an holistic understanding of these complex relationships and the difficulties embedded in the ethical implications for sustainable survival that has motivated this research project. The methodology developed for this research study aimed to enable the participants' learning to be mapped on to the framework shown in Figure 1.1.



**Figure 1.1 – Water in a Multi-Dimensional Environment**

**Source: Adapted from O’Donoghue (cited in Lotz-Sisitka and Raven 2001)**

During the 1970s, Chapman (1989) maintained that the need for innovative teaching in Geography arose in two key areas: students’ lack of conceptual understanding of farming and the inefficiency of formal teaching to do justice to the inter-relationships that are part of the decision making processes associated with farming. He developed a role-playing simulation of a rural based agricultural economy for the Indian sub-continent, the *Green Revolution Game* (GRG). This was modified at the behest of the World Bank to incorporate the dynamics of a whole country, which culminated in the *Green Revolution Game and Exaction Game* (GRG&EG). This simulation was subsequently modified by Fox and Rowntree (2007) into the *The African Catchment Game* (ACG) and has been used as an innovative teaching tool in higher education to highlight environmental teaching themes. The ACG models the African context and includes commercial farming, debt, cattle, sustainable development and HIV-AIDS. This research aims to develop a new environmental component, a dam and a river system, that models different rainfall

patterns in the catchment areas as well as water use and consumption in a southern African context. The aim is to facilitate students' understanding and appreciation of the inter-relationships of water management, food security and economic development.

### **1.3 Research Objectives**

The seven objectives of this research are:

- To provide a critical appraisal of the literature focusing on simulation games, especially a description and appraisal of the GRG, the GRG&EG and the ACG, as well as educational theory focusing on the need to develop teaching methods on water issues in Africa and other relevant topics.
- To conceptualize and describe the changes to be made to the ACG in order to model water as an environmental component for the southern African context.
- To develop instruments and techniques to capture, analyse and interpret data from the game runs.
- To play the modified game with diverse groups of students and professionals to assess the changes made to the ACG.
- To evaluate the impact of the game and the effectiveness of the simulation by assessing the participants' development of understanding as a result of playing the modified ACG.
- To consolidate and produce a final version of the ACG that models water as a new environmental component.
- To relate the findings to published studies and theories from the literature review.

### **1.4 Structure of the Research Report**

Chapter 2 reviews the literature that informs the study and provides a framework for the analysis of the data. Chapter 3 describes the data collection methods employed in this study. Chapter 4 explains and describes the new water processes developed for the trial run. Chapters 5, 6 and 7 present an analysis of the three games played with academics

and students from Finland, America (USA) and South Africa (SA). In chapter 8 the three games runs are compared and the findings are synthesised and discussed in light of the study's objectives. Chapter 9, the concluding chapter, presents the limitations, conclusions and recommendations for further study.

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## CHAPTER TWO

### REVIEW OF THE LITERATURE

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#### **2.1 Introduction**

This research project focuses on the modification of an educational simulation game to lead to an effective understanding of water issues in southern Africa. The literature reviewed provides an overview of the educational theory that informs this research study, an appraisal of the simulation game as well as its conception, and the importance of water for effective resource utilization in developing countries.

#### **2.2. Constructivism & Experiential Learning**

Working in the agricultural context, Ison (cited in Petty 1998) calls for the use of innovative teaching methods by arguing that when teaching includes neither a focus on self-development nor enhances the ability to learn, then the utilization of sustainable resources in agriculture is threatened. Most tertiary institutions enforce the impression that they are custodians of knowledge through their teaching style with lectures viewed as a means of transferring knowledge from someone who knows to someone who does not.

In contrast, role-playing simulation games allow students to construct their own knowledge through their experience. Experiential learning finds its roots in social constructivism and since participants learn through their game experience, role-playing simulation games can be positioned within this approach to learning.

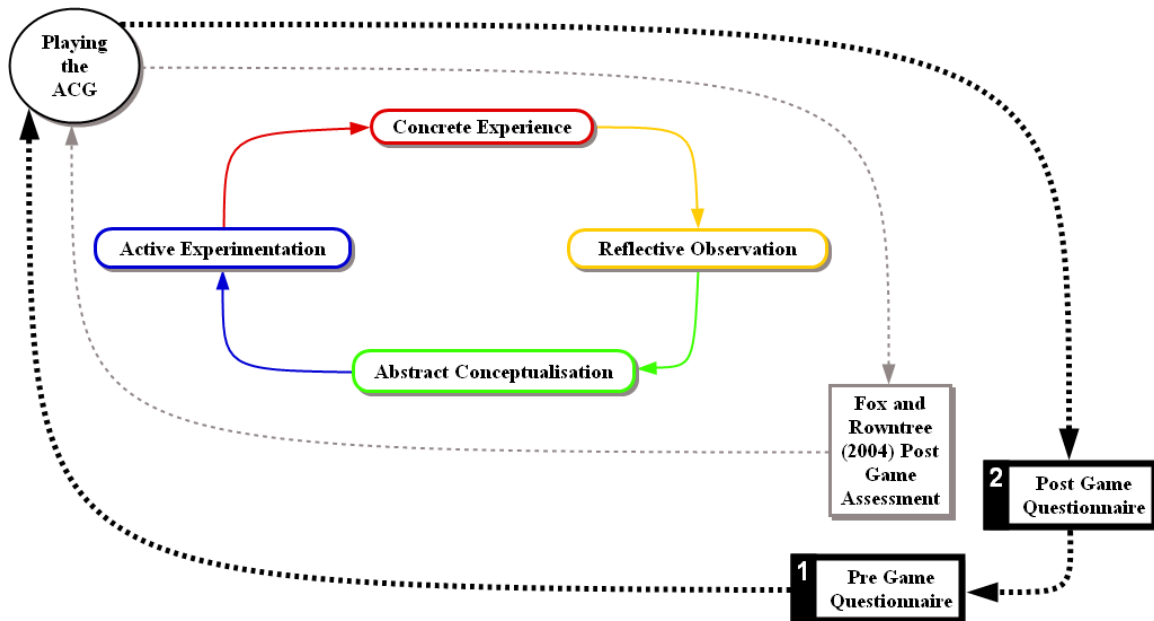
The psychologist, Jean Piaget (1896-1980), argued that children construct their own understanding through interaction with their environment. This theory of learning, commonly known as constructivism, asserts that knowledge is not transmitted directly from one person to another through face-to-face teaching, but is rather built up by the

learner through child-determined exploration and discovery (McInerney & McInerney 2006).

However, Vygotsky (1896-1934) argued that the learning process was also a social activity and not limited to a solitary process. Social constructivism refers to how a learner constructs knowledge in a social context by making personal meaning from socially shared perceptions (McInerney & McInerney 2006). The student is an active agent, making meaning in his/her life and in so doing, constructing knowledge (Donald et al. 2002). The student is then actively involved in a joint enterprise with the teacher in the construction of new meanings (Atherton 2005). New knowledge is created by making links between new information and experience and the existing knowledge base. These links are either in the form of adding to, modifying, or reorganizing existing knowledge and/or skills. Unless one makes these links, the new knowledge remains isolated and is not used effectively for new tasks or in new situations (McInerney & McInerney 2006). The ability to encode information, as well as the retention and retrieval of information, is critical for effective learning.

Experiential learning finds its roots in social constructivism. Atherton (2005) describes Kolb's learning cycle which consists of four interconnecting stages of experiential learning. Figure 2.1 displays this cycle. *Reflective observation* flows out of some form of meaningful *concrete experience* in which new information is linked with the present knowledge base. *Abstract conceptualization* refers to the application of known theories as a part of creating new meanings and thus constructing new knowledge. *Active experimentation* takes place as the learner 'tests' this new knowledge, which in turn requires some form of *concrete experience*. For example Fox and Rowntree's (2004) assignments (see the grey dashed lines in Figure 2.1) were designed for post-game assessment of the ACG and ensured learners' movement through Kolb's experiential learning cycle. In terms of this research study, (see the black dashed lines in Figure 2.1) there is also a pre-game questionnaire which allows participants to actively reflect on what they know about water management and consumption before playing the ACG, while the post-game questionnaire allows participants to reflect on their game

observations and to conceptualise their understanding of their experiences. The use of pre- and post-game assessment allows for the comparison of participants' responses both before and after playing the ACG and are described in chapters 5 to 8. In terms of learning, this teaching approach and form of assessment will facilitate participants' awareness of their own development and how they have constructed and negotiated their own meaning.



**Figure 2.1: Kolb’s Learning Cycle**  
**Source: Adapted from Atherton (2005)**

### 2.3 Models, Systems and Simulations

Role-playing simulation games are operational models that are comprised of interconnected systems. This section outlines the concepts and theories associated with models, systems, and simulations in order to gain an understanding of the thinking that informs role-playing simulation games.

Thomas (1970) argues that the “New Geography” of the late 1960s and early 1970s was characterized by the use of quantitative methods and should be recognized for the change in emphasis and attitude from the particular to the general. This shift placed the

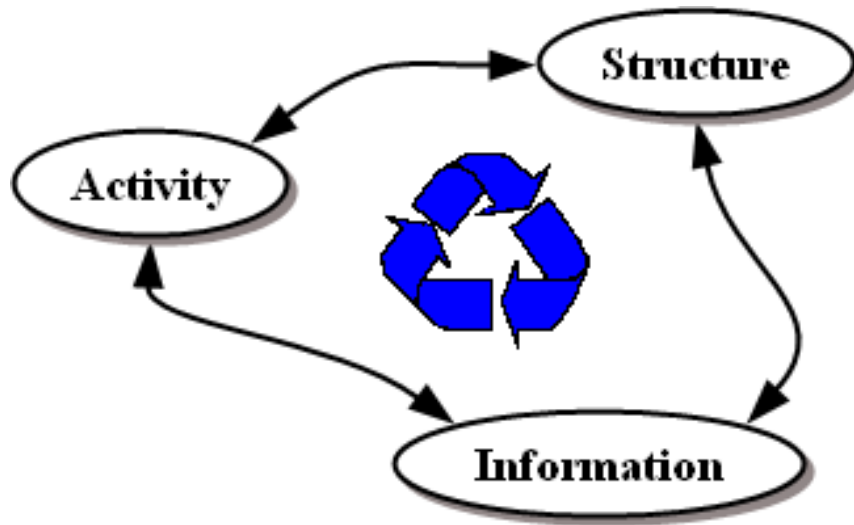
commonalities and patterns between regions in the foreground, taking preference over viewing the region as a unique entity. A particular region therefore becomes a source of information in the process of formulating the general overview. Spatial model building became the focus of geographical investigation at that time, which employed quantitative methods and computers to deal with large volumes of data (Holt-Jensen 1999).

The model is described as

a mathematical, logical, or mechanical representation of a relationship, theory, process, system or sequence of events, so designed that a study of the model functions either as a means of summarizing the complex relations of the real world or as a way of illustrating a theory (Goodall 1987: 308).

Models are often regarded as being difficult to grasp (Walford 1973). However, models do not have to be complex, jargon riddled or impossibly mathematical. The model that informs this research is the operational one that is based on empirical considerations and has a built in stochastic element (Goodall 1987). This means that both the managers' and participants' knowledge is derived from experience and that although the same modeled processes take place, there is no predicted outcome but rather an infinite set of alternative outcomes.

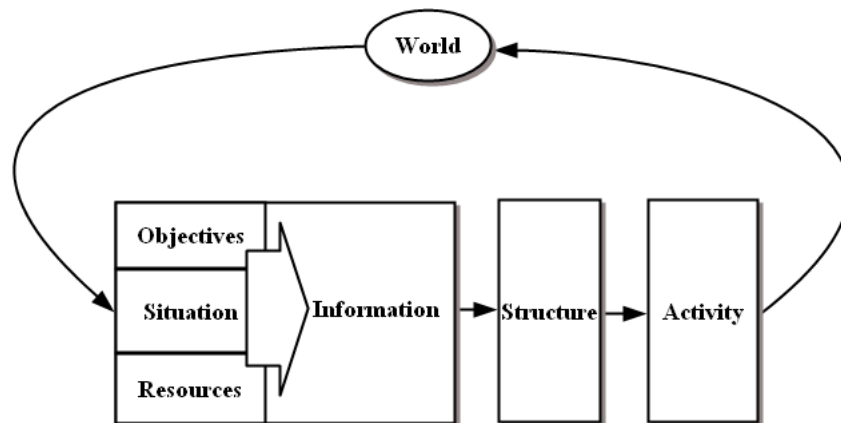
As defined above, models can be viewed as a system which is comprised of a set of interrelated components that are connected in some way to form a working unit or working whole (Goodall 1987). Kuusisto (2008) describes a system as a combination of various entities or actors that interact by means of exchanging something, i.e. energy, information, money, material, etc. According to Kuusisto, a system usually has three key components: structure, activity and information. These are displayed in Figure 2.2.



**Figure 2.2 - Interacting components within a system**

Source: Adapted from Kuusisto (2008)

Kuusisto makes use of an Aristolian Decision-Making Model to expand the information component into objectives, situation and resources. This is displayed in Figure 2.3.



**Figure 2.3 - Adaptation of the Aristotelian Decision Making Model**

Source: Adapted from Kuusisto (2008)

This model is significant in understanding change within the system. Due to the interconnected actors and components, a change in one component will be reflected in changes in other sections of the system. In addition, due to the built in stochastic element,

the outcome of the change in other parts of the system are unpredictable and therefore take the form of multiple outcomes.

In terms of this research study, the modifications made to the ACG's existing resources and structure, i.e. water availability and associated water rules, and their implementation in the Assegaai Trial Run and subsequent game runs (see chapters 4, 5, 6 and 7) allowed for the consideration of unaccounted outcomes. This also explains why data generation took the similar spiral form of an action research process. Figure 2.4 shows how, over a five month period, the water processes were adjusted for each game run based on the previous game's unaccounted outcomes. These adjustments had the potential to have an impact on the remaining information, structure and activity within the ACG game.

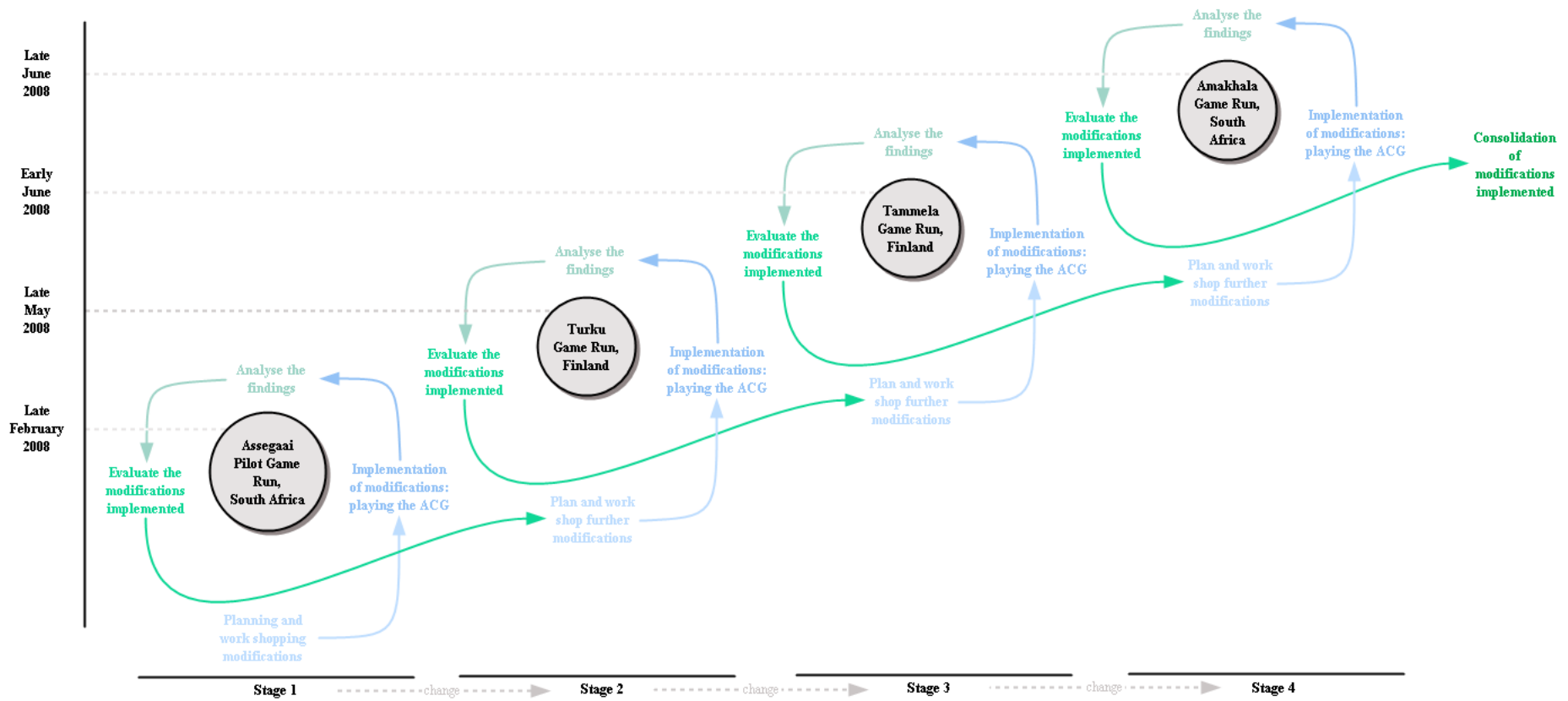


Figure 2.4 Chronology of research process employed

While systems thinking does not individually deconstruct or analyse each part of the system in question (Kuusisto 2008), it can be used as a tool for understanding and describing a complex system, its parts and internal interaction, as well as the comprehensive behaviour of the overall system. In other words, systems thinking does not analyse isolated parts or sub-parts of the system but incorporates a comprehensive understanding of the entire system's actors and their interactions.

It is important to realize that these unaccounted outcomes interact in various ways to produce different effects on their surroundings. Change is a product of interaction and affects the system internally by influencing its information, structure, and activity (Kuusisto 2008). By modifying the existing water processes for a southern African context, I wanted to see how fluctuations in the availability of water would impact on water management, food security and ultimately, development and the economy. The interactive nature of the game run allows each player to experience this impact as well as the impact created by his or her reaction to it. I therefore agree with Goodall (1987) that a simulation is a method for representing real systems in an abstract form for the purpose of experimentation. However, I would argue that this purpose includes gaining a comprehensive understanding of the actors and the impact of their interactions in a complex system. In so doing, the players' game experience allows for self-development and not only enhances the players' ability to learn but allows them to be conscious of this learning. It is therefore rationalized by educators such as Ison (cited in Petty 1998) that this form of teaching would encourage sustainable agricultural resource utilization.


#### **2.4 Pedagogical Use of Simulation Games**

In the late 1960s McLuhan (1969) argued that the importance of employing models in a classroom environment did not lie in the work done by university researchers or in curriculum improvement, but in the possibility of engaging students "through their active participation in model-building, model-operating, and model-evaluation" (McLuhan 1969: 25). Here the use of the term 'model' refers to the description of a range of

simulation techniques in which dynamic representations of reality are employed to replace real or hypothetical components with substitute elements (McLuhan 1969: 26). Taylor (1968, cited in McLuhan 1969: 26) classified the use of models in terms of their reality and abstraction and suggested the following as synthesized in Table 2.1.

**Table 2.1 – Classification of models**

**Source: Taylor (1968, cited in Walford 1969: 26)**

Reality  Increasing Abstraction					
Case study	In-basket or In-tray method	Incident process	Role playing	Gaming simulation	Machine or computer simulation

*Case studies* provide a comprehensive history or description of a particular problem or situation and are commonly known as the sample study to geographers. The *in-basket* method allows one to consider and act upon a set of issues. The *incident process* draws from the case study by searching for additional information and insights. *Role-play* allows for the spontaneous mock performances of participants placed in a hypothetical situation. Due to its complex nature role-play can form part of *gaming simulation*, in which decision makers can live out and test their choices. Similarly, computer simulation allows for the testing of decisions in that all the possible choices and consequences are packaged in a machine program.

Gaming simulations are important to this research study's competing element as well as providing the opportunity to live out one's decisions and strategies. According to McLuhan (1969), these elements date back to conflict and war games developed in the late eighteenth and nineteenth century in order to train officers in strategy and tactics. Today this tradition has not only made its way into the video game industry but also into

business and management where it is incorporated into sophisticated role-play situations and gaming simulations used for executive training.

McLuhan (1969) includes a reference to the jigsaw puzzle created by a cartography firm in the eighteenth century as “the philosophical trend in the amusements provided for Victorian children” (McLuhan 1969: 27). Initially named the ‘dissected map’ it was one of many parlour games, such as *Ludo* and *Snakes and Ladders*, and even Jane Austen makes mention of it in *Mansfield Park* when Franny is unable to ‘put the map of Europe together’ (McLuhan 1969: 28). An extended process situation in the form of a game dating back to 1843 required four participants, a pedestrian, a steam boat, a train and a then futuristic aeroplane, to embark on an “Eccentric Excursion to the Chinese Empire”. McLuhan (1969) argues that the enjoyment of these games is “a testimony to the soundness of their construction” (McLuhan 1969: 28) and that the employment of related activity methods in the primary classroom has positive developments. In terms of the secondary school classroom, he asks “why should we think that our good students are our *serious* ones?” (McLuhan 1969: 28). It can be argued that this research study asks the same question in terms of the university lecture room. The ACG employed in this research study has been adapted, not only in terms of what it simulates but also in its title, from the conception of the simulation game “*Green Revolution*” by Graham Chapman in the 1970s.

*Green Revolution/Exaction* (GR/E) is a gaming simulation that models modernization amongst rice-growing agricultural farmers in South Asia. Chapman (1989) made use of systems thinking and field data concerning the consequences of different farming choices to develop a simulation game with Elizabeth Dowler of the London School of Hygiene and Tropical Medicine. A lack of a conceptual understanding about rural based agricultural farming amongst students called for a different teaching approach (Chapman 1989). In addition, the formal presentation of information on the subject did not do justice to the inter-relationships that are bound to the decision making processes associated with farming. The simulation game provided students with the opportunity to wrestle with these same choices and devise their own farming strategies (Chapman 1989). This is

evident when considering the objectives of the GR/E, and subsequently the ACG, listed by Park, English, Gray, and Cleland (1995: 257). Students practice decision making in one or more subject matter areas relevant to their curriculum:

1. critical thinking activities are promoted by placing students in real life situations,
2. students are challenged with forming positions on value-laden issues in addition to making decisions that involve ethical considerations
3. allowing students to enhance interpersonal relationships and to practice interpersonal communication.

GR/E was based on a simple rural economy with core dimensions that made it possible for integrating different interdisciplinary themes: a dynamic physical environment including water and irrigation, agronomy, sociology, politics and a simple economy (Chapman 1989). At the request of the World Bank, the game was developed to incorporate the dynamics of a whole country so that it included an urban/industrial sector, an informal sector, trading intermediaries, overseas trade, as well as a government comprised of a president and two ministers (Rowntree & Fox 2007). The game has been modified by Rowntree and Fox (2007) to encompass the African context and was entitled the *African Catchment Game* (ACG). A commercial farming sector that includes starting assets such as a tractor, as well as debt, cattle, refugees and HIV-AIDS have been incorporated into the game. The ACG is used as part of a 3<sup>rd</sup> year undergraduate as well as a 4<sup>th</sup> year Honours course, and has been played in Botswana, Sweden and Finland. Figure 2.5 and Table 2.2 positions the ACG amongst other simulation games employed by Professor Fox and Professor Rowntree in various courses offered at Rhodes University, South Africa.

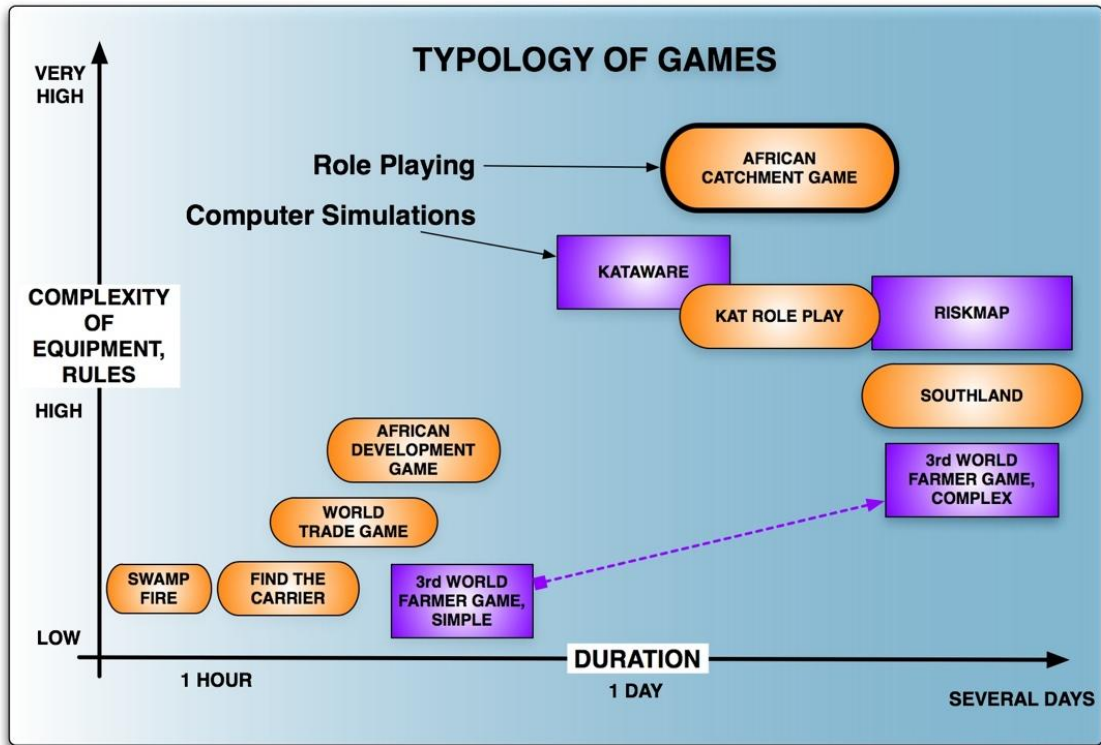


Figure 2.5 – The ACG positioned in terms of its complexity and duration

Source: Fraenkel, Fox, Rowntree and Wilmot (2008)

Table 2.2 – The ACG’s position in the Rhodes Geography Syllabus

Source: Fraenkel, Fox, Rowntree and Wilmot (2008)

Role Playing Games in Rhodes Geography Syllabus			
GOG 102 Introduction to Global Development	Swampfire and Find the Carrier	World Trade Game	African Development Game
GOG 201 Rural and Urban Structures in Southern Africa	3 <sup>rd</sup> World Farmer Game		
GOG 301 Environment and Development in Africa	African Catchment Game		
GOG HONS Rural Economy and Resource Utilisation in Africa	African Catchment Game	Riskmap	Southland OR 3 <sup>rd</sup> World Farmer Game

## 2.5 Playing the African Catchment Game

Fox and Rowntree (2007) use the same divisions as in the GR/E: the Rural Sector, the Urban-Rural Interface and the Urban Sector. Two managers facilitate the running of the game. The Rural Manager runs the Rural Sector, while the Rest of the World Manager runs the Urban-Rural Interface, the Urban Sector and international trade. These divisions, as well as the roles and the maximum number of players (in brackets) that can play are grouped under each division in Table 2.3.

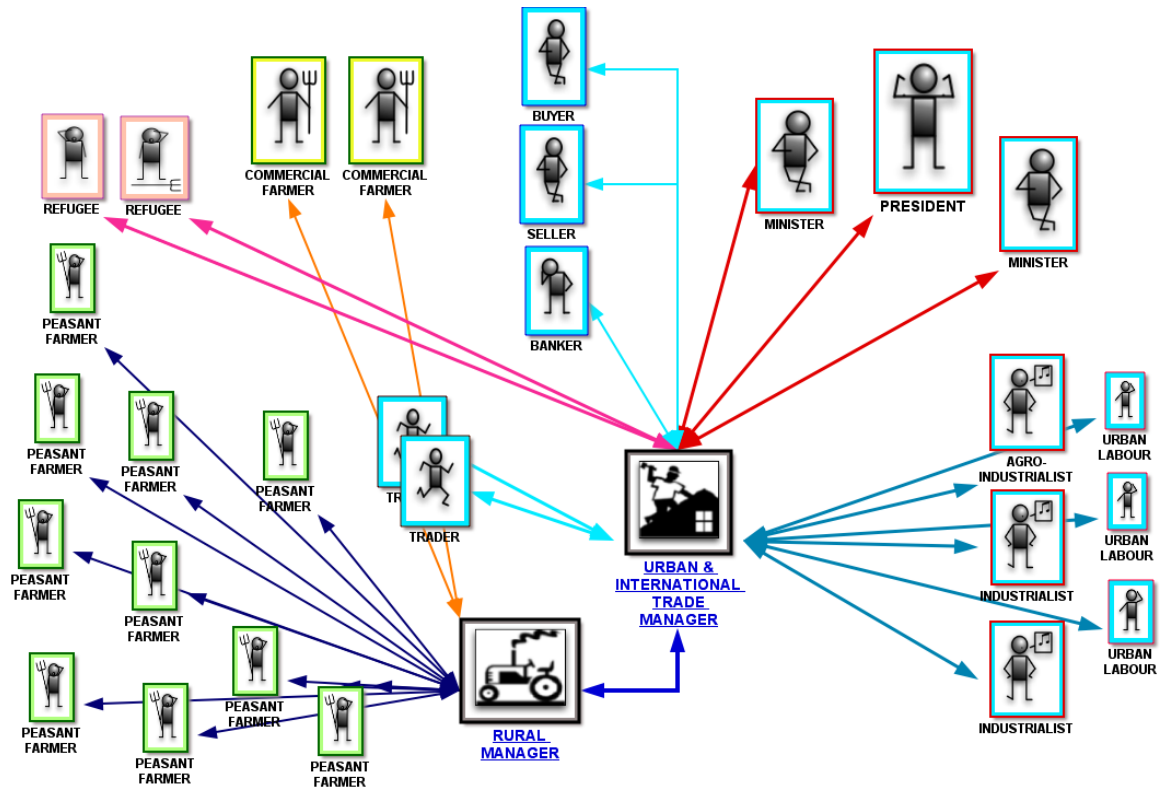
**Table 2.3 - Urban and rural roles**

**Source: Rowntree and Fox (2007)**

Rural Manager	Rest of the World Manager	
Rural Sector	Urban-Rural Interface	Urban Sector
Commercial farmers (2x2)	Banker (1)	President (1)
Subsistence farmers (8x2)	Seller (1)	Minister of Home Affairs (1)
	Buyer (1)	Minister of Land and Water (1)
	Trader (1)	Industrialist (2)
		Urban labour (2)
		Refugee (2) (can also be placed in the rural area)

Figure 2.6 outlines which roles are monitored by the rural and urban managers and shows the potential for mobility and communication between different roles within each sector at the start of a game run. Only the commercial farmer, trader and the government are provided with transportation: the trader has a bicycle while the commercial farmer has a light delivery vehicle (bakkie) and the President and two Ministers, Home Affairs and Land and Water, share a car. The remaining players may not move between the urban and rural sectors without transportation. Family size for each player is randomly determined by drawing from a deck of cards. Different cards are used to determine land and resource endowments for both the rural and the urban sector at the start of the game as well as rainfall, pest attacks, and industrial production during each year of the game run. This form of inequality not only mirrors the southern African context in terms of endowments

but is also responsible for creating the initial tension experienced by those who have difficulty in meeting their consumption requirements. Therefore while some farms are able to produce a surplus others have to consider alternative strategies to survive.



**Figure 2.6 – Potential mobility and communication between different roles**

**Source: Fox (2008)**

In order to play an operational game such as the ACG there needs to be a list of rules. Crookall et al. (1989) discuss how rules arise from three main sources: simulator rules, game rules and imported rules. *Simulator rules* are either representations of real-rules, rules simulating rules or symbolic rules. *Game rules* are designed for procedural reasons so that they structure the simulation activity and facilitate strategy building within given limits. *Imported rules* are those which participants bring into the game as culturally competent members of society. While a combination of simulator and game rules were designed for the ACG, Park, English, Gray, and Cleland (1995) point out that the only real rules in the GR/E game, and therefore in the ACG, are the consumption requirements

and the limits placed on mobility and communication. The following rules are a combination of simulator and game rules that were designed for the GR/E and used in the African Catchment Game:

- A maund is a measure of weight used in India and varies from approximately 25 to 85 pounds. Adults must eat 10 maunds of rice while children must eat 5 maunds every game year or die
- Farm productivity depends on the rice variety sown, the rain and drought sequences, as well as the pest attacks that are mitigated by irrigation, pesticides and fertilizer
- Industrial output is subject to water and electrical hazards as well as machine failure
- Cards determine global prices for imports and exports of commodities, rainfall variability, pest attacks on farms, as well as births and deaths.
- The banker, buyer and seller are seated at the rural-urban interface and are accessible to all game players
- Movement of players between sectors can only take place if some form of transportation is used. For example the trader has a bicycle, the commercial farmer has a light deliver bakkie and the government has a car
- A granary is the only storage for rice and is one of the items manufactured by the industrialists
- The president determines who can trade internationally by issuing trading licences
- Game activities stop when rains are announced

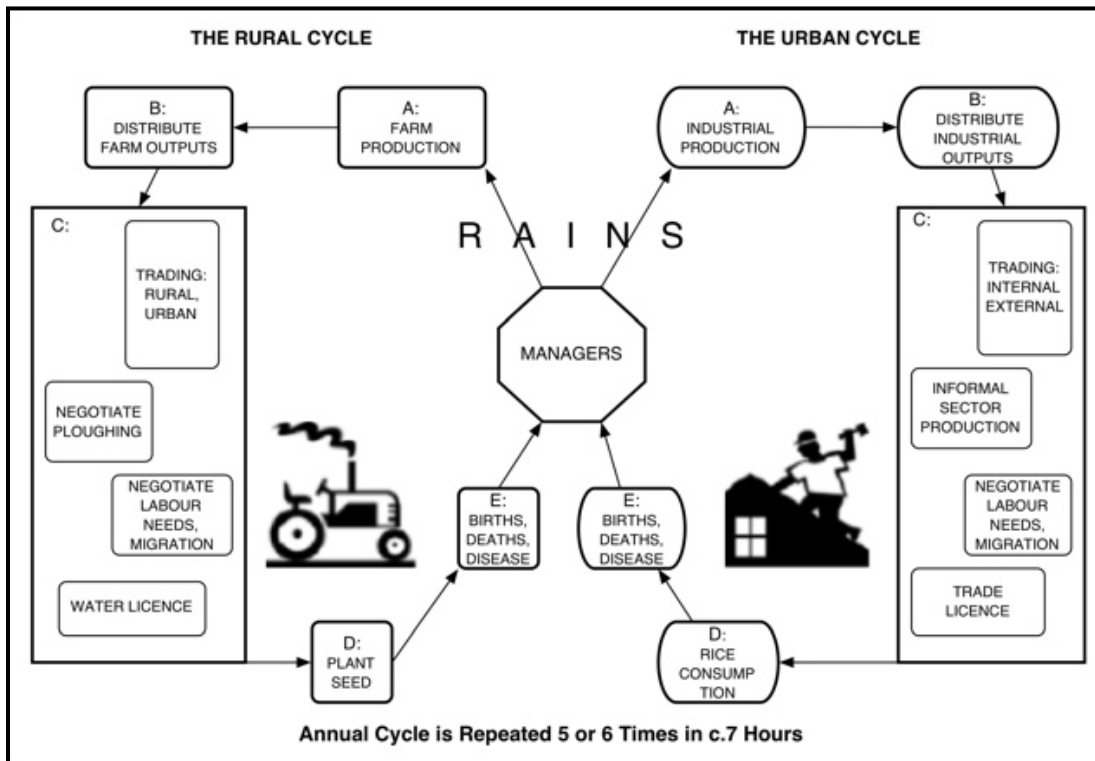
New simulator and game rules were designed that are compatible with the ones listed above in order to effectively model different rainfall regimes in the upper and lower catchments as well as water use and consumption in a southern African context. These new rules are described in chapter 3.

The game cycle for the rural sector starts with “the rains”. There are three seasons: germination, middle growth and flowering. Each season receives either drought or rain

which is determined by the turning of cards. This determines the amount of water that the cultivated fields receive and the subsequent yield reaped. In addition, individual farms are subject to pest attacks which are also determined by the turning of cards. The rice and/or sugar cane produced therefore depends on the rain and drought sequences, the occurrence of pest attacks, as well as the use of irrigation and the application of fertilizer and pesticide to alleviate their effects. In the ACG calves are born, cows are serviced by bulls and cattle can be used for ploughing fields for cultivation. Peasant and commercial farmers are responsible for the cultivation of their fields as well as for buying necessary farm supplies and selling their produce.

The game cycle for the urban sector starts with the “industrial disruptions”. The turning of cards determines which factories have suffered water or machine failure and even complete shutdown. The industrialists manufacture farm inputs such as water pumps, pesticide, herbicide and fertilizer for sale or export. In order to achieve this certain inputs such as water, industrial raw materials and labour are required as well. Government is responsible for forming policy and raising revenue to run the country. The banker, trader, buyer and seller keep goods and money flowing freely between the rural and urban sectors.

The rural and urban cycles are outlined in the Figure 2.7. These cycles take place simultaneously and each cycle represents a simulated year which is about 1 hour in reality.



**Figure 2.7 - Rural and Urban Cycles in the ACG**

**Source: Rowntree and Fox (2007)**

## **2.6 Resource Utilisation: Conflict, Competition and Collapse**

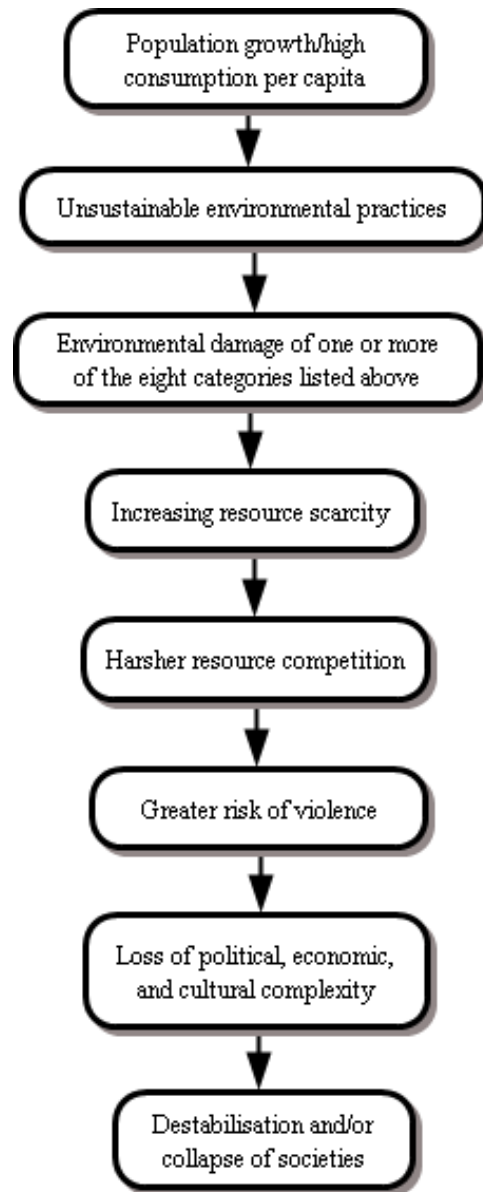
It is important to consider the following environmental themes since the modifications made to the ACG force students to make ethical decisions while practicing livelihood strategies and managing water resources in the simulation.

Renner et al. (1991, cited in Gleditsch 1998) argued that the importance of natural resources is undisputed in history, especially since the recognition of sovereign nation states. Renner et al. goes on to state that for centuries the struggles concerning access, control and management of natural resources have been the underlying cause of conflict and degradation. Furthermore, Renner et al. states that human history provides examples of how the rise and fall of states and nations is directly linked to environmental collapse which has manifested in famine, migration and rebellion.

Similarly, Diamond (2005) argues that past societies have been undermined in various combinations of magnitude by eight main environmental problems:

- deforestation and habitat destruction,
- soil problems,
- water management problems,
- overhunting,
- overfishing,
- effects of introduced species on native species,
- human population growth, and
- increased per capita impact of people.

Sadly, these problems remain a present and future concern with the addition of four new problems: human-caused climate change, build-up of toxic chemicals in the environment, energy shortages, and full human utilization of the earth's photosynthetic capacity. Both Diamond (2005) and Gleditsch (1998) recognize a common causal chain that attempts to explain the reason for contested natural resources and the above environmental problems. This is summarized in Figure 2.8.



**Figure 2.8 - Common Causal Chain for Contested Natural Resources and Environmental Problems**

**Source: Adapted from Gleditsch (1999) and Diamond (2005)**

These problems need to be addressed in light of balancing the need for human welfare and the protection of the resource base on which that human welfare depends (Falkenmark & Rockstrom 2004: xiii).

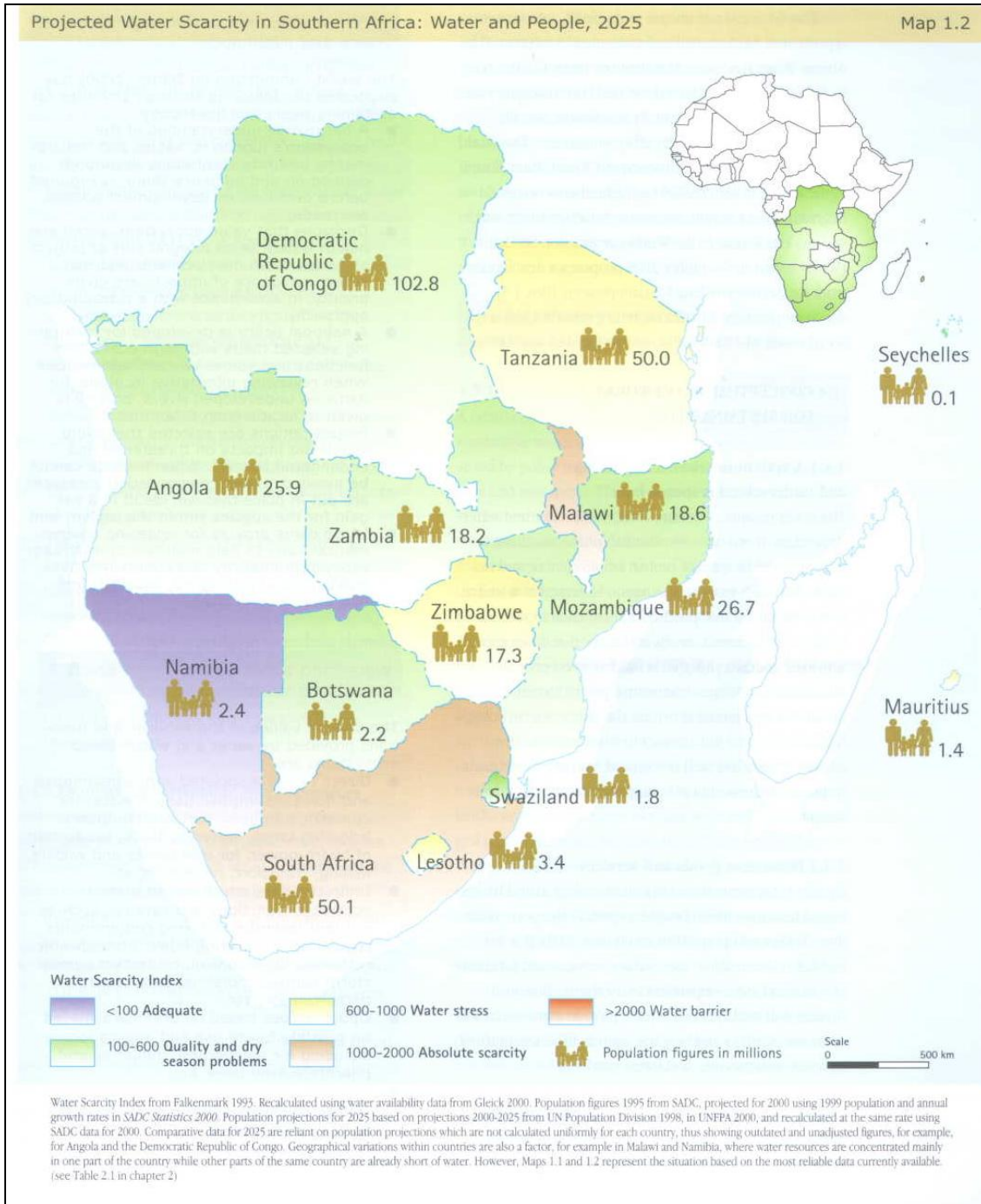
While Figure 2.8 provides a significant causal pattern, its simple linear sequence does not take into account the interrelated impacts and complex feedback systems. Environmental educators have argued for the conceptual understanding of the interrelated and interdependent interacting dimensions of our environment as described and illustrated in Figure 1.1 (see chapter 1).

## **2.7 Water and Development**

Gleditsch (1998) identified territory, raw materials, sources of energy, water, and food as the most prized of these contested natural resources. Water has long been a source of conflict due to its necessity for socio-economic development and survival:

Water is life. It nourishes our ecosystems, powers our industry, grows our food, and makes life itself possible (Tolba 2004, cited in Falkenmark & Rockstrom, 2004: xi).

In addition, it is also a limited and vulnerable resource in southern Africa. The following map uses data on renewable supplies and demographics to project which SADC countries will be facing severe water problems in 2025:



**Figure 2.9- Map Showing the Projected Water Scarcity for Southern Africa: Water and People, 2025**

**Source: Hirji and Molapo (2002)**

From the projected data in this map it is evident that the following countries will be facing issues related to water availability and quality in 2025:

**Table 2.4 - Projected Water Scarcity in Southern Africa in 2025**

**Source: Adapted from Hirji and Molapo (2002)**

<b>Projected Water Problems</b>	<b>Impacted Countries</b>
Absolute water scarcity	Malawi and South Africa
Water stress	Lesotho, Mauritius, Tanzania, Zimbabwe
Water quality and availability problems in the dry season	Angola, Botswana, DRC, Mozambique, Swaziland and Zambia

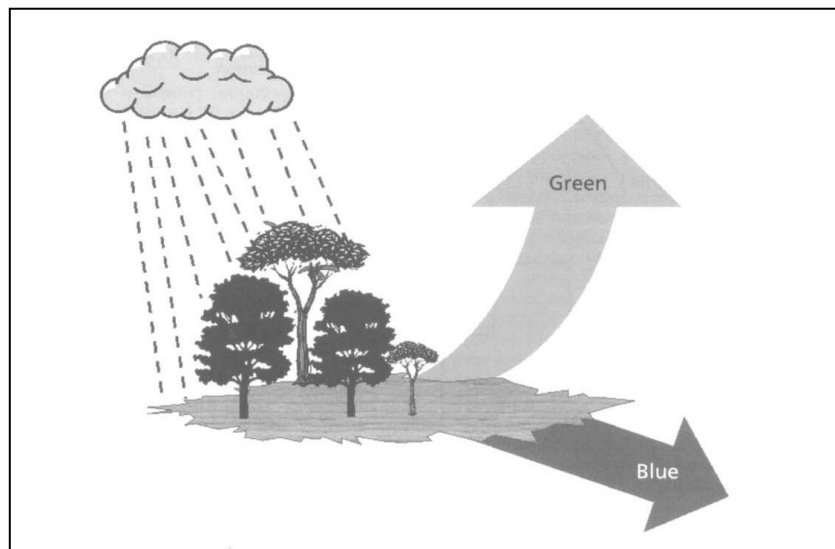
Causal factors for these projected water issues include the increasing demand due to a rapidly growing population, which is increasing at a rate of 3% per annum, and an urbanizing population, which is increasing at a rate of 6.5% (Hirji & Molapo 2002).

Factors including climate variability and climate change, the increased degradation of water resources, and the location of water sources over trans-boundary waters makes water a vulnerable resource in southern Africa (Hirji & Molapo 2002). Rural-based societies and agrarian economies are subject to climatic variability that determines whether they have a successful harvest or not. Rainfall is already modeled in the GR/E for an Indian context by randomly selecting rain or drought cards and was modified for the southern African context in the Assegai Pilot Game Run and is discussed in Chapter 4. Further modifications were made to the ACG for the subsequent game runs, i.e. the Turku, Tammela and Amakhala Game Runs, and are discussed in Chapters 5, 6, and 7.

## **2.8 Water, Agriculture & Food Security**

Internationally, agriculture is considered to be the largest sector dependent on freshwater sources. The necessary food for the world's population is agriculturally produced under both rain-fed and irrigated conditions (Appelgren & Klohn 2001, cited in Appelgren 2004). A distinction needs to be made between what is meant by rain-fed and irrigated

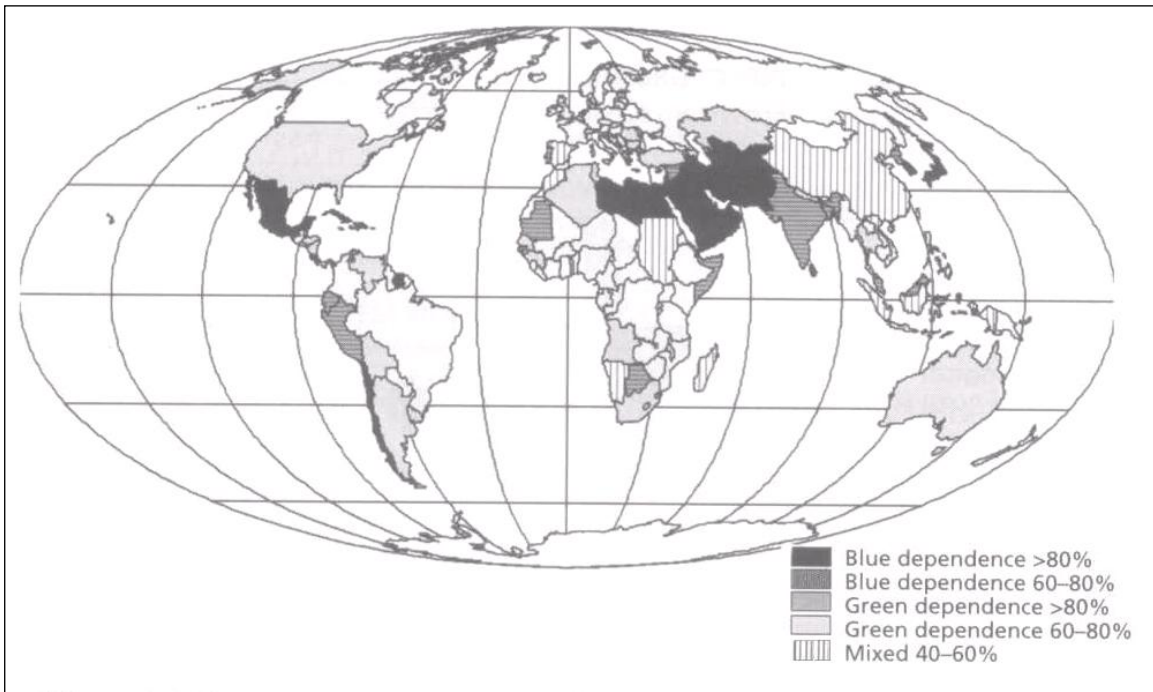
conditions in terms of water sources since these are two different water systems with different environmental impacts which are simulated in the modified ACG. Irrigated sources are considered to be blue water sources. Fallenmark and Rockstrom (2004: 5) described blue water flow as the “visible liquid flow moving above and below the ground as surface or sub-surface runoff, respectively”. They provide some examples: surface runoff includes water flowing in rills, gullies and rivers, while examples of sub-surface water include underground water that recharges water tables and aquifers. Green water flows are defined as “the invisible flow of vapour to the atmosphere” (Fallenmark & Rockstrom 2004: 6) and are further described as productive, the transpiration from plants or trees, and non-productive, the evaporation flows from the earth’s surface. A further distinction between green and blue water is that green water flow involves a consumptive use of water, while blue water flow does not. Forests, grasslands and rain-fed agriculture are responsible for this consumption, which sustains terrestrial ecosystems. Blue water flow can be drawn for these and other consumptive purposes and whatever surplus is left returns as part of the blue water flow. Precipitation is seen as the main water source and once it reaches the earth’s surface, it is partitioned into blue and green water flows. The vertical arrow marked “green” is the water branch of water vapour and the semi-horizontal arrow marked “blue” is the water branch of liquid water in Figure 2.10.



**Figure 2.10 - Rainfall partitioning: green and blue water flows**

**Source: Fallenmark & Rockstrom (2004)**

The modified simulation game will model rainfall, the blue and green water flows as well as the production of grey industrial water. Blue water flow is captured and stored in a dam located in the upper catchment, which receives a higher rainfall than the lower catchment. The dam is managed by the Dam Manager and the Water Minister will be responsible for issuing domestic drinking water, irrigated water and industrial water. Green water is represented in the game as the invisible flow of vapour from rain-fed agriculture. This distinction between blue and green water aids in the understanding of two concepts. One is that both society and ecosystems share the same water source, i.e. precipitation. Secondly, that the majority of the world's food production relies on green water flow, i.e. precipitation. Consider the map in Figure 2.11 below that shows the relative role of blue water withdrawals and direct green water use to sustain food production in different countries of the world (Fallenmark & Rockstrom 2004).



**Figure 2.11: The predominant sources of green or blue water to produce grain foods**  
(map produced for publishing in 2004)

**Source: Adapted from Fallenmark & Rockstrom (2004: 68)**

The map shows that 70% of countries depend up to 60% or more on green water flow to sustain food production, which means that rain-fed agriculture dominates food production. This is why the majority of the cultivated fields in the simulation game depend on rainfall and not irrigation. African livelihoods depend on the land and climate for food as well as household incomes (United Nations Environment Programme (UNEP) 2002). Given that most food production is rain-fed and that rainfall is both variable and extreme, water plays an important role in socio-economic development at the household level.

Food security is defined by the Food and Agricultural Organisation of the United Nations as “a state of affairs where all people at all times have access to safe and nutritious food which enables them to maintain a healthy and active life” (UNEP 2002: 287,288). This definition has two key dimensions, namely availability in terms of quality and quantity as well as access at household and individual level.

The World Bank highlighted Africa’s dependency on agriculture in a study compiled in 1993 (UNEP 2002: 191). This sector employs the largest number of workers both formally and informally: Africans are directly dependent on the land for their household food requirements (50%) and household incomes (40%) (UNEP 2002). Agriculture thus has a direct impact on food security. Agriculture itself has undergone significant changes with regard to paradigms that have informed it and the subsequent strategies that have been implemented in order to meet food demands. This is outlined in Table 2.5 below.

**Table 2.5 - The evolution of thinking about agriculture: 1950s – 1990s**

**Source: Maxwell and Devereux (2003: 39)**

<b>Period</b>	<b>Dominant Development Paradigm</b>	<b>Agricultural Strategy</b>
1950s	•Growth through industrialization	•Community development
1960s	•Growth through industry and agriculture	•Green Revolution
1970s	•Redistribution with growth and basic needs	•Integrated rural development
1980s	•Structural adjustment	•NGOs/emergency relief
1990s	•Poverty reduction	•Small-scale credit/linking relief and development

From this table one can see a circulation of agricultural strategies where community development from the 1950s is reflected in the emphasis on NGOs in the 1980s as well as on small scale credit in the 1990s. The production that underpinned the Green Revolution as well as the design of the GRG&EG in the 1960s, is echoed in the emphasis on credit in the 1990s (Maxwell & Devereux 2003).

The success of the Green Revolution depended on specific amounts of inputs in the form of fertilizer, pesticide and irrigation in creating larger yields per hectare. This is modeled in the GR/E, as well as the ACG, together with older farming technologies in order for participants to gain a better understanding of the pros and cons associated with high yield varieties. As mentioned above, irrigated agriculture is the largest extractor of freshwater sources in the world. Intensive agriculture has made it possible to not only reduce water inputs, but also natural resources and manpower (Appelgren 2004). The intensification of agriculture as well as new technologies has provided the means to produce and distribute the required global food demand. However, even though market liberalization and globalization has allowed for the availability of these new technologies, many are unable to gain access to them as well the necessary capital, food, land and water resources. Subsequently, approximately 800 million people live under conditions of poverty and food insecurity (Appelgren 2004). Many attribute this to a rapidly growing population and a relatively finite resource base.

Jolly (1994) outlines four theories that deal with the relationship between population change and the environment: neoclassical economics, classical economists or natural scientists, dependency and regional political ecology theorists and analysts. These theories show that although population change plays a role in environmental degradation, it is not the sole contributing factor. Other processes need consideration, especially the interdependent relationships between the political, economic, social and biophysical dimensions of the environment as argued above in section 2.5. These theories, their ultimate cause and result are summarized in Table 2.6 below:

**Table 2.6 - Summary of theories: population change and the environment**

**Source: Adapted from Jolly (1994)**

<b>Theory</b>	<b>Ultimate Cause</b>	<b>Result</b>
•Neoclassical Economists	•Economic inefficiencies	•Environmental degradation
•Classical Economists & Natural Scientists	•High population growth	•Environmental degradation
•Dependency & Regional Ecology Theorists	•Inequality & poverty	•Environmental degradation & high fertility
•Population as an Intermediate Variable	•Various ultimate causes	•Environmental degradation

The ACG enables one to model the ultimate cause and result of the above theories and in so doing allows participants to experience the processes impacting on livelihood strategies. For example, in past game runs participants adopted a Neoclassical approach and tried to maximize their outputs with little regard for the environment resulting in extensive environmental degradation. Further understanding and conceptualization is facilitated by connecting their game experience to the multi-dimensional framework of the environment and its political, economic, social and biophysical aspects.

## **2.9 Conclusion**

The literature reviewed has covered important aspects concerning educational theory, the conception and appraisal of the ACG, as well as the importance of water. The review has also shown that the literature concerning the modification of geographical simulation games is limited and this study provides valuable insight into the neglected arena of the learning associated with such simulation games as well as to the potential to use such games for future studies. It is evident that water plays an important role in farming and that together they are critical factors for socio-economic development in Africa. Experiential learning in the form of simulation games has been employed in an attempt to overcome a lack of understanding of the complex processes associated with rural agriculture, environmental degradation and socio-economic development. This research project focuses on the modification of the ACG simulation game as a tool for the effective learning of inter-relationships associated with water issues in rural and urban African contexts.

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## CHAPTER THREE

### RESEARCH METHODOLOGY

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#### **3.1 Introduction**

This chapter describes the methodological orientation selected for this research and goes on to explain and justify the case study method employed in the study. The various ways in which data were generated, the roles of the two game managers as well as the researcher and the analysis of the data was then clarified and justified. Ethical considerations and the limitations of the study are discussed.

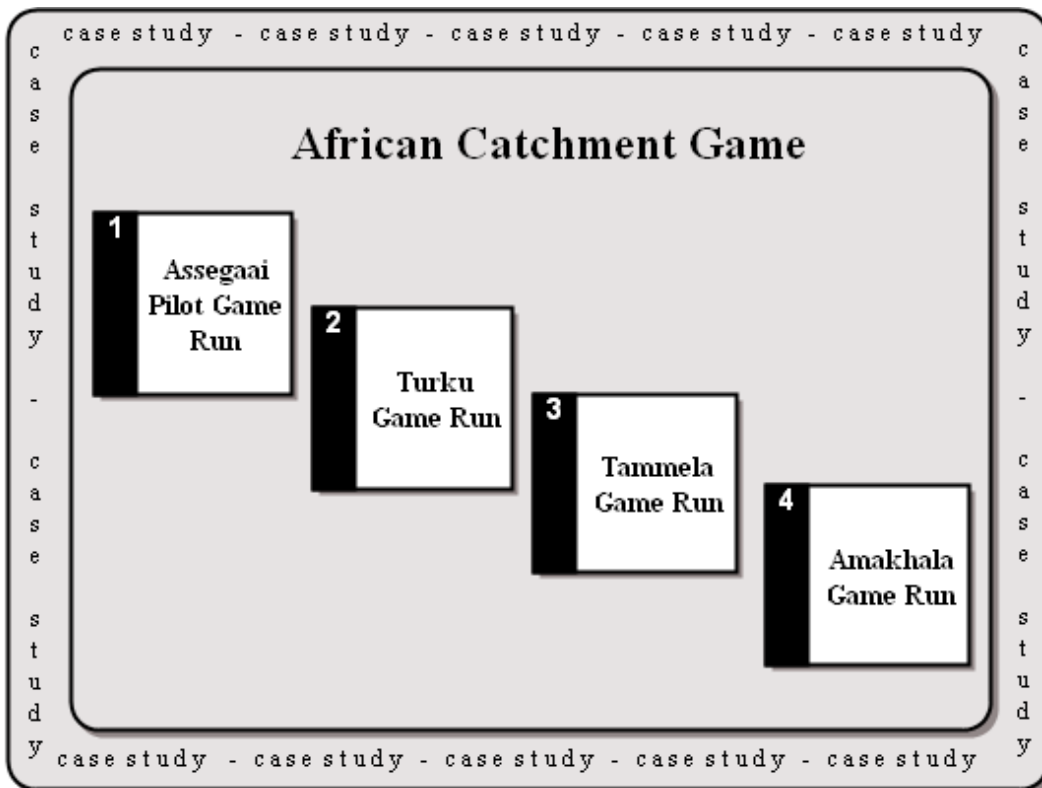
#### **3.2 The Research Orientation**

This study seeks firstly to modify, develop and implement new water processes in the ACG and secondly to understand what, if any, learning subsequently occurred. Since this type of research study is not common in geographical education, it was necessary to design a methodology appropriate to the study's epistemology and ontology. An interpretive orientation was chosen since it "seeks to understand and interpret the world in terms of its actors" (Cohen, Manion & Morrison 2000: 181). Both qualitative and quantitative data were generated in order to "accumulate sufficient knowledge to lead to understanding" (Maykut & Morehouse 1994: 174).

The aim of the research approach is to understand the learning associated with water management resulting from playing the ACG. Data generation and analytical methods were designed to examine knowledge of water management in the participants' own context and in a southern African context. Pre- and post-game questionnaires and audio recordings of the focus group debriefings provided information on the knowledge gained by the participants. The observations of the three managers, Professor Fox, Professor Rowntree and myself, gave material regarding game dynamics. Spreadsheet information gave quantitative information associated with the annual cycles in the rural and urban sectors of each game run. These are elaborated on below.

### 3.3 Case Study Method

The case study is described as “the particularity and complexity of a single case, coming to understand its activity within important circumstances” (Stake 1995: xi). Similarly, this study seeks to understand a specific phenomenon; learning associated with water management, in a specific context; involving different players participating in four separate African Catchment Games (shown in Figure 3.1).



**Figure 3.1 Use of the case study method outlined**

The four consecutive game runs show in Figure 3.1 are the single case study. The findings of this case study are context and content specific and as such they cannot be generalised for the larger population but can be applied to theory (Yin 1994, cited in Tellis 1997: 4). In the context of this research, the relevant geographical and educational theories would include social constructivism, experiential learning, systems and simulations, the pedagogical use of simulation games, especially the ACG, resource

utilisation, water and development, agriculture and food security as reviewed in Chapter 2.

Process tracing will allow for the identification of quantitative and qualitative evidence, in the form of patterns and trends associated with learning, both within and between game runs. According to Garson (2008), process tracing is a more systematic approach than pattern matching. This evidence will be “the result of a causal process and does not merely reflect spurious association” (Garson 2008: 2, 3). This technique was used together with the Chi-Square Test in order to unravel the dynamics of each game run and to determine what learning had taken place at the participant level.

### **3.4 Research Goals**

The objectives of the study are:

- 1. To provide a critical appraisal of the literature focusing on simulation games, especially a description and appraisal of the GR/E and the ACG, as well as educational theory focusing on the need to develop teaching methods; water issues in Africa; and other relevant topics.*

Chapter 2 provided a review of the relevant literature that informs this study.

- 2. To conceptualise and describe the changes to be made to the ACG in order to model water as a modified environmental component for the southern African context.*

The changes made to the ACG were work-shopped and conceptualised with Professors Fox and Rowntree of the Geography Department at Rhodes University, South Africa and are discussed below. The implementation of these changes, both in the trial run and the subsequent game runs, are discussed in Chapters 4, 5, 6 and 7 respectively.

- 3. To develop instruments and techniques that allow for the generation, analysis and interpretation of data from the game runs.*

The instruments and techniques employed to generate the data, in the form of pre- and post-questionnaires were work-shopped with Dr Wilmot and Ms Van Harmelen of the Education Department at Rhodes University, South Africa. The analysis and interpretation of the focus group recordings and participant observations are discussed in Chapters 5, 6 and 7. The analysis and interpretation of the Chi-Square Test and environmental dimensions are discussed in chapter 8.

- 4. To play the modified game with diverse groups of students and professionals to assess the changes made to the ACG.*

The ACG was modified after the trial run and between subsequent game runs. These game runs were played in four locations and with four diverse groups of students and professionals. The discussion of the trial run and the subsequent game runs are in chapters 4, 5, 6, and 7.

- 5. To evaluate the impact of the game and the effectiveness of the simulation by assessing the participants' development of understanding as a result of playing the modified ACG.*

The instruments and techniques, in the form of questionnaires, as well as the use of the Chi Square Test and process tracing, were used to assess the development of participants' understanding. The impact of the game and the effectiveness of the simulation could thus be evaluated. Chapters 5, 6, and 7 provide a discussion of the participants' questionnaire responses. Chapter 8 provides an analysis and interpretation of the Chi-Square Test results and subsequent analysis and interpretation of statistically significant questionnaire responses.

6. *To consolidate and produce a final version of the ACG that models new water processes as an environmental component.*

The implementation of the new water processes in the trial run, see Chapter 4, and the modifications made to the ACG after each game run, see Chapters 5, 6, and 7, allow for the consolidation and production of a final version of the ACG. The modified water processes for a southern African context are described in Chapter 9.

7. *To relate findings to published studies and theories from the literature review.*

Chapter 9 consolidates the findings of this study and relates it to published studies and theories from the literature reviewed in Chapter 2.

### **3.5 Data Generation**

This section aims to satisfy *Objective 3*: the development of instruments and techniques to capture, analyse and interpret data from each of the game runs. Data for each game were generated through questionnaires (described below), the focus group discussion (post game debriefing session) and the spreadsheet data relevant to each manager's sector in the game.

#### **3.5.1 Questionnaire Design**

For past game runs Fox and Rowntree (2004) had implemented a post game reflection exercise which allowed participants to reflect on and consolidate their game experience. This assignment, which included additional questions concerning biographical data, was given to the players after they had participated in the Assegaai Pilot Game Run.

After the Assegaai Pilot Game Run held in February 2008 I had a discussion with Dr Wilmot and Ms Van Harmelen in late April 2008 in order to consider an appropriate method of data generation that went beyond the simple reflective exercise given to the players. Pre- and post-game questionnaires were designed and questions were posed for

the participants' own context, called Your Context, as well as a southern African context. Not only did I want to identify learning about water management in a southern African context but I also wanted to establish whether participants would be able to connect this learning to their own local environment. It was also decided to use the environmental education framework, described previously in Chapter 1 (Figure 1.1), which focuses on the interrelated and independent dimensions of the environment to map participants' knowledge and understanding of water. Employing this environmental framework was done in order to identify and clarify which water processes participants were learning about and how they could be connected. This was the central concern of the focus group discussions. These questionnaires were administered before and after each game run. Figures 3.1 and 3.2 are examples of the pre- and post-questionnaires respectively.

The structure of the pre-questionnaire was designed to guide participants through questions relating to water in their own context and then in a southern African context. The ACG was then played and followed by a focus group debriefing. The post-game questionnaire then guided participants through questions relating to water in a southern African context and then in their own context. The design of the questionnaires therefore facilitated an examination of the change from the participants' own contexts to that of a southern African context and back again. Subsequent analysis using the Chi-Square Test allowed statistically significant questions to be identified and analysed further.

Questions posed in the Pre- and Post-Questionnaires are summarised in Figure 3.2. The first two questions for each context in both the pre- and post- examined whether participants were able to distinguish differences in water use and water control respectively, between the two contexts. Similarly, the third and fourth questions examined whether issues and challenges could be identified and explained as well as providing plausible reasons for why they had emerged. Three additional questions were posed in the post-game questionnaire only. The first examined how the game had or had not helped participants to gain a better understanding of water management in both these contexts. The second was posed only in their own context and examined the insights participants had gained from their game experience while the third examined what changes or improvements participants had recommended for the game itself.

Pre-Game Questionnaire			
Your Context		Southern African Context	
No.	Question	No.	Question
1	Please explain how water is used in your local environment?	5	Please explain how water is used in your local environment?
2	Please explain who controls water use?	6	Please explain who controls water use?
3	Please identify and explain what issues and challenges, if any, are associated with water management in your own environment.	7	Please identify and explain what issues and challenges, if any, are associated with water management in your own environment.
4	Why do you think these issues and challenges have emerged?	8	Why do you think these issues and challenges have emerged?

Post Game Questionnaire			
Southern African Context		Your Context	
No.	Question	No.	Question
1	Please explain how water is used in your local environment?	6	Please explain how water is used in your local environment?
2	Please explain who controls water use?	7	Please explain who controls water use?
3	Please identify and explain what issues and challenges, if any, are associated with water management in your own environment.	8	Please identify and explain what issues and challenges, if any, are associated with water management in your own environment.
4	Why do you think these issues and challenges have emerged?	9	Why do you think these issues and challenges have emerged?
5	In your own words please explain how the game has or has not helped you to gain a better understanding of water management in a southern African context.	10	In your own words please explain how the game has or has not helped you to gain a better understanding of water management in a southern African context.
		11	Do you think that you would be able to use insights gained from your game?
		12	Now that you have played the game and discussed it as a group do you have any recommendations or improvements?

**Figure 3.2 –Summary of the Pre- and Post-Game Questions**

### 3.5.2 Participant Observation

The managers, namely the rural, urban and dam manager made notes while observing the game dynamics of each game. During the pilot game run and subsequent three game runs played, Professor Rowntree managed the rural sector, Professor Fox managed the urban and rest of the world sectors and I managed the dam and water sectors.

Figures 3.3 and 3.4 show how the game was managed annually to reflect an annual cycle in the rural and urban sectors after the ACG was modified with the new water processes. Figure 3.3 outlines the annual sequences in the rural section. Rainfall takes place when one turns cards from a deck. This is followed by farm disruptions that are also determined by turning cards from a deck. Farmers then calculate their net rice surplus that they can use to buy additional farming assets. A new addition to these assets is that of water for both domestic and agricultural purposes in the form of water tokens from the government, i.e. the Water Minister. These tokens are collected by the rural manager towards the end of the year which are then returned to the dam manager. Births and deaths are determined by the players' ability to provide sufficient rice and water for their family members.

Figure 3.4 outlines the sequence of activities in the urban sector. Rainfall in the urban sector is determined by the water manager who turns a separate deck of cards which increases the water level in the dam. The urban sector has a higher rainfall probability than the rural area. At the same time, factory disruptions take place. The dam manager then calculates the dam level while the factory outputs, i.e. chemicals, bicycles, scrap metal, grey water, etc., are calculated and distributed and the factory inputs, i.e. industrial raw material, industrial water, etc. are collected by the urban and rest of the world manager. The Water Minister requests water from the water manager and has the rest of the year to distribute this water in the form of water tokens, to the urban and rural population. The urban manager determines import and export prices, thereafter international trade can take place. At the end of the year water and rice is collected by the urban manager which contributes to the number of deaths should players be unable to

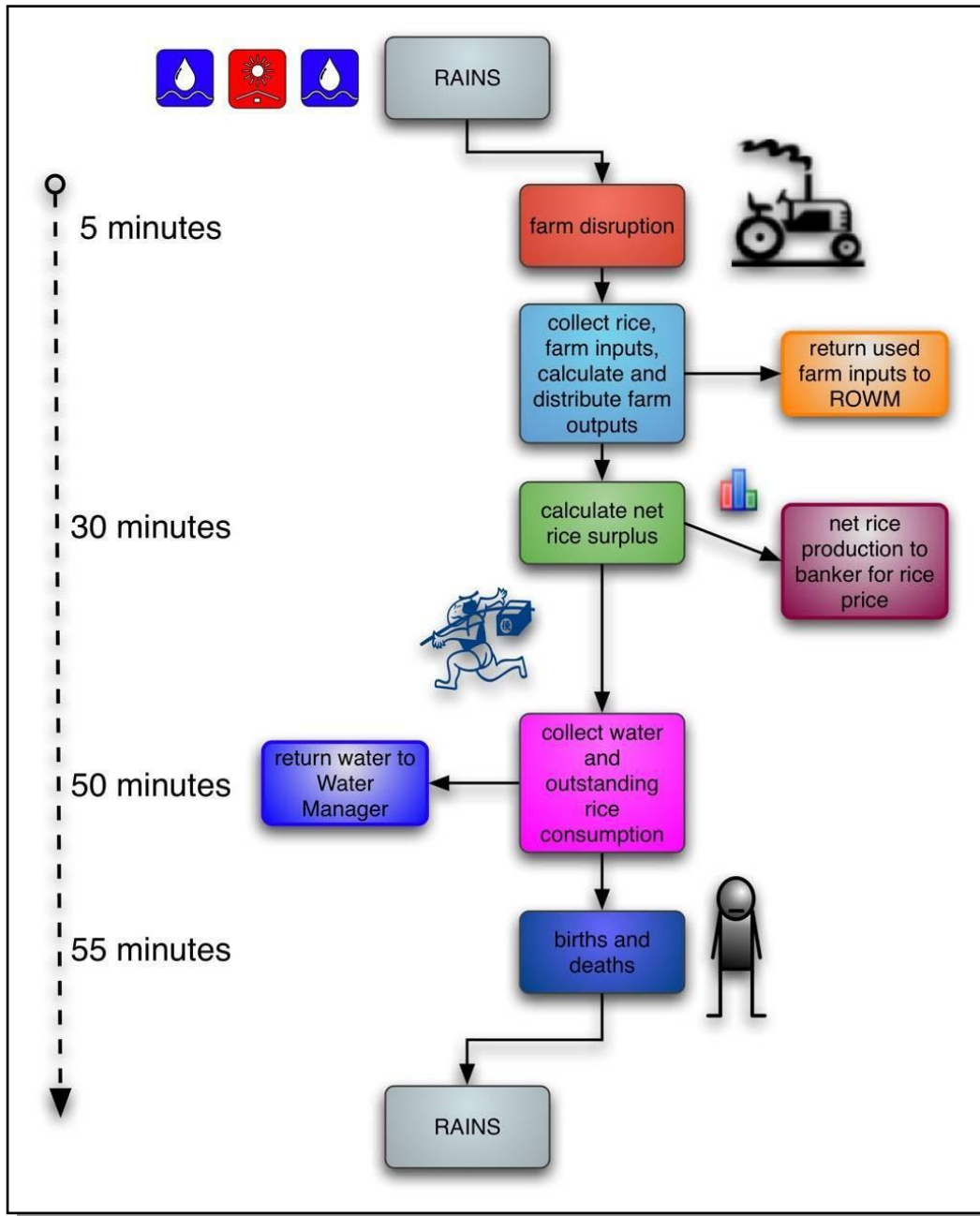


Figure 3.3 - Rural sector after modification. Source: Fox (2008)

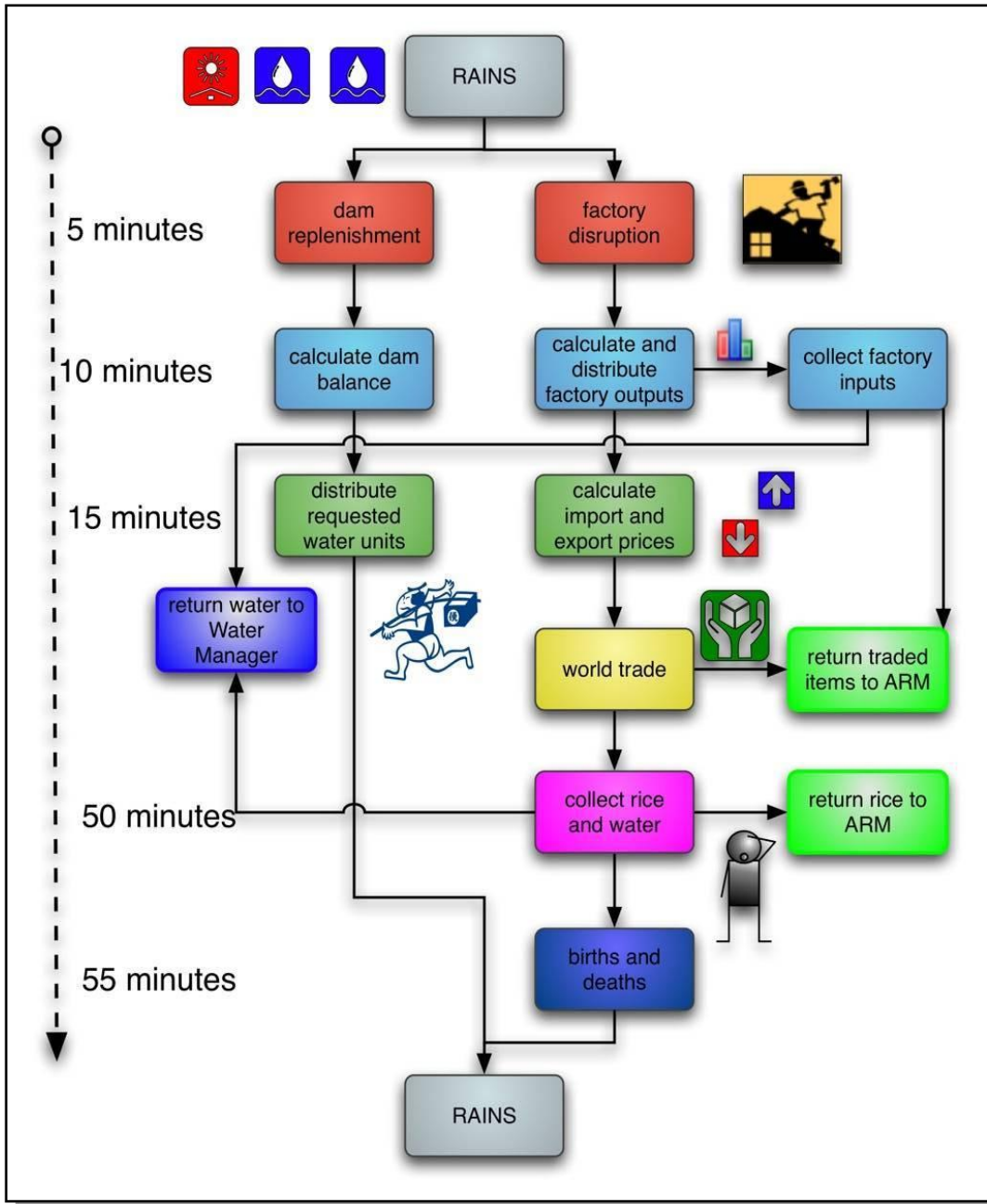


Figure 3.4 - Urban sector after modification. Source: Fox (2008)

provide sufficient water and rice for their family members. Births and deaths are then determined by turning a deck of cards ending the year's activities.

Spreadsheets concerning these activities include population statistics, productivity, rainfall and dam levels were kept in order to manage the game. Throughout each game run the managers took photos to capture significant moments. These, together with the observation notes and spreadsheets were used to provide insight into the game dynamics and the impact of participants' strategies in each game run. This enabled *Objective 3* to be met by capturing data for further analysis and interpretation.

### **3.5.3 Focus Group Discussions**

After each game run voice recordings of the focus group debriefing were made. Professor Fox facilitated the debriefing session after the Assegai Pilot Game Run and Tammela Game Run. The Turku Game Run debriefing was lead by both Professor Fox and Professor Rowntree while the Amakhala Game Run debriefing was lead by Professor Rowntree and myself. These focus groups provided a space for both the participants and managers to unravel and consolidate what had happened during the game run with the aim of linking the game's dynamics with real world events. It also allowed the participants and managers to ask questions and to comment on significant moments in each game run. Debriefings included mapping of the group's comments on to the environmental dimensions diagram, which is presented and discussed in Chapter 8.

### **3.6 Summary of the Water Modification Process**

This section describes the ongoing modifications made to the game for the pilot study and subsequent three game runs. The timeline (Figure 3.5) shows when the water modifications, as well as the data generation techniques and processes, were workshopped and then implemented.

Each game run is numbered 1 through to 4 with the dates of each game run and workshops appearing on the left of the figure. The ACG was played in four different

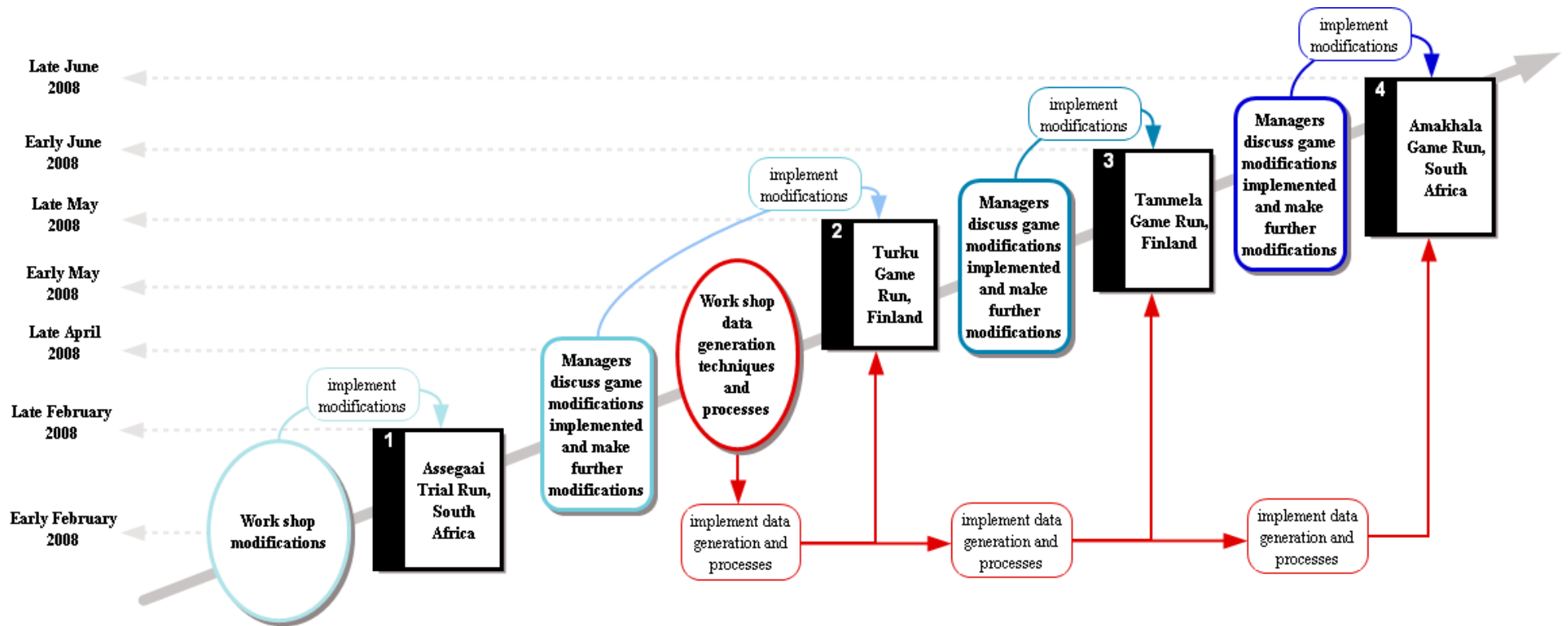


Figure 3.5 Timeline of Game Run Modifications and Workshops

locations in 2008 as part of this research process and with four different groups of participants.

The Assegai Pilot Game Run took place in February 2008 at Assegai Trails, South Africa. The participants were full time third year undergraduate Geography students at Rhodes University, South Africa. This game run was a trial run that implemented the new water processes, i.e. the dam, the water tokens and water related rules. The analysis revealed that the rainfall variability modeled produced water levels in the dam that were far too low, placing stress on resources that was beyond functional game dynamics. The game was thus modified by increasing the probability of rainfall which had an impact on dam levels before the Turku Game Run took place. The findings of the Assegai Game Run are presented and discussed in Chapter 4.

The Turku Game Run took place in June 2008 at Turku, Finland. The participants were academics from the University of Turku. The rainfall probabilities gave water levels that were far too high and therefore not much stress was placed on resources. Rainfall probability was decreased for the subsequent game run. Chapter 5 contains an analysis and discussion of this game run.

The Tammela Game Run took place in early July 2008 at Tammela, Finland. It was played with students registered for the Summer School entitled “Simulations and Systems” at the Finland Futures Research Centre in the Turku School of Economics. The dam and water levels remained constant throughout the game so did not place much stress on resources or limit their availability. The findings of this game run are presented and discussed in Chapter 6.

The Amakhala Game Run took place in late July 2008 at Amakhala Game Reserve, South Africa, and involved students from the USA registered for the Rhodes International Summer School at Rhodes University, South Africa as well as South African students and professionals associated with Rhodes University and the surrounding Grahamstown area. Throughout the game, the dam levels gradually decreased placing stress on resources

thereby limiting their availability. Chapter 7 contains the analysis and discussion of the findings of this game run.

### **3.7 Data Analysis**

The Pilot Run and subsequent three game runs were analysed individually and compared within the overall case study. The following analysis was designed in order to satisfy *Objective 5*.

Figure 3.6 shows that this analysis process consisted of three steps. These were as follows:

*1. Analysis of the game dynamics*

Analysis was done using data generated through the questionnaires, the managers' spreadsheets, their notes and the focus group discussions.

*2. Analysis of participants' responses to pre and post questionnaire*

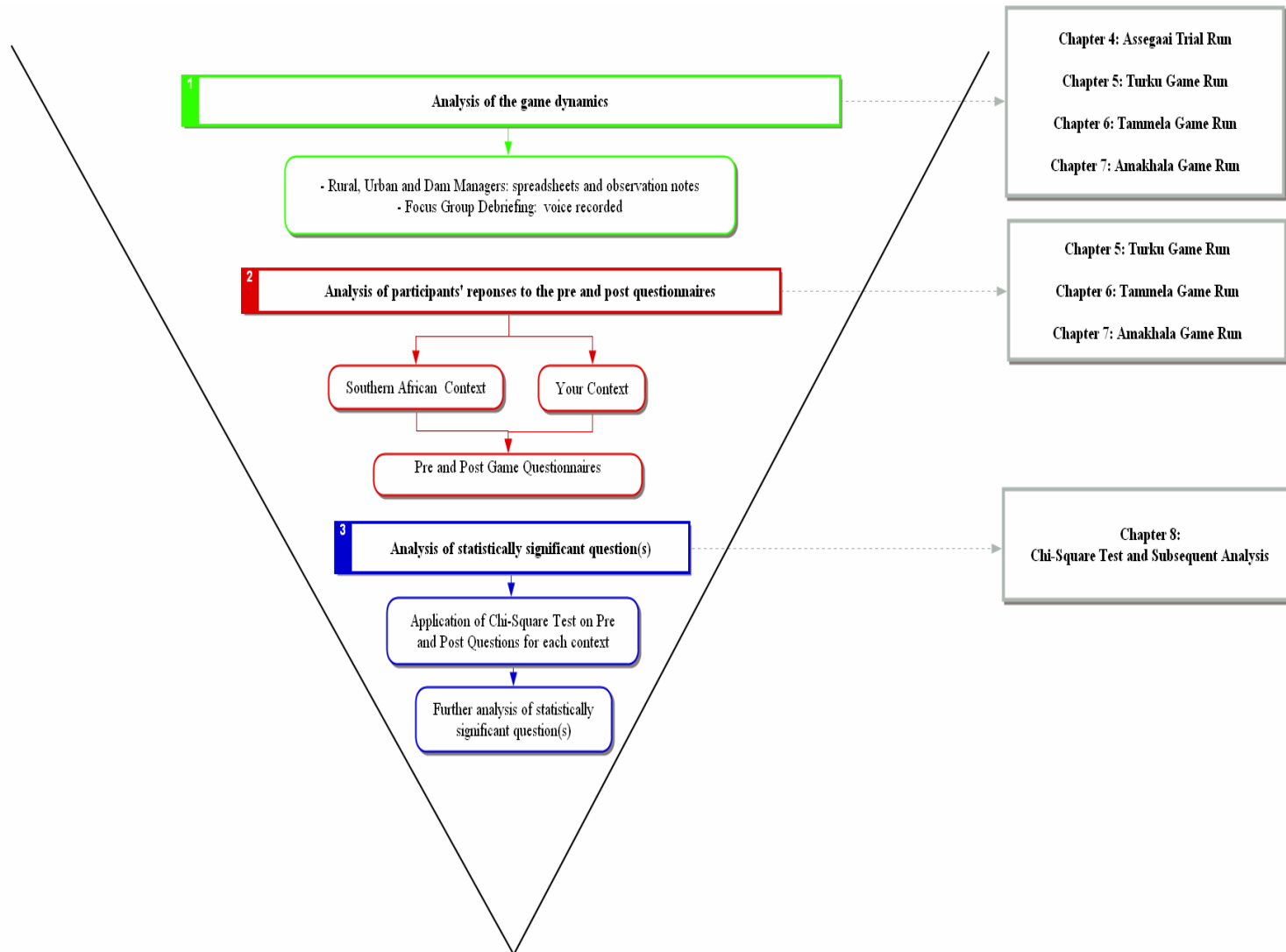
The participants' responses to the questions on water issues within their own context and a southern African context were analysed by means of process tracing in order to identify themes, patterns and anomalies. The responses to each question were thus categorised into themes. Participants' responses were layered and could be grouped under more than one theme. These themes were then placed in their appropriate environmental dimensions for both the pre- and post-game questions. Each question is discussed in the game run chapters (Chapters 4, 5 and 6) and a full break down of themes for each question was tabulated (see example in Table 3.1) and can be found in Appendices 1, 2 and 3.

*3. Analysis of statistically significant question(s)*

The responses to each question were categorised into themes. These themes were then placed in their appropriate environmental dimensions for both the pre- and post-game questions. See example in Table 3.1. The Chi-Square Test was applied to the number of responses in each of the pre- and post questions in their own context and a southern

African context to identify the most statistically significant question(s). An in-depth analysis of the most statistically significant question(s) followed in order to gain a deeper understanding of what individual participants had learnt. This was done by comparing the number of themes and their respective environmental dimensions.

The data analysis process described above was used for each of the three game runs. See Chapters 5, 6, and 7 for the analysis and discussion. This data analysis process enabled the researcher to understand what had happened in each game run in terms of the game dynamics and to analyse the learning/understanding taking place of the water issues in the game. Chapter 8 compares the findings of the three game runs. Patterns, trends and anomalies between the different games are illuminated and discussed.



**Figure 3.6 – V-Diagram: Summary of the analysis process**

**Table 3.1 – Example of Turku Pre Game Questionnaire Table: How is water used in a southern African context?**

Percentages were rounded off.

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=22)</b>
Severe water shortages due to water scarcity	2	7
Rain is collected, stored and distributed to community	1	3
<b>SUB-TOTAL: 2</b>	<b>3</b>	<b>10</b>
<b>Economic</b>		
Agriculture and/or irrigation	7	24
Industry	3	10
Mostly as irrigation for agriculture due to drought	1	3
Owning land near or on water source leads to owning the water resource	1	3
<b>SUB-TOTAL: 4</b>	<b>12</b>	<b>41</b>
<b>Social</b>		
Household and/or domestic activities	4	14
Household consumption low compared to agriculture and industry	1	3
Social	1	3
Used sparingly and reuse is common	1	3
<b>SUB-TOTAL: 4</b>	<b>7</b>	<b>24</b>
<b>Biophysical</b>		
Biophysical	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Other</b>		
I don't know	6	21
<b>SUB-TOTAL: 1</b>	<b>6</b>	<b>21</b>
<b>Totals</b>		
	<b>12</b>	<b>100</b>

### **3.8 Issues associated with the Case Study Method**

Given the goals of the study, firstly to modify, develop and implement new water processes in the ACG and secondly to understand what, if any, learning subsequently occurred, a case study method was selected. The following issues associated with case study method need to be taken into account.

#### **3.8.1 Quality and Rigour**

Throughout the research process, every effort was made to ensure that the data generated and analysed was done in a rigorous, systematic and ethical manner to ensure that the results could be trusted. The following strategies were employed in order to enhance the study's trustworthiness.

- *Triangulation*

Due to the subjective nature of the data collected it was necessary to triangulate it. This was done through the collection of multiple data sources of data. These sources are the pre- and post-questionnaires, the focus group debriefings and the managers' observations. The analysis was therefore able to draw from various forms and sources of data and allowed for a comparison of these data.

- *Internal validity*

All qualitative data, which includes the questionnaires, the managers' observations and the focus group debriefings, was analysed by the researcher alone. Internal validity can therefore be justified as this is an interpretative study undertaken by one person, the researcher, analysing the qualitative data.

#### **3.8.2 Research Ethics**

The rural and urban managers and the researcher strived to maintain an overt research programme which is described below.

Three of the game runs analysed formed part of broader educational programmes namely the third year Geography course offered at Rhodes University, South Africa, the Summer

School offered by the Finland Futures Research Centre, Finland and the Summer School offered by Rhodes University, South Africa. In addition, this was a collaborative research endeavour, focusing on simulation games, scenarios and futures studies with the staff at the School of Turku. In order to be as transparent as possible we explained both the purpose of these programmes as well as that of my Masters research in the game briefing sessions.

### **3.8.3 Particularity and Generalisations**

There are limitations in using the case study as a research method, namely the findings are not able to be generalised for a larger population. However, as mentioned above in section 3.3, generalisations are made to the theory not the larger population (Yin 1994, cited in Tellis 1997: 4). Furthermore, the findings are relevant to me, the researcher, as well as the staff at Rhodes University, South Africa and the Finland Futures Research Centre, Finland particularly in the context of the curriculum. This relevance is associated with the modification, design and learning associated with simulation games. In light of research focussing on the design and creation of this and similar role-playing simulations, this study provides valuable insight into the neglected arena of the learning associated with such simulation games as well as to the potential to use such games for future studies.

### **3.8.4 Additional Limitations**

The pre and post-questionnaires were administered before and after playing the ACG. Although participants had ample time to complete the pre-game questionnaires, due to the long game runs and travel arrangements there was limited time for both the focus group discussions and for participants to complete their post-game questionnaires. Thus, for some of the games, especially the Tammela Game Run, participants had to rush through their post-game questionnaires and may not have had the time to adequately consolidate their answers.

In addition to being rushed, participants from the Finnish Game Runs answered their questionnaires in their second or even third language. It became necessary to include a

question in the pre-game questionnaire asking all participants to state the proficiency of their English, i.e. first language, second language, etc. This was taken into account when analysing both the pre- and post-game questionnaires.

### **3.9 Synthesis and Conclusion**

This Chapter described the methodology selected for this study. It explained and justified the case study method employed as well as the various ways in which data was generated. It described how the two game managers and the researcher worked with the data and how the analysis was done. The ethical and limiting factors of the study were also considered.

The findings of each of the four game runs are presented in the following chapters.

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## CHAPTER FOUR

### ASSEGAAI TRIAL RUN

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#### **4.1 Introduction**

This chapter focuses on the game run that was played as part of the Geography 301 course offered by the Geography Department at Rhodes University during the first semester of 2008. Most of the participants were female South African students in their third year of study between the ages of 20 and 22. The initial changes, described in Chapter 3 were made to the ACG and played with 32 participants at Assegai Trails.

This chapter is structured according to three headings with the overall aim of assessing the implementations of the new water processes. The first considers the modifications to the rules and procedures implemented such as the use of water tokens, different rainfall regimes and the inclusion of a dam. And secondly the dam levels, participant observations, and Focus Group Debriefing are used to provide an overview of the game dynamics.

#### **4.2 Changes and Modifications to the African Catchment Game**

The ACG was modified by implementing new water processes in the form of a dam in the urban sector and different rainfall regimes for the upper and lower catchment. It was decided that the inclusion of the dam would mean that the government would have to pay back the loan that financed the building of the dam to the bank . The predominant reason for the dam level fluctuations was due to the game rules that had been put into place for a single year in a game run, namely annual rainfall, the environmental reserve and the amount of government issued water. A dam was located in the urban sector and flowed towards and through the rural sector. Different rainfall regimes were modelled and drinking, agricultural, industrial and grey water tokens were also implemented, as discussed in Chapter 3. It was necessary to keep several units of water in the dam as an environmental reserve that allowed the river system to function normally. These water

processes had to align with present game processes and it was therefore necessary to confirm this alignment by doing a trial game run.

Tokens were created so that both managers and players could distinguish between drinking, agricultural, industrial and grey water. I became a participant observer by taking on the role of the dam manager which involved monitoring dam levels throughout the game by means of specially designed spreadsheets.

### **4.3 The Discussion and Findings of the Assegaai Trial Run**

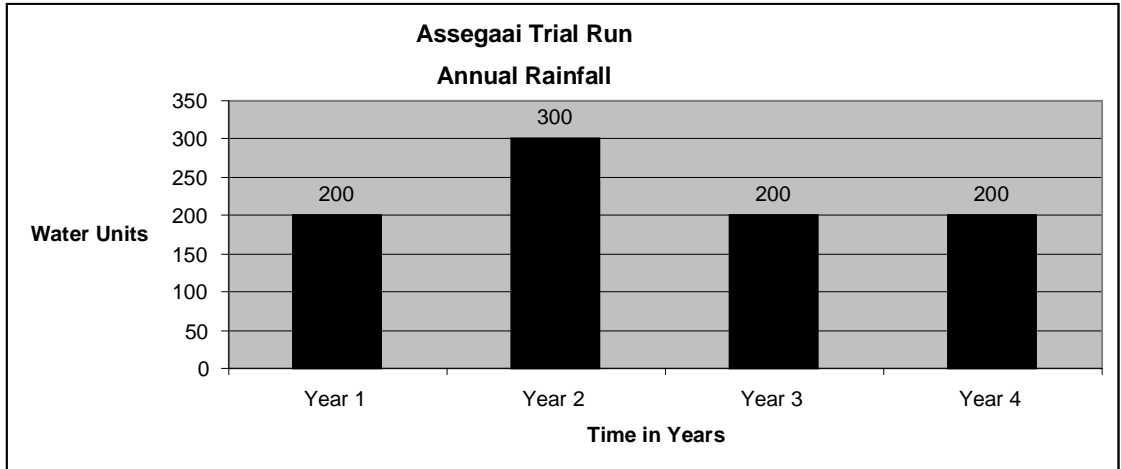
The aim of the following discussion is to establish why the dam levels remained so low over the five-year game run period. I used the information gathered from the focus group debriefing, the managers' observations and the dam manager's spreadsheets.

The predominant reason for the dam level fluctuations is due to the game rules that had been put into place for a single year in a game run. These game rules are as follows:

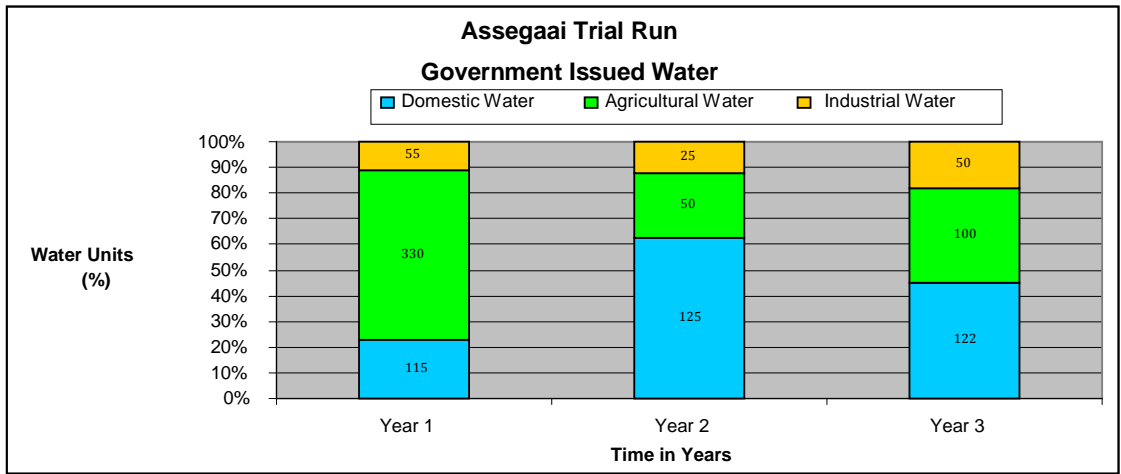
1. The rains: increases the water level,
2. The environmental reserve: decreases the water level, and
3. Government issued water: decreases the water level.

In terms of “**the rains**”, the amount of rain for the year is determined by drawing rain and drought cards from a 10 card pack. Figure 4.1 displays the rainfall for each year and shows that the annual rainfall increased to 300 units in Year 2 while the remaining four years of the game run received only 200 units.

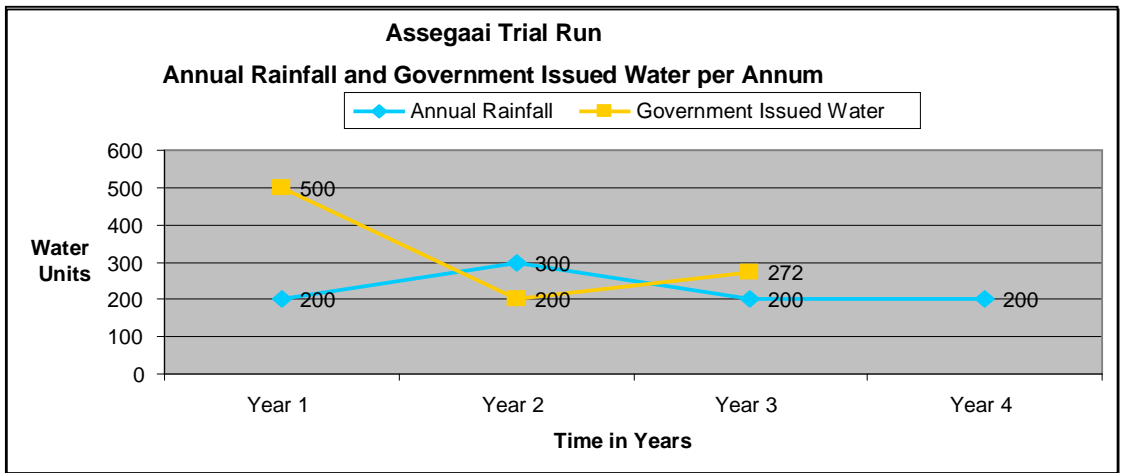
In terms of “**the Government issued water**” the participant who takes on the role of Water Minister determines the amount of water issued from the dam for domestic, industrial and agricultural use. Figure 4.2 displays how much water of each water type was issued annually and shows that while agricultural water was the highest water issued in Year 1, this was replaced by domestic water in Years 2 and 3. In addition, the amount issued as industrial water fluctuated over the first three game years.



**Figure 4.1 –Assegaai Trial Run: Annual Rainfall**



**Figure 4.2 – Assegaai Trial Run: Government Issued Water per Annum**



### **Figure 4.3 –Assegaai Trial Run: Comparison of Annual Rainfall and Government Issued Water**

When comparing the annual rainfall and the government issued water displayed in Figure 4.3, note that the initial 600 water units in the dam is not included. Therefore in Years 1 and 3 Government issued water exceeded annual rainfall. It was only in Year 2 that rainfall exceeded the amount of water issued by 100 units. This can be attributed to Year 2 receiving the highest rainfall, see Figure 4.5, throughout the entire four year game run.

The trend line in Figure 4.4 below shows that the dam level steadily decreased as the game proceeded. This decrease was sharp enough to cause severe water shortages placing severe stress on this resource. The government was forced to import water in order to alleviate the devastating impact that the drought was having on human, animal, and crop life as well as the spin off effects that had a negative impact on the industrial sector and the country's economy.

Participant observation and post game discussion of the three managers revealed that the new rules and the modifications implemented worked well with the game's present processes. However, the amount of water in the game, in the form of annual rainfall as well as the initial dam level, needed to be increased.

#### **4.4 Conclusion**

To summarise, the findings show that water availability steadily decreased throughout the game run. Players placed too much stress on a limited resource which had a drastic impact on food security, rural and urban production. This is evident in the players' interactions. Many had abandoned sustainable practices and were relying on the generosity of both the government and their neighbours. The Trader commented that by making friends with as many people as possible she had just enough to survive. It was a disheartening situation evidenced in the player's dejected and hopeless demeanour both during the game and the focus group debriefing. One of the industrialists stated that

“everyone was really frantic all the time and seemed desperate to stay alive” while a farmer commented that survival was the driving force behind her farming strategy.

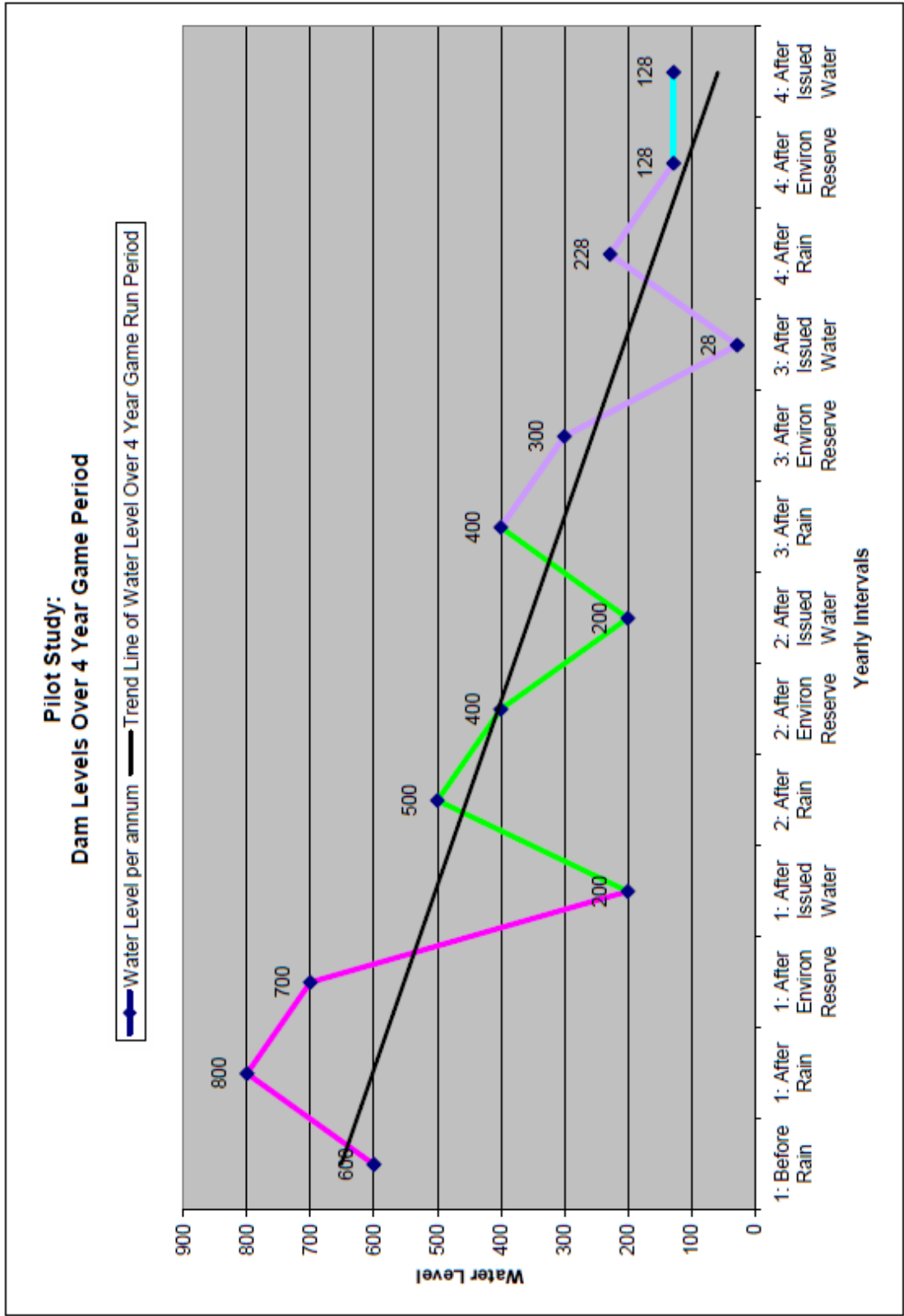


Figure 4.4 – Assegaai Trial Run: Dam Levels Over Four Year Game Period.

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## **CHAPTER FIVE**

### **TURKU GAME RUN**

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#### **5.1 Introduction**

This chapter focuses on the game run played in Turku, Finland with 23 participants and is structured under the following headings:

- Profile of the research participants
- Further changes and modifications to the African Catchment Game
- Discussion and findings of the Turku Game Run
- Participants' learning: southern African context
- Participants' learning: their own context
- Reflecting on modifications implemented

#### **5.2 Profile of the Research Participants**

The biographical data is summarised in Appendix A (See Biographical Data: Figures A.1 to A.7) which are expressed as percentages rounded off to the nearest whole number. The biographical data shows that the players were well qualified, mostly Finnish, speaking English as a second language and working in the Higher Education field. Nearly two thirds were female and most were aged between 26 and 40 years.

#### **5.3 Further Changes and Modifications to the African Catchment Game**

After the Assegai Trial Run, all three managers met in April, to workshop further modifications to the ACG. The outcome of these modifications was to simulate dry climatic conditions indicative of a southern African context. Due to the drastic water shortage in the Assegai Trial Run these water processes had to be reassessed and water levels increased. This was a rather difficult task due to the interconnecting impact of game rules in different areas of the game. For example, when determining the size of the

domestic water tanks it was necessary to take into account how much a water token represented and how much water one person needed to survive for a year in real life. According to the Food and Agriculture Organisation (FAO) a person requires 10 000 litres of water per year (25 litres per day x 365 days) therefore one domestic water token or one unit of water in the game represents 10 000 litres. Annual rainfall of 750ml on a 100m<sup>2</sup> roof delivers 75 000 litres of drinking water therefore a water tank capacity of 60 000 litres would provide six people with drinking water. These amounts had an impact on calculating the annual rainfall as well as the initial water level in the dam that in turn had to match starting and projected population growth.

Since there were three rain cards and seven drought cards in a pack of 10 that determined the annual rainfall in the urban sector, the managers decided that each rain card would represent 30 000 litres of water. Therefore two rain cards, 60 000 litres or six water units, would fill a water tank. A game has a starting population of 102 and a maximum population of 125. Since one domestic water token provides 1 person with 1 year's worth of drinking water, a maximum of 125 domestic water units was required. If all 18 commercial fields were irrigated then 450 agricultural water tokens (18 fields x 25 agricultural water tokens) would be needed. Therefore a total of 675 water tokens (125 domestic water units + 100 industrial water units + 450 agricultural units) would be necessary if population, industry and agriculture operated at maximum levels. It was therefore decided to make the dam capacity 1000 water units. In addition, each rain card would bring 200 water units which meant that 600 (3 rain cards x 200 water units) of the maximum 675 water units could be provided through annual rainfall. The 75 water unit shortage would ensure that water would be scarce and therefore have a negative impact on water associated practices.

It was also decided to recalculate the starting cost of water which had to be consistent with the cost of rice and cattle. In the ACG rice is measured in maunds which is equivalent to 37.4 kg or rounded off to 40 kg of rice. Since today's price of rice is averaged at R10 per 1kg, 40kg would cost R400 while in the game 40kg, represented as 1 maund in the ACG, would cost 20 rupees. This meant that one rupee would be the

equivalent of R20. This ratio of 1 rupee to R20 was used to recalculate the cattle price to 100 rupees for one cow when working with the present day cost of R2 000. According to Farolfi and Bonté (2005), a ratio of 1:40 is used to calculate the difference in price between domestic and agricultural water since the latter is subsidised by government. The initial cost of water in the game was set at 40 rupees each for one domestic, one industrial, and one grey water token while agricultural water was set at one rupee. These modifications were implemented to account for soaring price costs during a bad year, e.g. drought. These new prices and calculated amounts were implemented for the Turku Game Run.

#### **5.4 Discussion and Findings of Turku Game Run**

The participants played the modified African Catchment Game. The findings are discussed as follows:

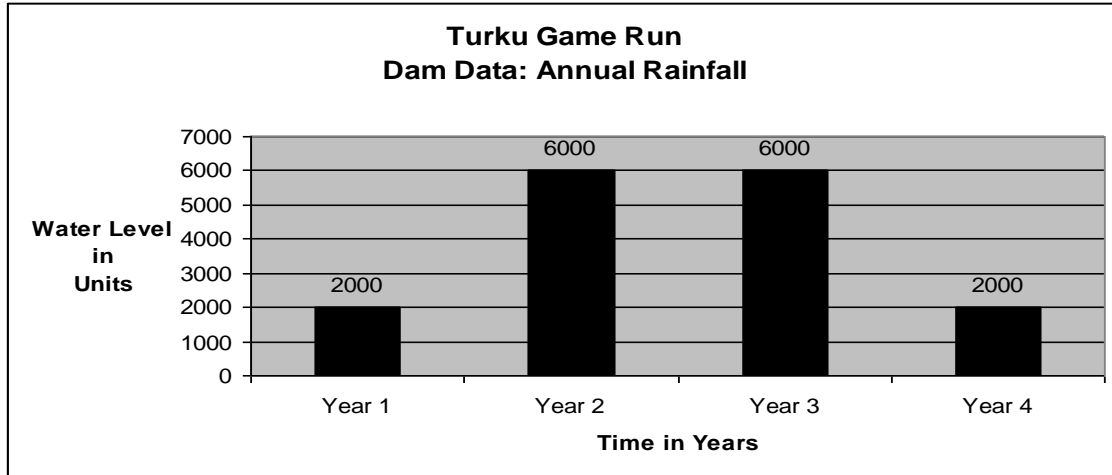
1. rainfall and water allocation,
2. population statistics, and
3. productivity.

##### **5.4.1 Rainfall and Water Allocation**

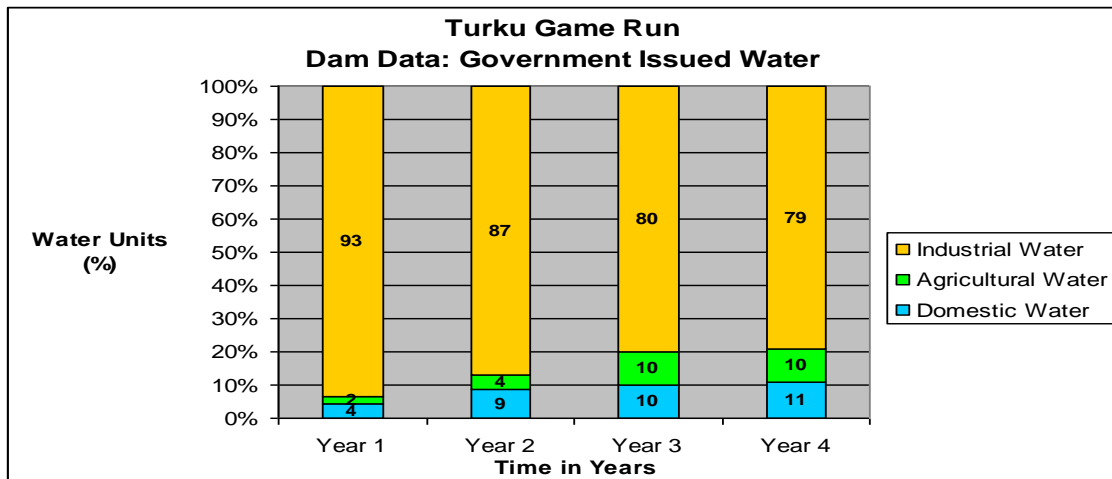
The following discussion draws from the manager's observations and spreadsheets as well as the focus group debriefing. The aim was to provide insight into the availability of water during the game run period.

Figure 5.1 displays the total rainfall for each year and shows that the annual rainfall tripled from 2 000 water units in Year 1 to 6 000 water units in Year 2 and 3.

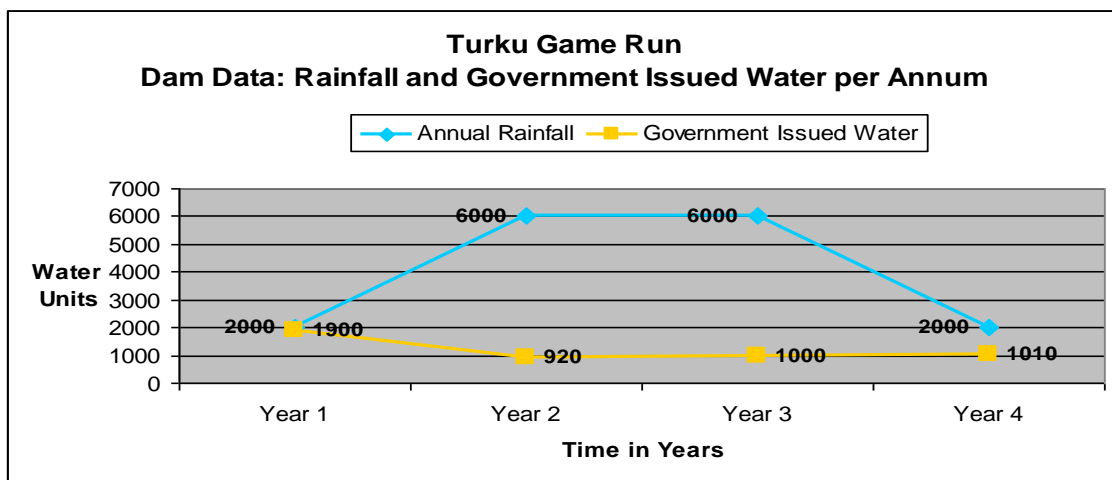
Figure 5.2 shows the water ratios that the Water Minister issued for domestic, agricultural and industrial use. In all four game years, the most water issued was for industrial use. This gradually decreased from 93% of the total water issued in Year 1 to 79% in Year 4, as the percentages for both domestic and agricultural issued water gradually increased.



**Figure 5.1 – Turku Game Run: Annual Rainfall**



**Figure 5.2 – Turku Game Run: Government Issued Water per Annum**



**Figure 5.3 – Turku Game Run: Comparison of Annual Rainfall & Government Issued Water**

When comparing annual rainfall and government issued water, displayed in Figure 5.3, it is evident that government allocations never exceeded annual rainfall during the four year game run. While annual rainfall drastically increased in Year 2 and 3, the amount of government allocated water declined in Year 2 and then gradually increased throughout the game.

The trend line in Figure 5.4 shows that the dam level increased over the four year game period. This increase was sharp enough to result in an abundance of water that exceeded dam capacity in Year 3. The Water and Rural Managers decided to simulate a small scale flood by releasing excess water from the dam. This water would then flow through the urban and rural sectors and since farms were located along the river, they would receive sufficient water to irrigate one field.

These modifications resulted in a drastically increased amount of water in the game. It appears as though water was thus over-compensated for in an effort not to repeat the drought experienced in the Assegai Trial Run. The game run was useful in displaying that by merely changing the amount of water in the game, a manager could simulate extreme weather conditions and its impact on society. Should a flood be simulated in the future, it was noted that a further decision regarding the amount of water flowing through the river system would need to be made. The water level in the river could either increase to sufficiently irrigate fields situated along the river, or it could increase to the extent that these fields would be flooded, rendering them useless for agricultural purposes. Therefore a cut off point would need to be determined between irrigation and flooding. However, in terms of this research study, it was still necessary to identify the starting amount of water in the game so that it would be scarce enough to be viewed as a limited resource and at the same time not bring rural and urban production to a complete halt.

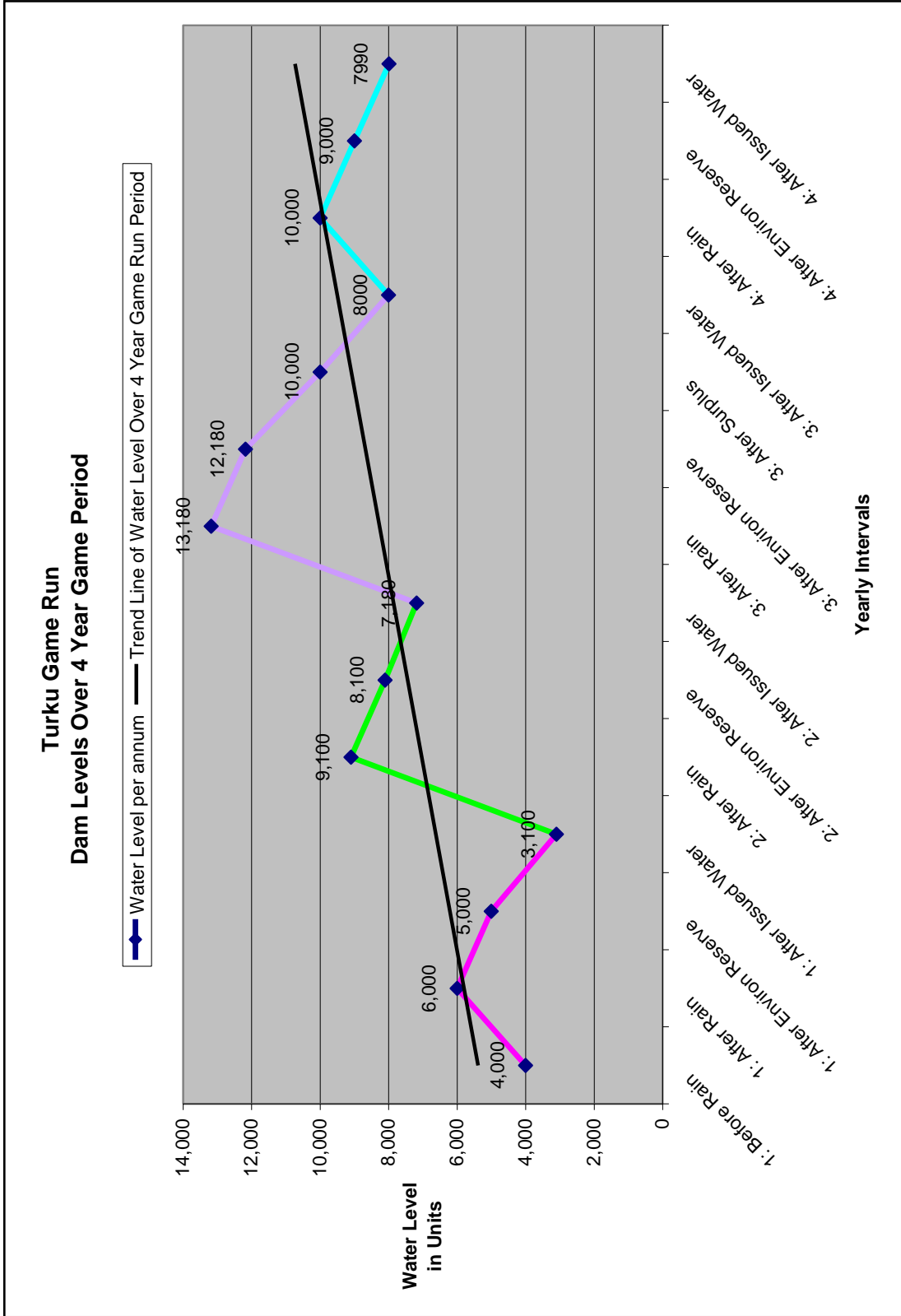


Figure 5.4 – Turku Game Run: Water Levels Over a Four Year Period

### 5.4.2 Population Statistics

The trend lines in Figures 5.5 to 5.8 show that the rural sector experienced an increase in population growth and that a decline was experienced in the urban sector. This decline cancelled out the rural sector's rather rapid growth resulting in a gradual increase for the country's total population growth, 67 people in Year 1 to 71 people in Year 4. The rapid population growth in the rural sector, 47 people in Year 1 to 54 people in Year 4, could have placed additional stress on water had there been a gradual decline in water levels within the river system. Instead, there was an excess of water resulting in minimal flooding during Year 3.

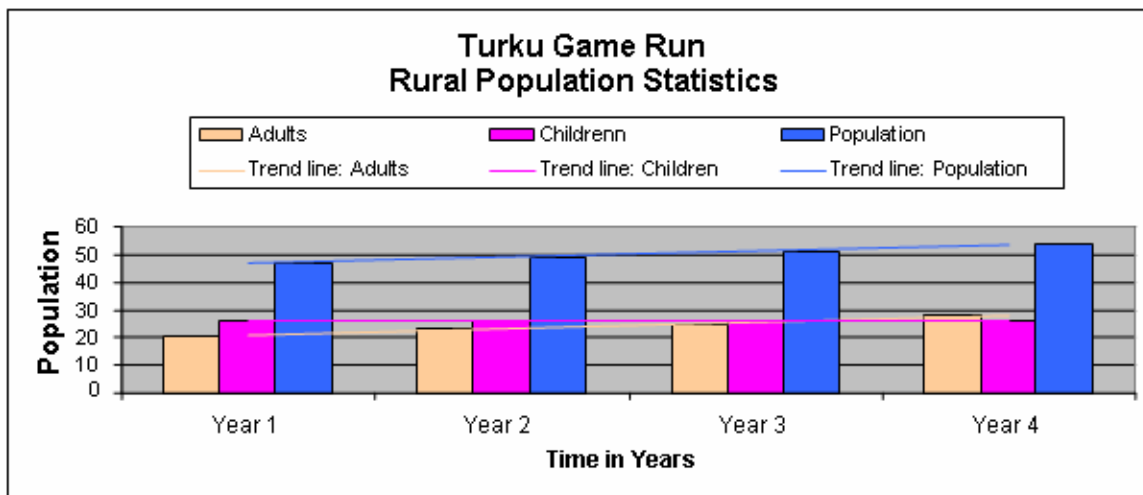


Figure 5.5 – Turku Game Run: Rural Population Statistics

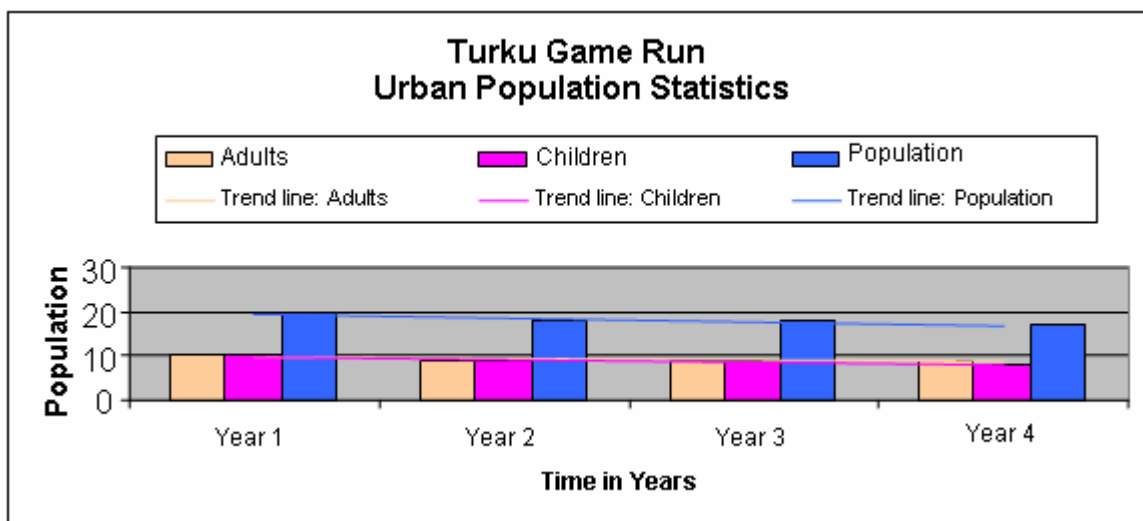
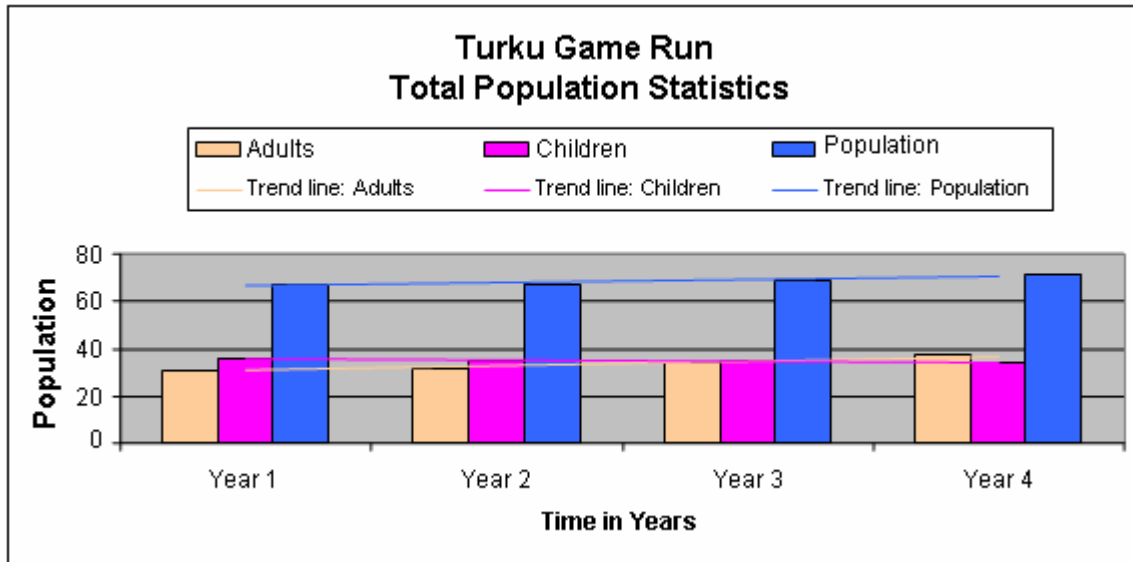


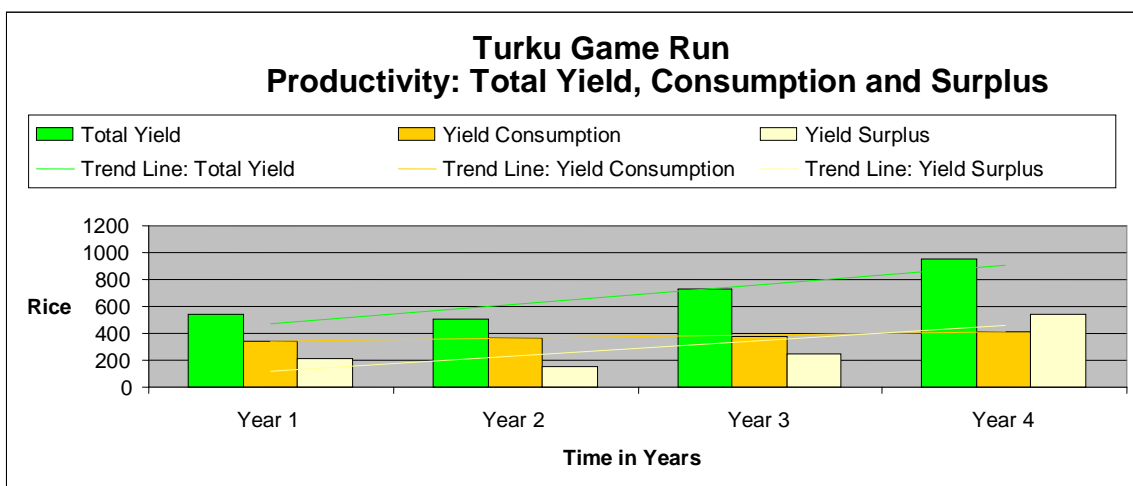
Figure 5.6 – Turku Game Run: Urban Population Statistics



**Figure 5.7 – Total Population Statistics**

### 5.4.3 Productivity

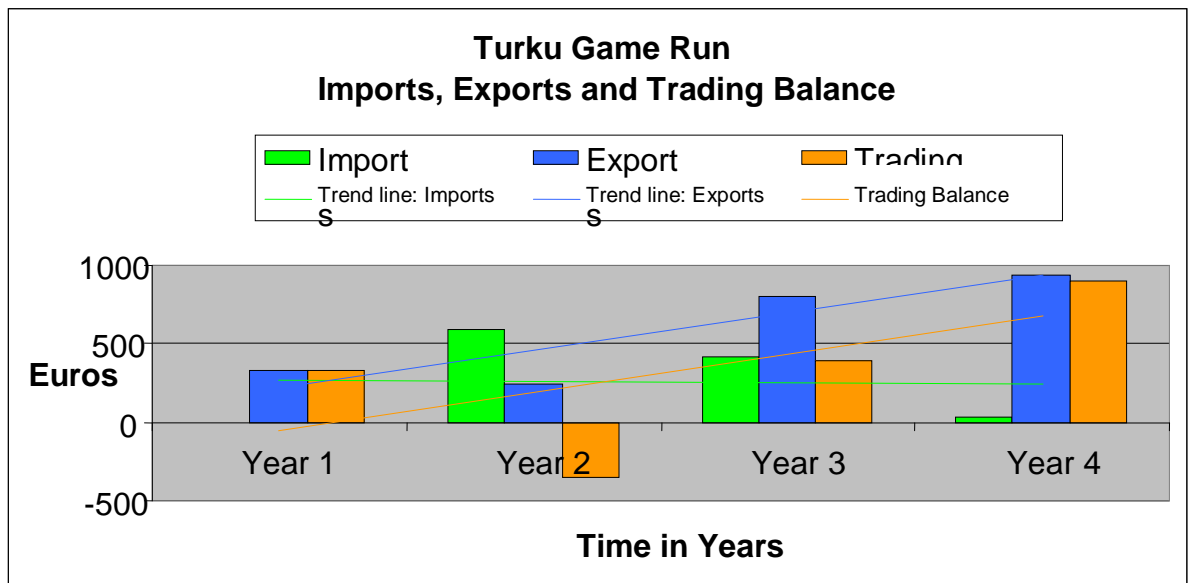
In terms of productivity in the rural sector (Figure 5.8) the total rice yield nearly doubled from 546 units to 957 units and the consumption rates increased gradually resulting in a lack of the desired stress on food and food security. Farmers, both commercial and peasant, did not have had much difficulty in making profits on their yields which made the procurement of additional farming implements rather easy.



**Figure 5.8 – Turku Game Run: Total Yield, Consumption and Surplus**

As for game strategies, citizens were law abiding and civil peace was the norm. There was no need for theft since food was readily available.

In the urban sector (see Figure 5.9), there were several interesting outcomes. Although water and food was readily available, the industrialist was unable to produce an output so there was only limited domestic production. This had an impact on imports and exports resulting in a negative trading balance in Year 2 due to imports exceeding exports by 345.35 Euros. However, in the long run the trading balance nearly tripled its value from 325 Euros in Year 1 to 897.36 Euros in Year 4 as total exports steadily increased.



**Figure 5.9 – Turku Game Run: Imports, Exports and Trading Balance**

Regardless of the country's high production rates, the large debt incurred by the cost of building the dam proved to be a problem for the government. This issue was 'solved' by nationalising the banking institution rendering the debt void and allowing these payments to be pumped into other areas of the economy.

#### **5.4.4 Conclusion**

The game was not a stressful experience for players due to the abundance of water and rice throughout the game. This abundance can account for why the country's economy did not suffer due to initially limited industrial productivity. Farmers were able to buy their international trading licenses and sell their produce internationally after meeting the immediate food needs within the country. During the debriefing, it was discovered that strategies taken by the government, farmers and urban population were not based on survival but were in favour of the country's well-being. It was interesting to see how, as a result of these strategies, players attained almost maximum profits, both in the urban and rural sectors. As one participant commented, she started off as a peasant farmer with almost nothing and was 'on the verge of collapsing and dieing'. However, due to clear planning better 'results' were evident and she ended the game with several livestock, sufficient savings as well as enough rice to eat and cultivate.

#### **5.5 Participants' Learning: Southern African Context**

The following discussion is structured according to the questions posed in the pre- and post-game questionnaires. The first discussion focuses on questions that relate to the southern African context which is followed by a discussion that focuses on questions that applied to their own context.

##### **5.5.1 Question 1: How is water used in a southern African context?**

- **Pre-Game Questionnaire: Overview of Participants' Responses**

There were 22 participants that provided 29 responses to this question. (See Appendix A, Table A.1. Please note that figures have been rounded off to the nearest whole number. Furthermore, a given participant's response was layered and could be grouped under more than one theme.) In total 12 main themes were identified which were then classified according to the four environmental dimensions. A fifth category, "Other", was included should a response not fall under these dimensions. 24% (7/29) of the responses fell under *agriculture and/or irrigation*, making it the dominant theme followed by *I don't know* with 21% (6/29) of the responses. The participants have thus highlighted the Economic

Dimension and Other as the predominant use of water in a southern African context. Together the Economic and Social Dimensions received the most responses, 65% (19/29), and themes, 28% (8/29). Both the Social and Economic Dimensions had the same number of themes, four, while the Economic Dimension received the highest response rate, 41%. This is due to the dominant theme, *agriculture and/or irrigation*, falling under the Economic Dimension.

- **Post Game Questionnaire: Overview of Participants' Responses**

After playing the ACG participants provided a total of 49 responses (see Appendix A, Table A.2), of which 27% (13/49) fell under *irrigation for agriculture: considered a luxury that improved yields in a dry climate*, making it the most dominant theme followed by *domestic and/or household* with 22% (11/49) of the responses. Together, the Economic and Social Dimensions received the highest response rates, 77%. The Economic Dimension had the highest number of themes followed by the Political Dimension. The political and economic uses of water were thus highlighted as the main users of water. Interestingly, the Social Dimension had only one theme, *domestic and/or household*, with the second highest response rate (22% or 11/49) as mentioned above. In both the Pre- and Post Questionnaire participants identified that agricultural irrigation is an important water use in a southern African context. However, after playing the ACG participants were able to acknowledge that while agricultural irrigation is a necessity for survival, it is also considered a luxury

### 5.5.2 Question 2: Who controls water?

- **Pre-Game Questionnaire: Overview of Participants' Responses**

For this question the participants' responses were grouped into seven main themes (see Appendix A, Table A.3). The Social and Biophysical Dimensions were not highlighted for this question. The Political Dimension received the most responses, 48% while the Political and Economic Dimensions received the most themes, three each. *Government and/or state: including clean water and availability* had the most responses, 40% which was followed by *I don't know* with 26%.

- **Post-Game Questionnaire: Overview of Participants' Responses**

There was an increase in the number of themes from seven in the Pre-Game Questionnaire to 13 in the Post-Game Questionnaire (see Appendix A, Table A.4). In total there were 29 responses of which 48% (14/29) fell under *Government: Minister of Water controlled water distribution not the resource*, making it the most dominant theme by 41%. It appears that for both the Pre- and Post-Game Questionnaire the participants were of the opinion that the *government* controls water use in a southern African context.

### **5.5.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in a southern African context.**

- **Turku Pre-Game Questionnaire: Overview of Participants' Responses**

For this question the participants' responses were grouped into 16 main themes under the four Environmental Dimensions including "Other" (see Appendix A, Table A.5). In total there were 35 responses of which 26% (9/35) fell under *Main issue: water quality*, making it the most dominant theme followed by *Dry periods impact quantity and quality* with 14% (5/35) of the responses. Participants have highlighted water quality as both a political and biophysical issue and challenge.

The Political Dimension had the most responses, 52%, and themes, 44%, followed by the Biophysical Dimension with 20% of the responses and 33% of the themes. It is thus evident that the Political Dimension was highlighted as the predominant dimension for issues and challenges associated with water management in a southern African context.

- **Post-Game Questionnaire: Overview of Participants' Responses**

Participants' responses were grouped into 20 main themes under the four Environmental Dimensions and Other. (See Appendix A, Table A.6.) The Political Dimension had the most responses, 52%, and themes, 45%. In total there were 31 responses of which 13% fell under *scarcity common*. This was followed by two themes, each with 10% of the responses: *ensure water resources for agriculture and industry* and *water management impacts survival and economy*. The 21% difference between the three highest responses

indicates that participants are of the opinion that *scarcity*, as a Political Dimension, is the predominant issue and challenge associated with water management in a southern African context. It can be concluded that for both the Pre- and Post-Game Questionnaires, the Political Dimension remains the predominant cause for concern of water management in a southern African context. This is significant since there was not a scarcity of water in the game run itself.

#### **5.5.4 Question 4: Why do you think these issues and challenges have emerged?**

- **Pre-Game Questionnaire: Overview of Participants' Responses**

There were 13 main themes that were identified for this question and out of the 20 responses *I don't know* received the most, 30%. (See Appendix A, Table A.7.) This was followed by two themes, *absolute and relative scarcity of water resources* and *resources not fairly distributed* with 10% of the responses each. Participants therefore did not know why issues and challenges associated with water management may emerge. Overall the participants highlighted the Political Dimension as it received the most responses, 55%, and the most themes, 69%.

- **Post-Game Questionnaire: Overview of Participants' Responses**

Post-game responses were grouped into 25 main themes. (See Appendix A, Table A.8.) The Political Dimension received more than half of the responses, 61%, as well as the most themes, 59%. While the Political Dimension remains the highlighted dimension in both the Pre- and Post-Game Questionnaires, the themes with the highest response rates do not fall under this dimension. Rather, the theme with the highest responses in the Pre-Game Questionnaire, *I don't know* (30%), fell under Other and in the Post-Game Questionnaire, *natural climatic conditions* (10%), fell under the Biophysical Dimension. These were the dominant themes in the Pre- and Post Questionnaires. For the Post-Questionnaire this was followed by *lack of cooperation and co-ordination within and between sectors* and *lack of sufficient technology as well as access to such technical equipment*. Both these Political themes received six percent of the responses.

### **5.5.5 Question 5: How has the game helped you to gain a better understanding of water management?**

- **Post-Game Questionnaire: Overview of Participants' Responses**

This question was only posed in the Post-Game Questionnaire and from the participants' responses 13 main themes were identified and 41% of the 22 responses fell under *understand importance of water and water management: associated dependencies, challenges and complexity*. (See Appendix A, Table A.9.) This is the most dominant theme followed by *material economy system as a whole is a dynamic process* with nine percent of the responses. The 32% difference indicates that almost half of the participants gained a better understanding of the importance of water, its management, its associated dependencies, challenges and the complexity of these issues.

### **5.6 Participants' Learning: Their Own Context**

The section follows the same structure as the southern African context. However, three additional questions were posed in the Post-Game Questionnaire and are examined in section 5.6.5, 5.6.6, and 5.6.7:

1. How has the game helped you to gain a better understanding of water management in a southern African context?
2. Do you think that you would be able to use insights from your game experience and if yes where?
3. Now that you have played the ACG and discussed it as a group, do you have any recommendations for changes or improvements?

#### **5.6.1 Question 1: How is water used in your local environment?**

- **Pre-Game Questionnaire: Overview of Participants' Responses**

For this question the participants' responses grouped into 16 main themes. (See Appendix A, Table A.10.) The Economic Dimension received more a third of the responses, 44%,

while the Political Dimension had 44% of the themes. This was followed by Social Dimension with 33% of the response rate and the Economic Dimension with 30% (4/13) of the themes. In total there were 63 responses of which 21% (13/63) fell under *domestic or households are principal users: drinking, sanitation, and gardening*. It was the dominant theme followed by *industry: including construction, electricity, and transporting heat* with 19% (12/63) of the responses and *agriculture and/or irrigation* with 14% (9/63) of the responses.

- **Post-Game Questionnaire: Overview of Participants' Responses**

Participants' responses were grouped into 17 main themes, one more than the Pre-Game Questionnaire. (See Appendix A, Table A.11.) The Economic Dimension received the most responses, 54%, followed by the Social Dimension with 29% of the responses and nearly two thirds of the themes, 65%. In total there were 39 responses of which 23% (9/39) fell under *domestic* followed by *industrial* with 21% of the responses. It can be concluded that for both the Pre- and Post- Game Questionnaires, *domestic*, which falls under the Social Dimension, is the dominant means of water use in the participants' local environment.

### 5.6.2 Question 2: Who controls water?

- **Pre-Game Questionnaire: Overview of Participants' Responses**

Of the 17 main themes that were identified, more than a third of the themes, 35% fell under the Political Dimension which also received half of the responses, 50%. (See Appendix A, Table A.12.) This is followed by the Economic Dimension with 22% of the responses and 29% of the themes. In total there were 36 responses of which 25% (9/36) fell under *national, state, city, local government and/or municipality*. This makes it the dominant theme followed by *local water companies, owned by community/town who control prices* and *households and consumers*, each with 11% of the response rate. Together these three themes account for almost half of the responses, 49%.

- **Post-Game Questionnaire: Overview of Participants' Responses**

For this question the participants' responses were grouped into 10 main themes. (See Appendix A, Table A.13.) The Political Dimension received almost two thirds of the responses, 65%. This is followed by the Economic Dimension with 17% of the responses. Together, the Political and Economic Dimensions have the same number of themes, 36%, which accounts for 72% of the total themes. In total there were 23 responses dominated by 48% (11/23) under *national, state, city, local government, municipality, and water department*. This is followed by two themes, *laws: society and environmental authorities* and *households and consumers*, each with 9% of the responses. One can thus confirm that for both the Pre- and Post-Game Questionnaires participants are of the opinion that the *government*, as part of the Political Dimension, controls water use in their local environment.

### **5.6.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in your local context.**

- **Pre-Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 16 main themes for this question. (See Appendix A, Table A.14.) Together the Political and Biophysical Dimensions received more than two thirds of responses and themes: 84% and 81% (13/16) respectively. In total there were 35 responses of which 26% (9/35) fell under *main issue: quality*. This makes it the dominant theme followed by *dry periods impact on quantity and quality* with 14% (5/35) of the responses.

- **Post-Game Questionnaire: Overview of Participants' Responses**

In comparison to the Pre-Game Questionnaire the participants' responses were grouped into 15 main themes and had a total of 30 responses. (See Appendix A, Table A.15.) The Political Dimension received the most responses, 47%, as well as the most themes, 53% (8/15). This is followed by Other with 30% of the responses and 20% (3/15) of the themes. The majority of the responses fell under three themes, each with 13% of the response rate:

- *Sea pollution: polluters should pay hefty fines* (Political Dimension),
- *Water quality* (Political Dimension), and
- *Water shortages especially during summer* (Biophysical Dimension).

It can thus be concluded that after playing the ACG the participants are of the opinion that the political aspects of water management is the leading problem associated with water management in their local environment.

#### **5.6.4 Question 4: Why do you think these issues and challenges have emerged?**

- **Pre-Game Questionnaire: Overview of Participants' Responses**

It was possible to group the responses for this question into 22 main themes. (See Appendix A, Table A.16.) The Political Dimension received more than half of the response rate and themes: 55% each. This is followed by the Economic Dimension with 17% of the responses and 18% (4/22) of the themes. The top seven themes, listed below, each received 7% of the total:

- *areas without or decreasing ground water* (Political Dimension),
- *political decisions unable to curb eutrophication of the Baltic Sea* (Political Dimension)
- *poor water resources within towns thus imported* (Political Dimension)
- *water quality* (Political Dimension)
- *water availability taken for granted* (Economic Dimension)
- *use water freely as a public commodity* (Social Dimension)
- *climate change* (Biophysical Dimension)

These seven account for 32% (7/22) of the total themes. In addition, although the majority of them fall under the Political Dimension, 57% (4/7), the remaining three environmental dimensions are also represented.

- **Post-Game Questionnaire: Overview of Participants' Responses**

Participants' responses were grouped into 17 main themes and there was a total of 19 responses. (See Appendix A, Table A.17.) The themes with the highest response rates, 10% each, were:

- *political decisions unable to curb eutrophication of the Baltic Sea* (Political Dimension), and
- *ground water level is too low* (Political Dimension).

Both themes fall under the Political Dimension, which received the highest response rate, 80%, as well as the most themes, 78% (14/18). This was followed by the Social Dimension with 10% of the responses and 11% (2/18) of the themes.

This indicates that political aspects remain the predominant reason, in both the Pre- and Post-Game Questionnaires, why issues and challenges associated with water management in the participants' local environment, in this case Finland, have emerged.

#### **5.6.5 Question 5: How has the game helped you to gain a better understanding of water management in a southern African context?**

This question, together with Questions 6 and 7 was only posed in the Post-Game Questionnaire.

- **Post-Game Questionnaire: Overview of Participants' Responses**

For this question the participants' responses were grouped into 13 main themes and consisted of 21 responses. (See Appendix A, Table A.18.) The majority of the responses, 29%, fell under the following theme:

- *strengthened understanding of water's essential role, its management, complexity of associated issues and how crucial water resources are in all regions and countries.*

This theme falls under the Political Dimension and is followed by two themes that fall under the Social Dimension:

- *will give more attention to water issues especially shortages during dry summers* (14% of the total response rate), and
- *use water as a non-limited resource and should appreciate it more* (10% of the total response rate).

Together these three themes account for half of the responses (53%). This indicates that participants have gained a better understanding of the importance and complexity of the water supply. Participants have also realised that it should be used and appreciated as a non-limited resource.

#### **5.6.6 Question 6: Do you think that you would be able to use insights from your game experience and if yes where?**

- **Post-Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 19 main themes (see Table 5.1) under the three categories listed below:

- application possible,
- learning, insight and/or understanding, and
- negative and/or uncertain.

The majority of the responses, 20%, fell under *can use game in research, for training purposes, analysing different cultures and decision making*, which falls under "application possible". This was followed by two themes, each with 8% of the responses:

- *need cooperation and understanding of others' situation to survive*, and
- *personal and communication skills*.

**Table 5.1 – Turku Post-Game Questionnaire: Do you think that you would be able to use insights from your game experience?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Application possible</b>		<b>(n=19)</b>
Can use game in research, for training purposes, analysing different cultures and decision making	5	20
Can apply my game experiences to my work experiences	1	4
Gained idea of how reality mirroring games can be used in teaching	1	4
Great potential in using games to develop future thinking and scenario building	1	4
Not directly involved with water or environmental issues but can apply simulation game as a learning method to own work	1	4
Used some role simulations in "Environmental Management" course to teach students to understand processes, causes & consequences	1	4
Yes, for teaching my students who can put themselves in the place of government, rural farmers, industrial workers, etc.	1	4
<b>SUB-TOTALS: 7</b>	<b>11</b>	<b>44</b>
<b>Learning, insight and/or understanding</b>		
Need cooperation and understanding of others situation to survive	2	8
Personal and communication skills	2	8
Game inspiring	1	4
Know names of colleagues	1	4
Might organize Finnish farm game	1	4
Shows that alternatives in water issues are also in foresight processes	1	4
Significant insights: annual cycles and time tables important, limited work force and resources thus used carefully	1	4
Yes, to some extent	1	4
Yes, verified universal basic principles that exist: in all complex systems there are critical parameters that shall be understood and taken account for success	1	4
<b>SUB-TOTALS: 9</b>	<b>11</b>	<b>44</b>
<b>Negative and/or uncertain</b>		
Feel that the game was more about playing than reality	1	4
No, due to not working with related issues	1	4
Not sure yet	1	4
<b>SUB-TOTALS: 3</b>	<b>3</b>	<b>12</b>
<b>Totals</b>		
	<b>19</b>	<b>100</b>

### 5.6.7 Question 7: Do you have any recommendations for changes or improvements?

- **Post-Game Questionnaire: Overview of Participants' Responses**

Table 5.2 shows the participants' responses grouped into 17 main themes. Since the question called for recommendations, it was decided to group these themes under the following three categories:

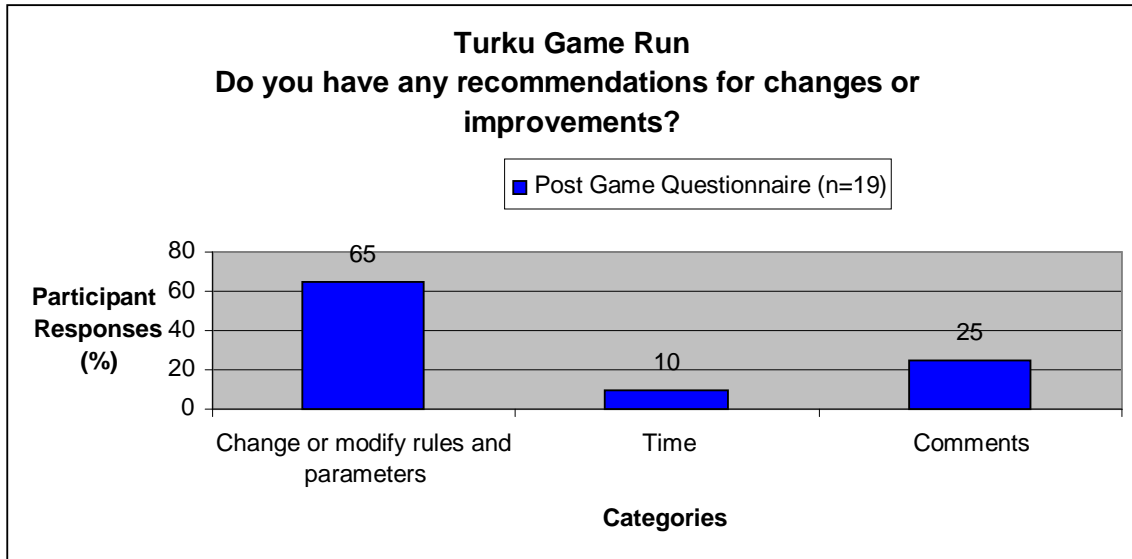
- Change or modify rules and parameters,
- Time, and
- Comments.

In total there were 20 responses of which 15% fell under *board with basic information and prices*, making it the theme with the most response. This was followed by *water issue needs to be emphasised: neither the government nor I had any real water shortages*, with 10% of the responses. Together these two themes account for a quarter of the responses, 25%.

**Table 5.2 – Turku Post-Game Questionnaire: Now that you have played the ACG and discussed it as a group do you have any recommendations for changes or improvements?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Change or modify rules and parameters</b>		<b>(n=19)</b>
Board with basic information and prices	3	15
Water issue needs to be emphasised: neither me nor government had any real water shortages	2	10
Adapt game parameters to Finnish society	1	5
Cattle did not consume water	1	5
Clearer basic rules although announced in advance	1	5
Completing charts confusing	1	5
Controlling players to obey rules	1	5
Need something that represents water infrastructure: water trading too abstract	1	5
Rules on separate papers	1	5
Use ICT to make whole game more visual	1	5
<b>SUB-TOTALS: 10</b>	<b>13</b>	<b>65</b>
<b>Time</b>		
Not enough time to read and understand rules	1	5
Not yet: think I needed to play longer	1	5
<b>SUB-TOTALS: 2</b>	<b>2</b>	<b>10</b>
<b>Comments</b>		
Do not have recommendations right now	1	5
Game teaches many aspects of human interaction and learning	1	5
Geographical distance to gain access to water: where water scare then prices high, where water abundant then prices low	1	5
Not sure if players should play role or themselves	1	5
Wonderful job and enjoyed playing the game	1	5
<b>SUB-TOTALS: 5</b>	<b>5</b>	<b>25</b>
<b>Totals</b>		
	<b>17</b>	<b>20 100</b>

The categories are compared in Figure 5.10 and shows that *change or modify rules and parameters* received more than half of the responses, 65%. This is followed with *comments* with a quarter of the responses, 25%. The remaining 10% fell under *time*.



**Figure 5.10 – Turku Post-Game Questionnaire: Now that you have played the ACG and discussed it as a group do you have any recommendations for changes or improvements?**

The following table lists these themes and my own impression of whether or not it is possible to implement the suggested game rules.

**Table 5.3 – Turku Post-Game Questionnaire: Implementing Suggested Game Rules**

Suggested Recommendations	Responses	Is it possible to implement these suggested game rules?	
<p><b>Game Rules</b></p> <p>Board with basic information and prices</p> <p>Clearer basic rules although announced in advance</p> <p>Completing charts confusing</p> <p>Rules on separate papers</p> <p>Use ICT to make whole game more visual</p>	<p>3, 15%</p> <p>1, 5%</p> <p>1, 5%</p> <p>1, 5%</p> <p>1, 5%</p>	<p><b>Yes or No</b></p>	<p><b>Why or why not?</b></p> <p>This was done by means of briefing the rural and urban sectors before the game.</p> <p>This was done by means of briefing the rural and urban sectors before the game.</p> <p>This was done by means of briefing the rural and urban sectors before the game.</p> <p>This was done by means of briefing the rural and urban sectors before the game.</p> <p>This was done by means of briefing the rural and urban sectors before the game.</p>
		Yes	
		Yes	
		Yes	
		Uncertain	
<p><b>Simulator Rules</b></p> <p>Water issue needs to be emphasised: neither the government or I had any real water shortages</p> <p>Adapt game parameters to Finnish society</p> <p>Cattle did not consume water</p> <p>Need something that represents water infrastructure: water trading too abstract</p>	<p>2, 10%</p> <p>1, 5%</p> <p>1, 5%</p> <p>1, 5%</p>	<p>Yes</p> <p>Yes</p> <p>Yes</p> <p>Yes</p>	<p>In the process of identifying the adequate water levels within the game.</p> <p>One would have to change the similar rules accordingly.</p> <p>This will be addressed in the next game run.</p> <p>Although not possible to address this in the next game run it should be considered.</p>
<p><b>Imported Rules</b></p> <p>Controlling players to obey rules</p>	<p>1, 5%</p>	<p>No</p>	<p>These are strategies that participants decide to follow and such imported rules are culture specific.</p>

One can therefore infer that after playing the ACG, participants felt that additional “game rules” associated with readily available rules and information were the major changes or improvements to be considered. After considering these recommendations five were already in place or in the process of being implemented, while three would have to be addressed in future game runs.

### **5.7 Reflecting on Modifications Implemented**

Water modifications implemented in this game run increased water availability in order to decrease water availability and to place stress on water associated activities and resources. However, the availability of water simulated in the game is not in keeping with the availability of water in a southern African context. This will have to be revisited and adjusted for the Tammela Game Run.

The modifications made to the pricing structure were successful in that domestic rice and cattle costs were lower resulting in more financial capital per capita.

### **5.8 Conclusion**

This chapter has provided an analysis and presentation of the data generated in the Turku Game Run. The research participants as well as the modifications made to the ACG were described. Data generated from the pre- and post-questionnaires was analysed and presented. The next chapter employs the same format in its analysis and discussion of the Tammela Game Run.

This chapter has provided an analysis and presentation of the data generated in the Turku Game Run. The research participants as well as the modifications made to the ACG were described. Each question was analysed according to the data generated from the pre- and post-questionnaires and the extracted most relevant responses for comparison for each question were presented.. The next chapter employs the same format in its analysis and discussion of the Tammela Game Run and includes a reference to findings made in the Turku Game Run.

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## CHAPTER 6

### TAMMELA GAME RUN

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#### **6.1 Introduction**

This chapter focuses on the game run that was played in Tammela, Finland as part of the Summer School held in June 2008. A total of 28 participants attended. The chapter has the following structure:

1. Analysis and discussion of the game run, and
2. Analysis overview and discussion of each question posed in the Pre- and Post-Questionnaires.

#### **6.2 Profile of the Research Participants**

The biographical data (summarised in Appendix B, Figures B.1 to B.7) indicate that participants were mostly female Finnish students who had obtained their second degree and were completing their Masters' degree. The majority of these players spoke English as their second language and fell within the 20 to 35 year old cohort.

#### **6.3 Further Changes and Modifications to the African Catchment Game**

In terms of further changes to the ACG, note that after the Turku Game Run in Finland, the Managers decided to adjust the starting water level in the dam as well as the annual rainfall game rules to 10% of the original figure. This meant that the initial water level was reduced from 4 000 to 400 units and that the maximum annual rainfall was reduced from 6 000 to 600 units. The adjustment was done in order to significantly reduce the amount of water in the game so that it would simulate dry climatic conditions that resemble southern African. It was also decided to use a dice instead of turning the pack of cards to determine rainfall in the upper catchment, i.e. the urban sector. The managers decided that this would increase the degree of chance regarding rainfall and drought.

## **6.4 Discussion and Findings of Tammela Game Run**

The contestants played the modified game and the findings are discussed under the following headings:

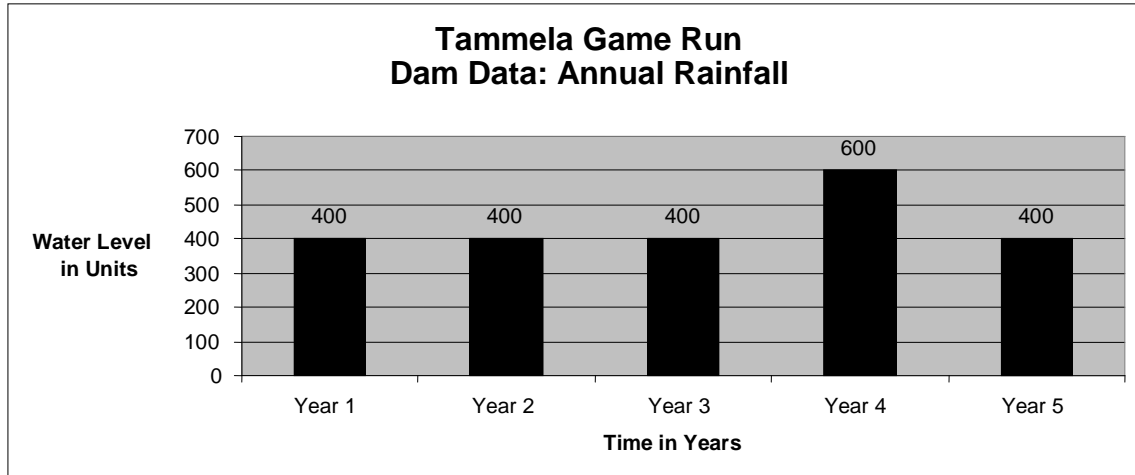
4. rainfall and water allocation,
5. population statistics, and
6. productivity.

### **6.4.1 Rainfall and Water Allocation**

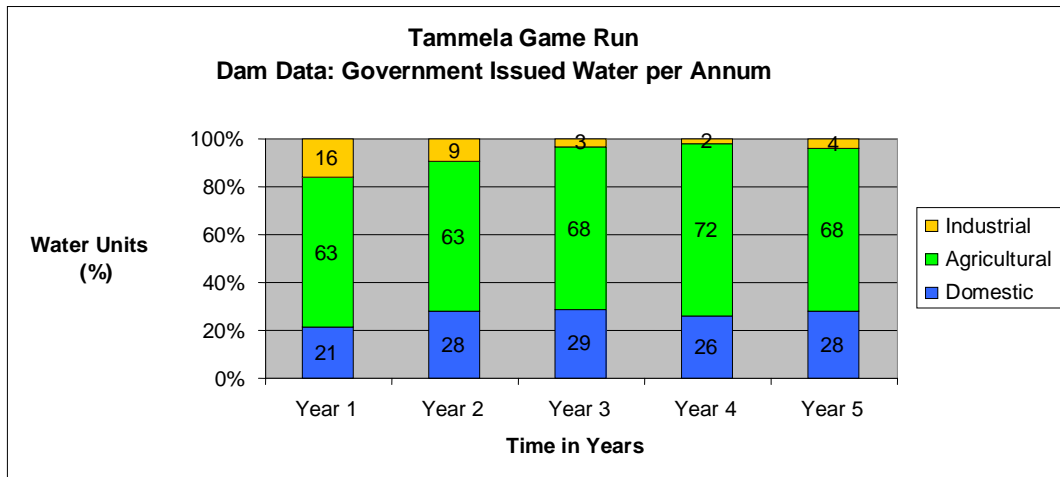
The predominant reason for the dam level fluctuations is due to the game rules that had been put into place for a single year in a game run, namely annual rainfall, the environmental reserve and the amount of government issued water.

As mentioned above, the rains are determined by three throws of a dice. Figure 6.1 displays the total rainfall for each year and shows that the annual rainfall remained constant at 400 water units save for Year 4 where it increased to 600 water units.

The water issued by government is grouped into domestic, agricultural and industrial water. Figure 6.2 displays these water ratios which the Water Minister issued annually throughout the five year game. The most water issued was for agricultural use which peaked at 72% in Year 4 and managed a gradual increase of five percent between Year 1, 63%, and Year 5, 68%. The peak in Year 4 can be attributed to the 200 water unit increase in rainfall received in the same year. Similarly, the water issued for domestic use gradually increased by 7% over the five year game period from 21% to 28%. The increase in water allocated for domestic use can be attributed to increasing population numbers while the 5% increase in the agricultural water allocation can be attributed to the 12% decrease in Industrial water: 16% in Year 1 to four percent in Year 5.

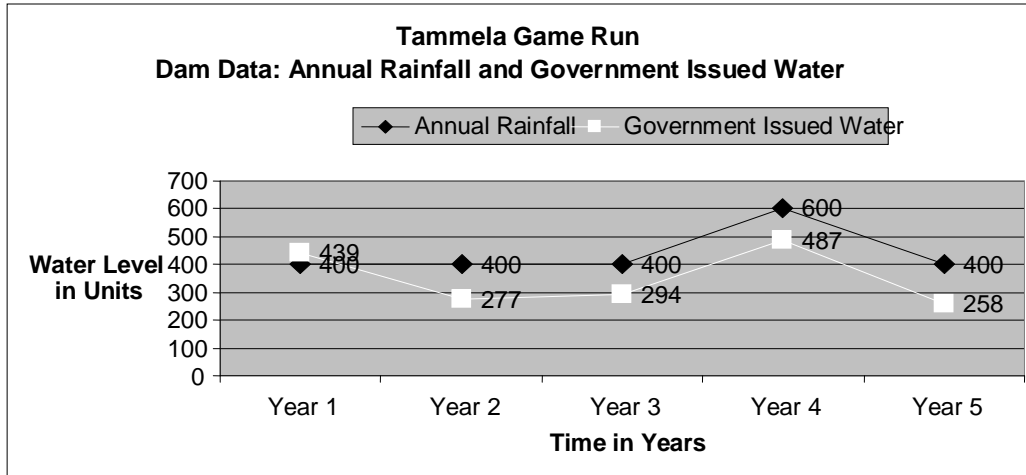


**Figure 6.1 – Tammela Game Run: Annual Rainfall**



**Figure 6.2 – Tammela Game Run: Government Issued Water per Annum**

When comparing the annual rainfall and the water issued by government, displayed in Figure 6.3, it is evident that water tokens issued by government exceeded rainfall totals in the first year by 39 units. The lowest issue of government water tokens took place in the next year, Year 2, when the water supply was low and future rainfall unpredictable. The largest issue of government water tokens took place in Year 4, when the annual rainfall had increased to 600 water units. This was a time when water was plentiful and rainfall more predictable.



**Figure 6.3 – Tammela Game Run: Comparison of Annual Rainfall & Government Issued Water**

The trend line in Figure 6.4 shows that the dam level remained constant throughout the five-year game period. These stable water conditions are not in keeping with the southern African climate where water is not readily available and thus considered a scarce resource. Although the desired impact of water as a scarce resource was not realised in the game, the 10% adjustment had significantly decreased the availability of water and ruled out the chance occurrence of a flood. The amount of available water in the game would have had an impact on population numbers as well as productivity which is discussed in the following section.

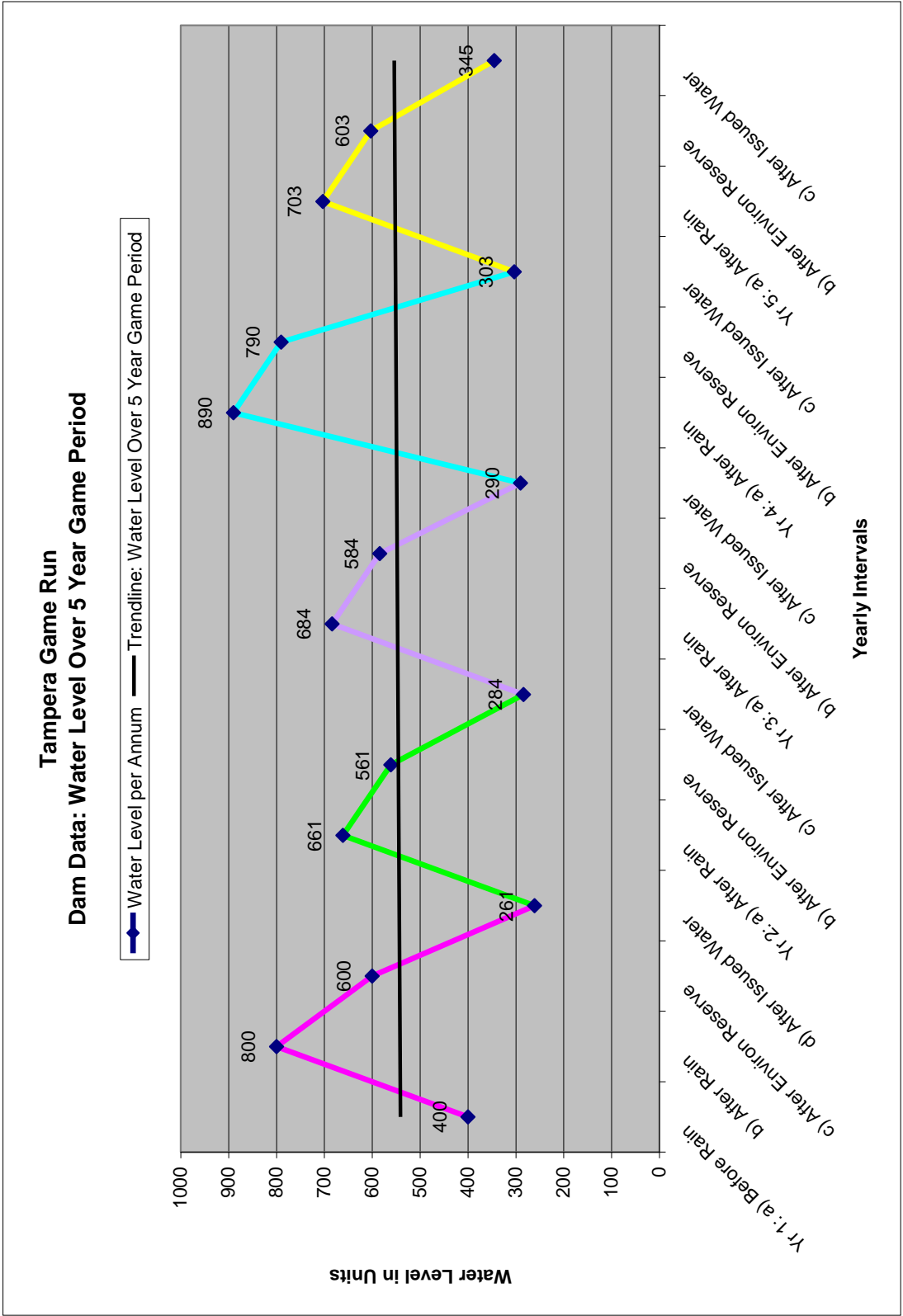


Figure 6.4 – Tammela Game Run: Water Levels Over a 5 Year Period

## 6.4.2 Population Statistics

In terms of population statistics, it was possible to group and compare this data between both the rural and urban sectors. This is displayed in Figures 6.5 to 6.7.

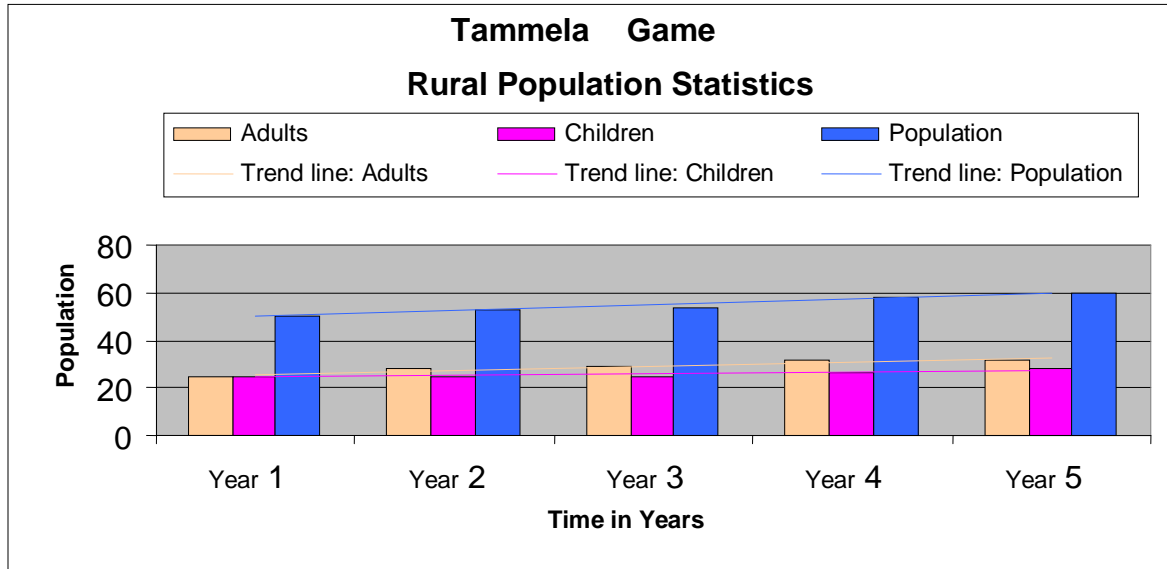


Figure 6.5 – Tammela Game Run: Rural Population Statistics

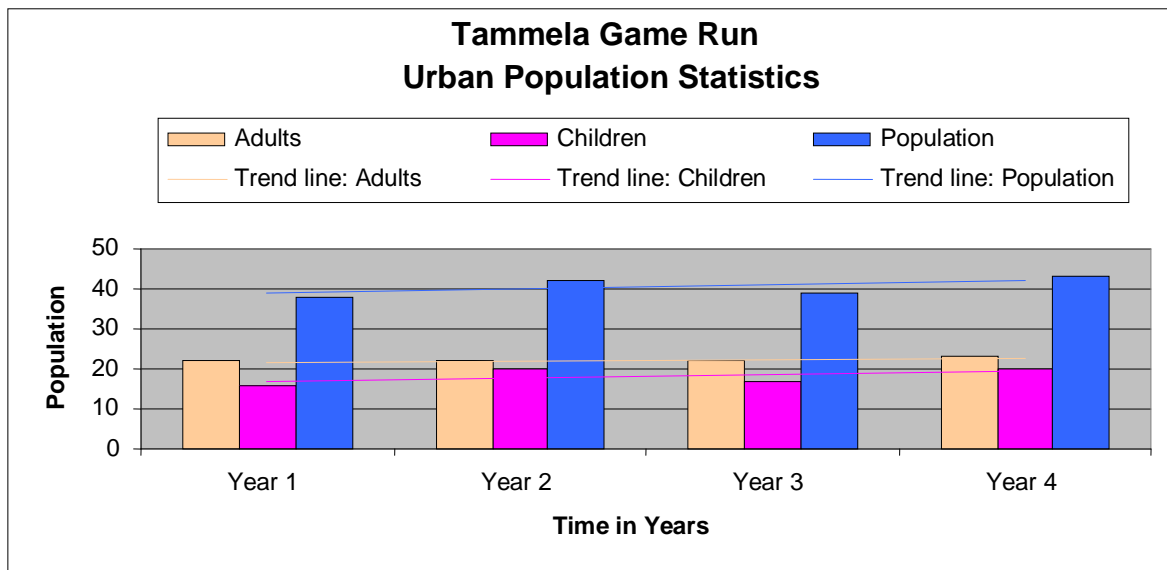
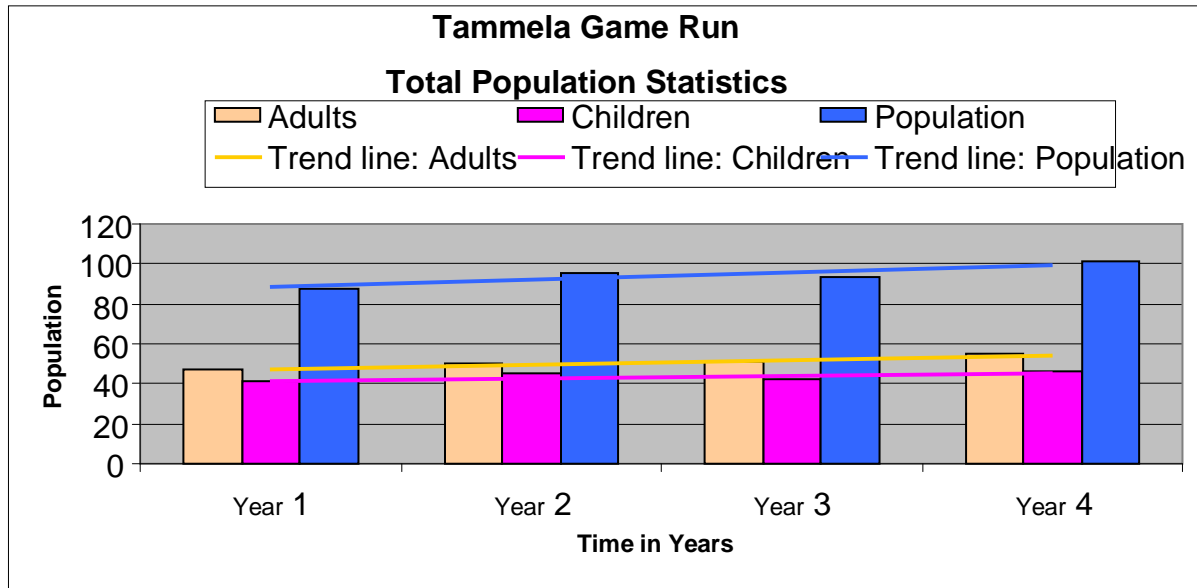


Figure 6.6 – Tammela Game Run: Urban Population Statistics



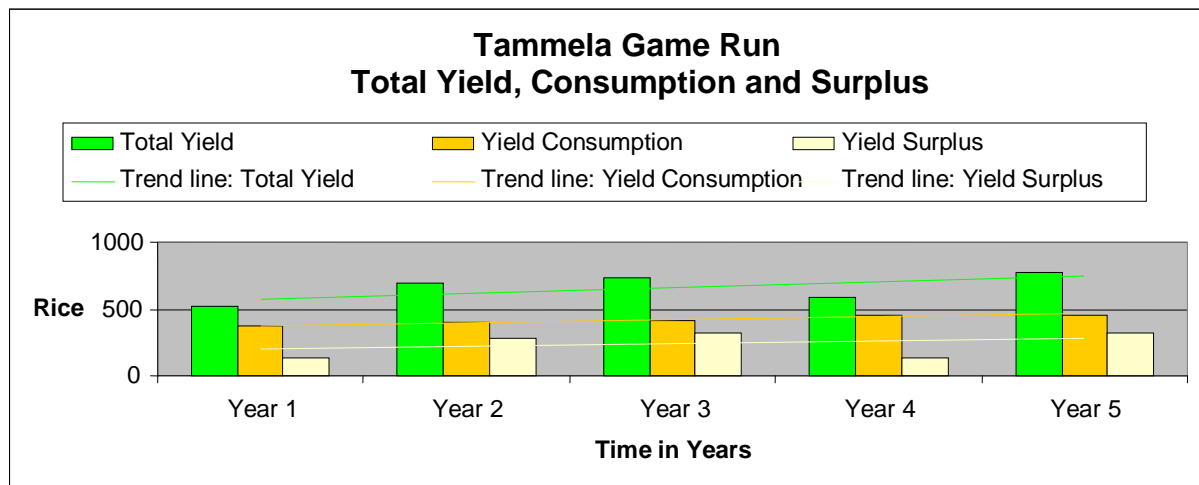
**Figure 6.7 – Tammela Game Run: Total Population Statistics**

The trend lines show that there was an increase in population growth in both the rural and urban sector. Therefore the country’s total population increased from 88 people in Year 1 to 101 people in Year 5. Due to the constant water levels in the game this increase in population gradually placed stress on water as a resource.

Although players were rather placid during Year 1 in terms of activity and negotiations, this changed from Year 2 onwards as players realised that survival depended on their own initiative. Therefore the gradual stress placed on the constant water level by an increasing population would not have been readily noticed and taken into account when budgeting. This was further exacerbated by government implementing taxes in the second and not the first year. It can be argued that by the rural peasant farmers forming a commune and pooling all available resources, they were able to collectively voice their wants and needs to government, but they also had the resources to survive in a climatic dependent agricultural culture.

### 6.4.3 Productivity

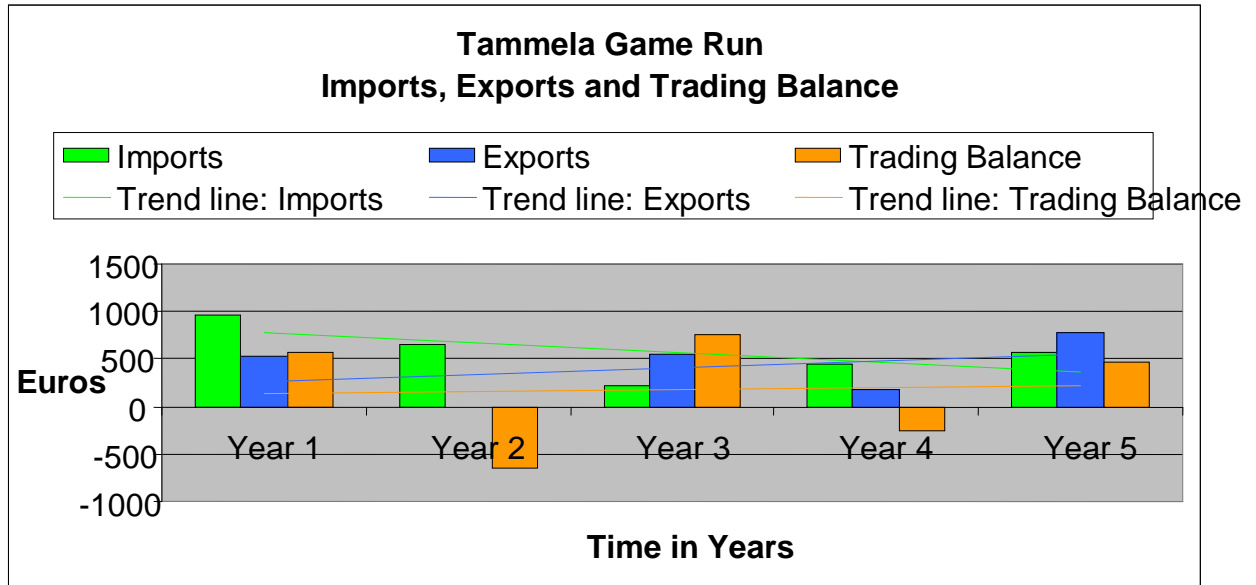
In terms of productivity in the rural sector, displayed in Figure 6.8, the total rice yield increased by 262 rice units over the five-year game period from 515 to 777 rice units. This increase is less than the 546 total rice yield in the Turku Game Run which increased from 546 to 957 rice units over the four-year game run period. However, this increase was high enough to exceed the rising consumption demand and allowed for an increase of 177 surplus rice units between Year 1 and 5. This meant that water was not having a negative effect on food security and therefore not placing the desired stress on players' ability to improve their standard of living.



**Figure 6.8 – Tammela Game Run: Total Yield, Consumption and Surplus**

As for game strategies these were similar to the Turku Game Run in that citizens were law abiding citizens and that there was civil peace. This can be attributed to the peasant farmers forming a commune therefore enabling them to negotiate their demands as a collective voice. Of interest is that the trader decided that it was financially profitable not to have children and therefore deliberately starved them until they died. The government was not aware of this and therefore the act went unpunished.

In terms of urban productivity, Figure 6.9 shows that imports significantly decreased throughout the game while exports increased. This resulted in a trading balance that fluctuated between extreme positive and negative balances. Although food security was sustainable, factories were not reliable and this contributed to the fluctuating trading balance.



**Figure 6.9 – Tammela Game Run: Imports, Exports and Trading Balance**

#### 6.4.4 Conclusion

The game was not that stressful for players since water availability was not simulated according to that of a southern African Context, remaining fairly constant throughout the game. However, it was interesting to see how the participants' level of activity and manner of interaction adapted from a rather passive to a much more aggressive stance. One participant commented that negotiations became increasingly aggressive and impolite as the game progressed. This was largely due to participants' realising that survival depended on their own initiative and resourcefulness. As a participant commented, dynamics were intense and we (our peasant farm) 'experienced some tension in the air'. Regrettably, there was not enough time to have a thorough focus group debriefing after the game due to time and travel schedules. The manager leading the focus

group debriefing, Professor Fox, had to end the discussion prematurely due to travel arrangements for participants and managers. Consequently, and as a result valuable insights were not revealed or reinforced. This shows that the focus group discussion is of great importance since it allows participants to consolidate not only what happened during the game but also what they had learned.

## **6.5 Participants' Learning: Southern African Context**

The following discussion is structured according to questions in the Pre- and Post- Game Questionnaires and follows the same format as the previous chapter. The first discussion focuses on questions that fall under the southern African context followed by a second discussion that focuses on questions concerning the participants' own context.

### **6.5.1 Question 1: How is water used in a southern African context?**

- **Pre-Game Questionnaire: Overview of Participants' Responses**

Participants' responses grouped into 14 main themes. (See Appendix B, Table B.1). In total there were 37 responses of which 28% (10/37) fell under *agriculture*, making it the principal theme followed by *rural areas have wells but no connecting infrastructure to houses*, with 17 of the responses. The participants highlighted the Economic and Political Dimensions of the environment as the main uses of water in a southern African context.

Together the Political and Economic Dimensions received the most responses, 89% (32/37), and half of the themes, 79% (11/14). When comparing the Political and Economic Dimensions, the Political Dimension had received the highest response rate, 53% (19/37) and half of the themes, 50% (7/14).

- **Post- Game Questionnaire: Overview of Participants' Responses**

After playing the ACG it was possible to group the participants' responses into eight main themes. (See Appendix B, Table B.2.) In total there were 66 responses of which 32% (21/66) fell under *agriculture*, making it the most dominant theme followed by *industry* and *domestic*, each with 20% (30/66) of the responses. The Economic

Dimension received the most responses, 65% (43/66), as well as the most themes, 50% (4/8). This is followed by the Social Dimension with 32% (21/66) of the responses and 25% (2/8) of the themes. The participants have once again pointed to the Economic and Political Dimensions of the environment as the primary uses of water in a southern African context. This is similar to the Turku Game Run in which the Economic Dimension received the highest responses for both the Pre- and Post Questionnaires.

### 6.5.2 Question 2: Who controls water?

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 10 main themes under the four environmental dimensions. (See Appendix B, Table B.3.) Nearly 40%, (37%, 10/27) of the participants are of the opinion that the single theme, *government, state, municipality, and/or local authorities* in the Political Dimension of the environment, controls water use in a southern African context.

Together the Political and Economic Dimensions received the most responses and themes: 48% and 26% respectively. When comparing these two categories, the Economic Dimension has the most themes, 40% (4/10), while the Political Dimension had the highest response rate, 48% (13/27).

- **Post- Game Questionnaire: Overview of Participants' Responses**

There was a decrease in the number of themes from 10 in the Pre- Game Questionnaire to seven in the Post- Game Questionnaire. (See Appendix B, Table B.4.) In total there were 30 responses of which 80% (24/30) fell under the single theme *government: state, water minister, municipalities*, making it the most dominant theme. This indicates that participants in both the Pre- and Post- Questionnaires are of the opinion that the Political Dimension controls water use in a southern African context. This is similar to the Turku Game Run in which participants highlighted *government*, as a political dimension, as the dominant theme.

### **6.5.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in a southern African context.**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 13 main themes. (See Appendix B, Table B.5.) There were 34 responses of which 24% (8/34) fell under *Infrastructure: equal water supply system*, making it the most dominant theme followed by *Dry seasons: lack of water, ground water, impact on food security*, with 18% (6/34) of the responses. The participants have thus highlighted political issues or challenges associated with water management in a southern African context.

The Political Dimension had the most responses, 56%, as well as the most themes, 54% (7/13). This is followed by the Biophysical Dimension with 24% of the response rate and 23% (3/13) and of the themes.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses can be grouped into 18 main themes and in total, there were 37 responses. (See Appendix B, Table B.6.) The two themes with the most responses, 16% each, were *supply cannot meet demand* and *droughts*. This was followed by *High water fees* with 14% of the response rate. This indicates that the participants have again highlighted political and biophysical issues and challenges associated with water management in a southern African context but they express this in different themes.

The Political Dimension received the highest response rate, 49%, as well as 50% of the themes, (9/18). This is followed by the Biophysical Dimension with 22% of the responses and the Economic Dimension with 17% (3/18) of the themes. It can be concluded that for both the Pre- and Post- Game Questionnaires *droughts*, as a Biophysical Dimension, remains the leading concern and challenge associated with water management in a southern African context. In comparison to the Turku Game Run, participants highlighted the issue of scarcity, as a Political Dimension.

#### **6.5.4 Question 4: Why do you think these issues and challenges have emerged?**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

For this question 16 main themes were identified. (See Appendix B, Table B.7.) In total there were 40 responses of which 18% (7/40) fell under *historical reasons: apartheid*, as part of the Political Dimension. This makes it the primary theme followed by *poor management: over- use and mis-control* and *supply not meeting demand*, each with 13% of the responses. The Political Dimension received more than two thirds of the responses, 68% (27/40) and the most themes, 56% (9/16). This was followed with the Economic Dimension with 13% (5/40) of the responses. The Tammela participants therefore highlighted political reasons as an area of concern while the Turku participants had also highlighted political reasons but in the form of water quality.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into fewer (13) main themes. (See Appendix B, Table B.8.) There was a shift from climatic to historical concerns between the Pre- and Post- Game Questionnaire. In total there were fewer responses (31) of which 26% (8/31) fell under *depend on climate that is challenging*, as a Biophysical Dimension, making it the main theme. This was followed by *government distribution and management problems* with 19% (6/31) of the responses. This indicates that the participants identified climatic aspects as the major cause of concern.

The Political Dimension received the highest response rate, 61%, and the most themes, 62% (8/13). This is followed by the Biophysical Dimension with 29% of the responses and 15% (2/13) of the themes.

#### **6.5.5 Question 5: How has the game helped you to gain a better understanding of water management in a southern African context?**

- **Post- Game Questionnaire: Overview of Participants' Responses**

This question was only posed in the Post-Game Questionnaire. The participants' responses were grouped into 20 main themes. (See Appendix B, Table B. 9).In total there

were 33 responses of which *how sectors work together* and *lack of routine and control in SA*, each received the highest response rate of 12% (4/33). This was followed by *access: difficult to get money to pay for domestic water* and *problems small farmers face was authentic*, where each received 9% (3/33) of the responses. This means that the Tammela participants say they have gained a better understanding of how various sectors operate and realised that management in SA is poor and that access is a problem to many in a southern African context. In comparison the Turku participants gained a better understanding of the importance of water, its management, its associated dependencies, challenges and the complexity of these issues.

## **6.6 Participants' Learning: Their Own Context**

The section follows the same structure as the southern African context and has the three questions that were posed in the Post- Game Questionnaire for this context:

4. How has the game helped you to gain a better understanding of water management in your context?
5. Do you think that you would be able to use insights from your game experience and if yes, where?
6. Now that you have played the ACG and discussed it as a group, do you have any recommendations for changes or improvements?

### **6.6.1 Question 1: How is water used in your local environment?**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 14 main themes. (See Appendix B, Table B.10.) In total there were 122 responses of which 23% (28/122) fell under *drinkable water used for everything*, making it the most dominant theme followed by *industry* with 18% (22/122) of the responses. The participants highlighted the Political and Economic Dimensions of the environment as the predominant uses of water in their own context.

Together the Political and Economic Dimensions received the most responses, 90% (110/122), and themes, 79% (11/14). When comparing the Political and Economic

Dimensions, the Economic Dimension had the most themes, 44% (54/122), and received the highest response rate, 46% (56/122).

- **Post- Game Questionnaire: Overview of Participants' Responses**

In total there were fewer responses (46) of which 25% (12/48) fell under *domestic*, making it the most dominant theme followed by *agriculture* and *industry* with 21% (10/48) of the responses. (See Appendix B, Table B.11.) This indicates that the participants are now of the opinion that the Social and Economic Dimensions are highlighted as the predominant use of water in their own context.

Together the Economic and Social Dimensions received the most responses and themes: 90% and 67% (10/15) respectively. When comparing the Economic and Social Dimensions, the Economic Dimension received 50% of the responses as well as most of themes, 40% (6/15). In both the Tammela Pre- and Post- Game Questionnaires the Economic Dimension was highlighted as the predominant use of water in their own context while the Turku participants highlighted the Social Dimension in both the Turku Pre- and Post- Questionnaires.

### 6.6.2 Question 2: Who controls water?

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 16 main themes. (See Appendix B, Table B.12.) In total there were 38 responses of which 37% (14/38) fell under *municipality, government, and state*, making it the dominant theme followed by *communities: communal bodies* with 13% (5/38) of the responses. These two themes received more than half of the responses and the Political Dimension, as a whole, received the most responses and themes: 68% and 56% respectively. This is followed by the Economic Dimension with 24% of the responses and a quarter of the themes.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses could be grouped into nine main themes. (See Appendix B, Table B.13.) In total there were 34 responses of which 56% (19/34) fell under *national*

*and communal government, minister of environmental science, state, city, municipality,* making it the dominant theme followed by *private owners, e.g. water companies* with 18% (6/34) of the responses.

The Political Dimension received the most responses and themes: 68% and 44% (4/9) respectively. This is followed by the Economic Dimension with 21% of the responses. In both the Tammela Pre- and Post- Game Questionnaires participants are of the opinion that the *government*, as part of the Political Dimension, controls water use in their local context. This is similar to the Turku Game Run in which *government*, as part of the Political Dimension, also received the most responses in both the Pre- and Post- Questionnaire.

### **6.6.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in your local context.**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 15 main themes. (See Appendix B, Table B.14.) In total there were 35 responses of which 20% (7/35) fell under *quality assurance*, making it the most dominant theme followed by *maintenance: plumbing* with 17% (6/35) of the responses each. Together these themes account for more than a third of response rate: 37%.

The Political Dimension received more than three quarters of the responses, 86%, as well as more than two thirds of the themes (73%, 11/15). This is followed by the Social Dimensions with a mere 9% of the responses and 13% (2/15) of the themes.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' 28 responses grouped into 18 main themes. (See Appendix B, Table B.15.) 14% (4/28) fell under *maintenance: freezing water pipes, sewage control in country houses, 1995 technology used* and *pollution in Baltic Sea*. This was followed by *waste water management is state regulated*, with 11% (3/28) of the responses.

The Political Dimension received the majority of the responses, 71% (20/28), as well as the themes, 56% (10/18). This is followed by the Social Dimension with 14% (4/28) of the responses and 22% (4/18) of the themes. For both the Pre- and Post Questionnaires, Tammela and Turku participants have highlighted either quality and/or maintenance.

#### **6.6.4 Question 4: Why do you think these issues and challenges have emerged?**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 16 main themes. (See Appendix B, Table B.16.) In total there were 25 responses of which 16% (4/25) fell under *used liberally: overused not conserved*. This makes it the principal theme followed by *low level of environmental awareness* with 12% (3/25) of the responses.

The Political and Social Dimensions received the most responses, 36%, while the Political Dimension received half of the themes, 50% (8/16). Together these two dimensions account for 72% of the response rate.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 16 main themes. (See Appendix B, Table B.17.) In total there were 20 responses of which 20% (4/20) fell under *nature and/or climate* in the Biophysical Dimension. This makes it the principal theme followed by *maintenance: underground piping difficult to inspect, maintenance problems emerge slowly, misuse and poor management* in the Political Dimension with 10% (2/20) of the responses.

The Political and Biophysical Dimensions received the highest response rates, 40% each. The Political Dimension had the most themes, 44% (7/16), followed by the Biophysical Dimension, 31% (5/16). The Tammela as well as the Turku Pre- and Post Game Questionnaires highlighted the Political Dimension as the dominant reason for why issues and challenges associated with water management have emerged.

### **6.6.5 Question 5: How has the game helped you to gain a better understanding of water management in a southern African context?**

This question, together with Questions 6 and 7, were only posed in the Post- Game Questionnaire.

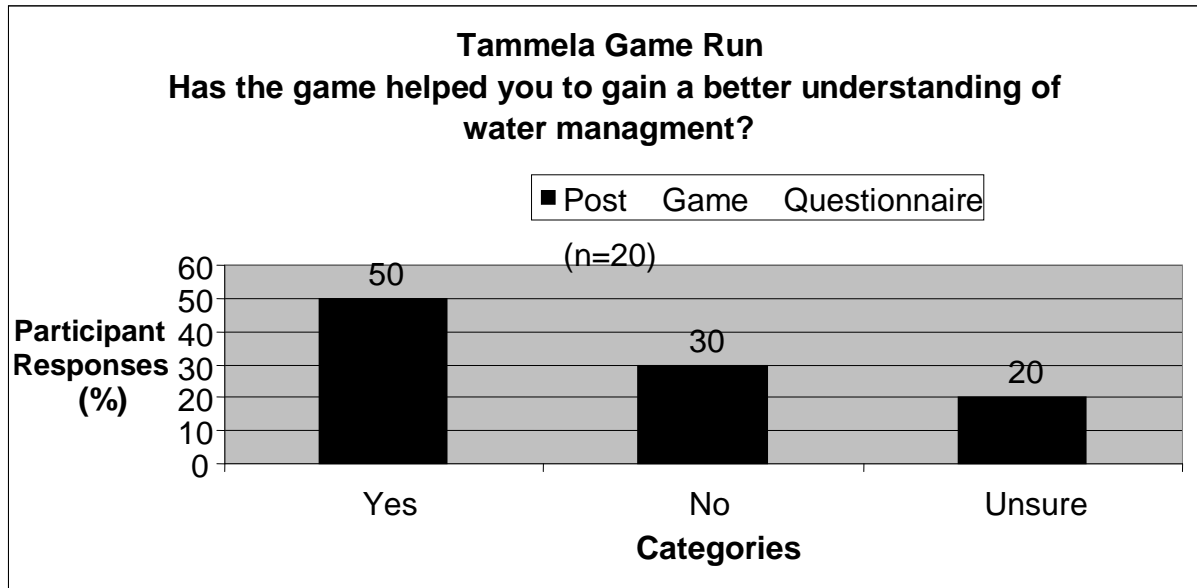
- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 14 main themes. (See Appendix B, Table B.18.) In total there were 23 responses of which 17% (4/23) fell under *African context so very different that it did not make a difference* and *raised awareness: water has social, economic and biophysical value and should be appreciated*, each with 17% of the responses.

Other received the highest response rate, 60%, as well as the most themes, 47%. This is followed by the Biophysical Dimensions with 22% of the responses.

Both the Tammela and Turku participants (section 5.6.5) thus gained a better understanding of water's role as a valuable resource.

The themes were categorised under the following headings in Figure 6.10: yes, no and unsure.



**Figure 6.10 – Tammela Game Run: Participant Responses per Category**

While 30% of the participants felt that they had not gained a better understanding, 50% felt that they had. The remaining 20% was unsure and felt that they needed more time to consolidate what they had learnt from their game experience.

**6.6.6 Question 6: Do you think that you would be able to use insights from your game experience and if yes where?**

- **Post- Game Questionnaire: Overview of Participants’ Responses**

The participants’ responses grouped more or less equally across the 16 main themes. (See Appendix B, Table B.19.) There were 27 responses in total of which 22% (6/27) each fell under *need more time to think and reflect* and *yes*. This was followed by *can use idea of ACG in job and in lectures* with 7% (2/27).

**6.6.7 Question 7: Now that you have played the ACG and discussed it as a group, do you have any recommendations for changes or improvements?**

• **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 20 main themes. (See Table 6.1.) Since the question called for recommendations, it was decided to group these themes under the following three categories:

- *change or modify game rules,*
- *time,* and
- *comments.*

In total there were 22 responses of which nine percent each fell under *better laws and reinforcement of them* and *choose better target group: great for geographical sector*. These are the two dominant themes. The remaining 18 themes each received low response rates, five percent each, which together account for 82% (18/22) of the responses and 90% (18/20) of the themes.

*Change or modify game rules* received the most responses, 64%, and the most themes, 60% (12/20). This was followed by *comments* with 27% of the responses and 30% (6/20) of the themes.

Table 6.2 displays all the themes and indicates which recommendations can be implemented or not and why. The comment category was not included since these are not recommendations

**Table 6.1 – Tammela Post- Game Questionnaire: Now that you have played the ACG and discussed it as a group do you have any recommendations for changes or improvements?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Change or modify game rules</b>		<b>(n=20)</b>
Better laws and reinforcement of them	2	9
Choose better target group: great for geographical sector	2	9
Bigger room space	1	5
Clearer instructions: what you need and what it looks like	1	5
Include a form of media that allows for the discussion of the government's actions	1	5
Include impact of HIV/AIDS	1	5
Managers should stop people discussion over the boarder	1	5
More export industries	1	5
Narrative collection of experiences	1	5
Play one round as a practice round	1	5
Recycling	1	5
Social policies	1	5
<b>SUB-TOTAL: 12</b>	<b>14</b>	<b>64</b>
<b>Time</b>		
Game too long	1	5
Shorter years would make game more dynamic	1	5
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>9</b>
<b>Comments</b>		
Game already so advanced and pieces work together: game management went smoothly	1	5
Good that time was taken to explain game before hand since at the start of its very confusing	1	5
Have to think and reflect about this	1	5
Initially game difficult but this is same as a real life situation	1	5
Interesting to play it two more times to see what changes	1	5
Not really	1	5
<b>SUB-TOTAL: 6</b>	<b>6</b>	<b>27</b>
<b>Totals</b>		
<b>20</b>	<b>22</b>	<b>100</b>

**Table 6.2 – Tammela Post- Game Questionnaire: Implementing Suggested Game Rules**

<b>Game Rules</b>	<b>Is it possible to implement these suggested game rules?</b>		
<b>Change or modify game rules</b>	<b>Responses</b>	<b>Yes or No</b>	<b>Why or why not?</b>
Better laws and reinforcement of them	2, 9%	No	Participants are able to create new rules and are therefore responsible for reinforcing them
Choose better target group: great for geographical sector	2, 9%	Yes and No	Anyone is able to play the ACG should they wish to
Bigger room space	1, 5%	Yes	When possible more room is always welcome
Clearer instructions: what you need and what it looks like	1, 5%	No	The debriefing serves this function
Include a form of media that allows for the discussion of the government's actions	1, 5%	Yes	In previous games the role of journalist was included
Include impact of HIV/AIDS	1, 5%	Yes	In previous games this has been simulated
Managers should stop people discussion over the boarder	1, 5%	Yes	This is something that can be addressed
More export industries	1, 5%	Yes	This is something that can be addressed
Narrative collection of experiences	1, 5%	Yes	This is something that can be addressed
Play one round as a practice round	1, 5%	Yes	This is something that can be addressed
Recycling	1, 5%	Yes	Water is already recycled
Social policies	1, 5%	No	Participants are able to create new rules and are therefore responsible for reinforcing them
<b><u>Time</u></b>			
Game too long	1, 5%	Yes	This is at the managers discretion
Shorter years would make game more dynamic	1, 5%	Yes	This is at the manager's discretion

## **6.7 Reflecting on Modifications Implemented**

The reduction to 10% of the starting dam level and the annual rainfall significantly reduced water availability within the game. However, this reduction was not enough to place sufficient stress on water as a limited resource or on associated processes and resources. This adjustment would have to be revisited for the Amakhala Game Run since water availability was still too high when compared to the dry climatic conditions in a southern African context.

## **6.8 Conclusion**

The data generated in the Tammela Game Run of the ACG simulation was analysed and presented in this chapter. The research participants and the changes made to the ACG were described and the findings of each question posed in the Pre- and Post-Questionnaires were presented. Similarities and differences between the Tammela and Turku Game Run were included where possible. The following chapter provides an analysis and discussion of the Amakhala Game Run and reference is made to the Tammela and Turku Game run where significant.

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## CHAPTER 7

### AMAKHALA GAME RUN

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#### **7.1 Introduction**

This chapter focuses on the game run that was played as part of the Rhodes University International Summer School in June 2008. The majority of the 23 participants were South African and American. The chapter is structured under the following headings:

- Profile of the research participants,
- Further changes and modifications to the African Catchment Game,
- Discussion and findings of the Turku Game Run,
- Participants' learning: Southern African Context,
- Participants' learning: Their Own Context, and
- Reflecting on modifications implemented.

#### **7.2 Profile of the Research Participants**

The biographical data (summarised in Appendix C, Figures C.1 to C.7) indicate that participants were mostly undergraduate students speaking English as their first language, female and between 21 and 25 years old. Two had obtained their doctorates of which one was a visiting professor from the USA and the other was working at the Amakhala Game Reserve as a conservationist.

#### **7.3 Further Changes and Modifications to the African Catchment Game**

After the Tammela Game Run in Finland, the Managers decided to keep the starting water level in the dam, a game rule, at 400 units. It was also decided to change a simulator rule and provide the commercial farmers with water pumps. This would provide the commercial farmers with the much needed infrastructure to irrigate large fields and is in keeping with commercial farming practices, especially in South Africa.

## **7.4 Discussion and Findings of Amakhala Game Run**

The modified game was played and the findings are discussed as follows:

7. rainfall and water allocation,
8. population statistics, and
9. productivity.

### **7.4.1 Rainfall and Water Allocation**

The following discussion aims to provide insight into why the dam level fluctuated over the 5-year game run period by drawing from the focus group debriefing, the managers' observations and spreadsheets.

Figure 7.1 displays the rainfall for each year and shows that the annual rainfall doubled from 200 to 400 units in Year 4 and 5. Figure 7.2 displays the water ratios that the Water Minister issued for domestic, agricultural and industrial use. During the five year game run, the most water issued was for agricultural use which gradually increased from 51% in Year 1 to 75% in Year 5. This is due to the decreasing percentages for both domestic water, 30% in Year 1 to 24% in Year 5, and agricultural water, 19% in Year 1 to 2% in Year 5, during the same period.

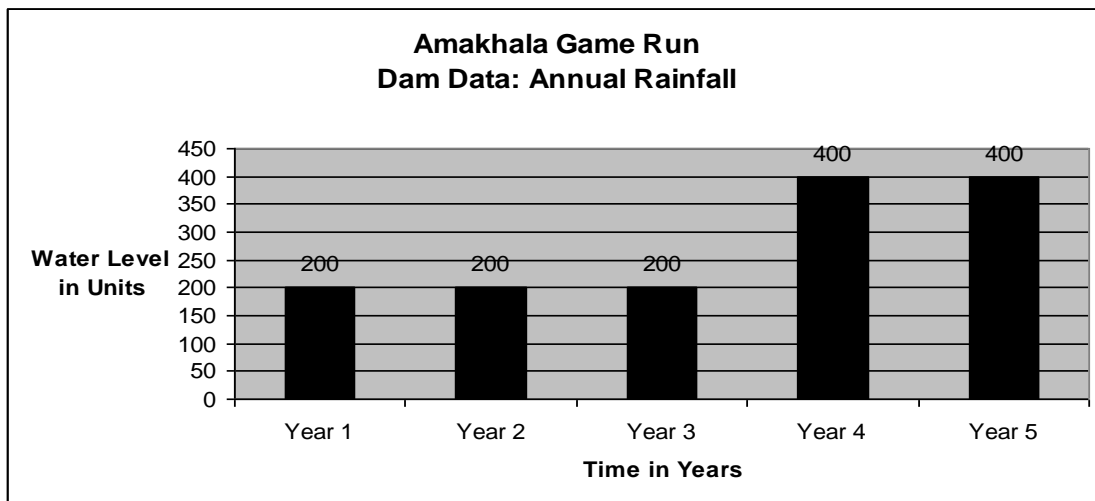
When comparing the annual rainfall and the water allocations, displayed in the Figure 7.3, it is evident that the lowest allocation took place at the beginning of the year, when the water supply was low and future rainfall unpredictable. Similarly, the largest allocation took place in Year 4, when the annual rainfall had doubled from 200 to 400 water units. Water was thus plentiful and participants had gained valuable game experience to effectively play their roles.

Of interest is that Year 2 is the only year in which the Government Issue exceeded the Annual Rainfall. This is explained by examining the fluctuation of the dam's water level over the five year game period which is displayed in Figure 7.4. It shows that although Government Issue exceeded the Annual Rainfall, it

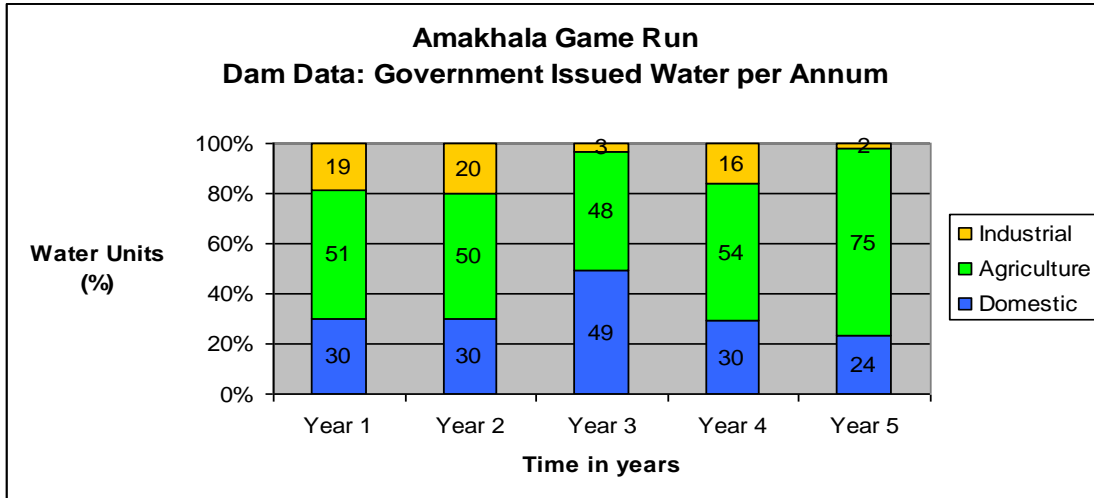
- a) did not exceed the 200 water unit mark, which is the half way point of the original dam level in Year 1 (400 water units), and
- b) was not the lowest dam level over the five-year game period.

The lowest water level occurred at the end of Year 3, which was the third year with significantly low rainfall, 200 water units. Such low rainfall over a three year period explains why the water issued by government exceeded annual rainfall in Year 2 and why Year 3 had the lowest water level during the five year game.

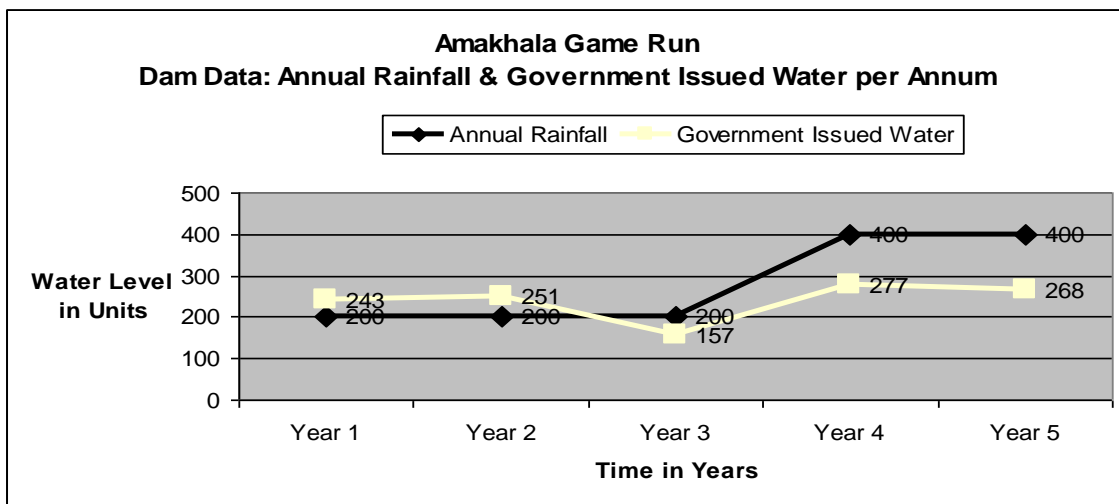
The trend line in Figure 7.4 shows that the dam level gradually decreases from Year 1 through to Year 5. This decrease is not as sharp as in the Assegai Trial Run so as to cause complete water shortage but enough to cause significant stress on water allocation and its use. It can therefore be concluded that the Game and Simulator Rules implemented, i.e. the starting water level of 400 units and the starting number of water pumps, were successful.



**Figure 7.1 – Amakhala Game Run: Annual Rainfall**



**Figure 7.2 – Amakhala Game Run: Government Issued Water per Annum**



**Figure 7.3 – Amakhala Game Run: Comparison of Annual Rainfall & Government Issued Water**

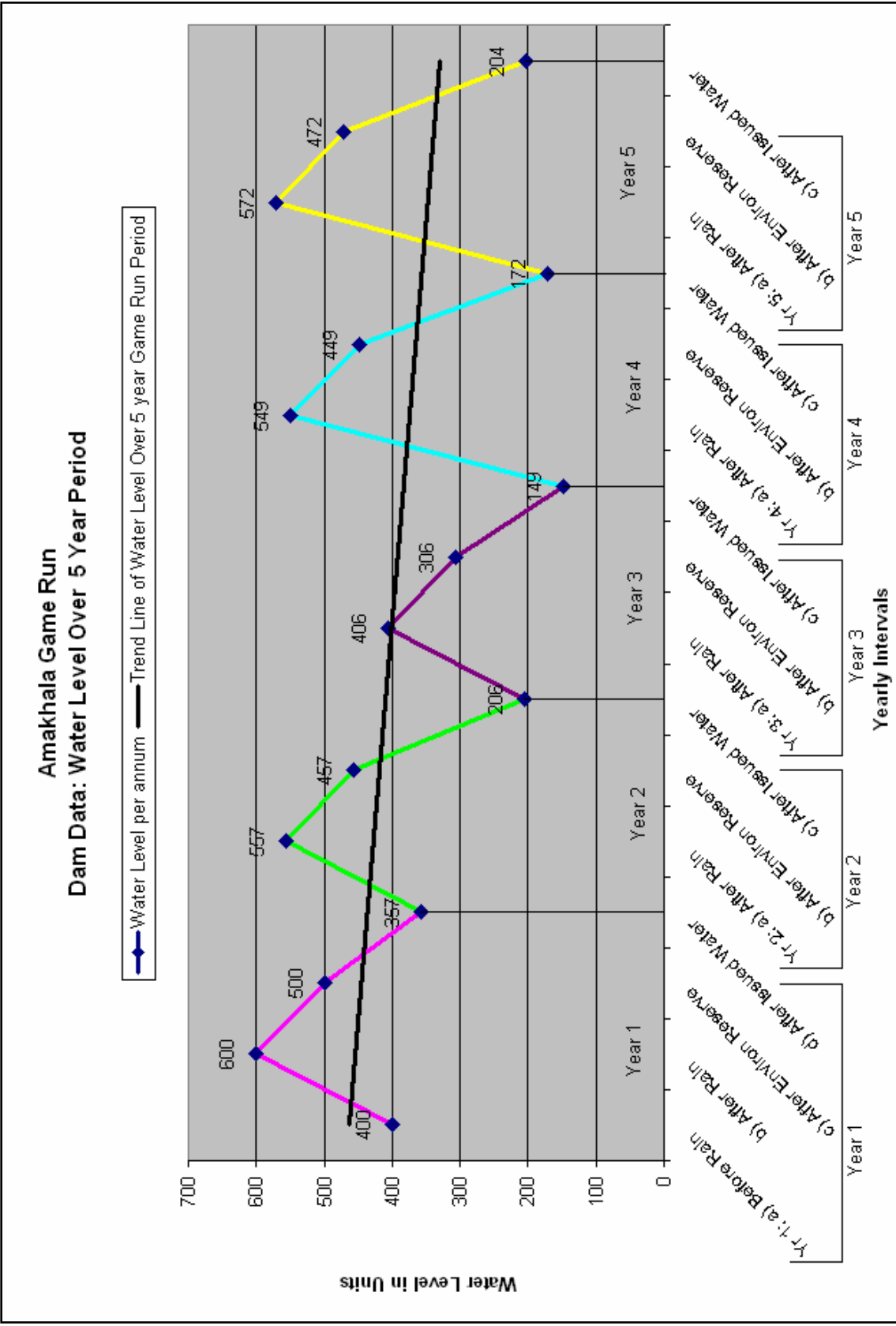
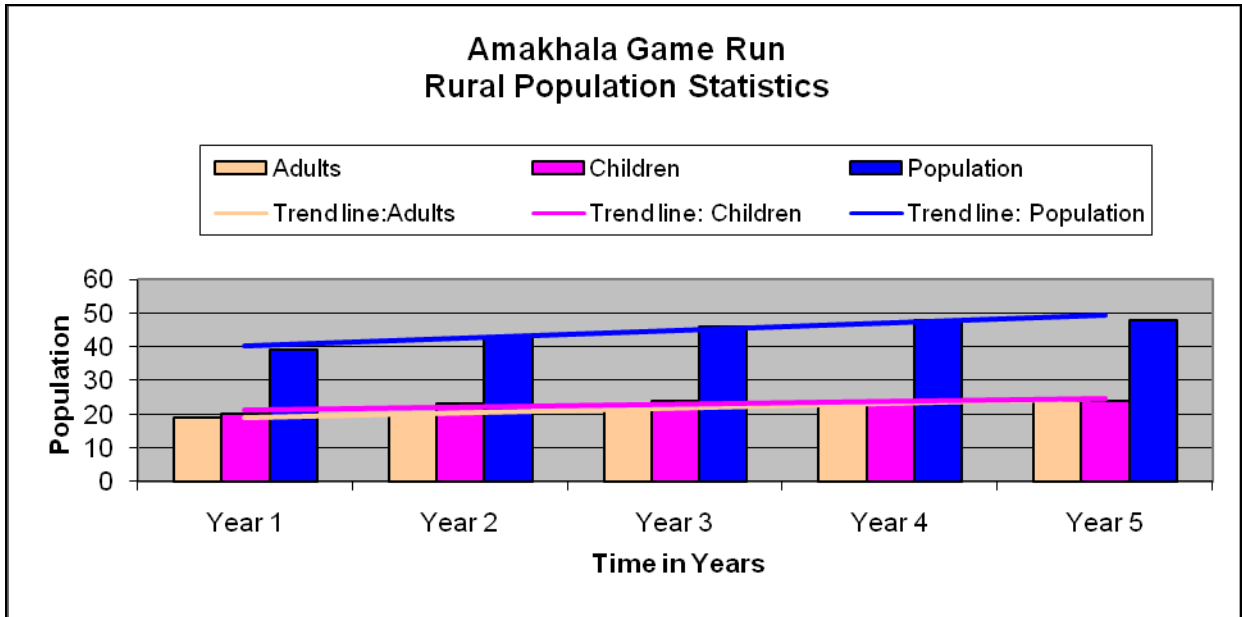


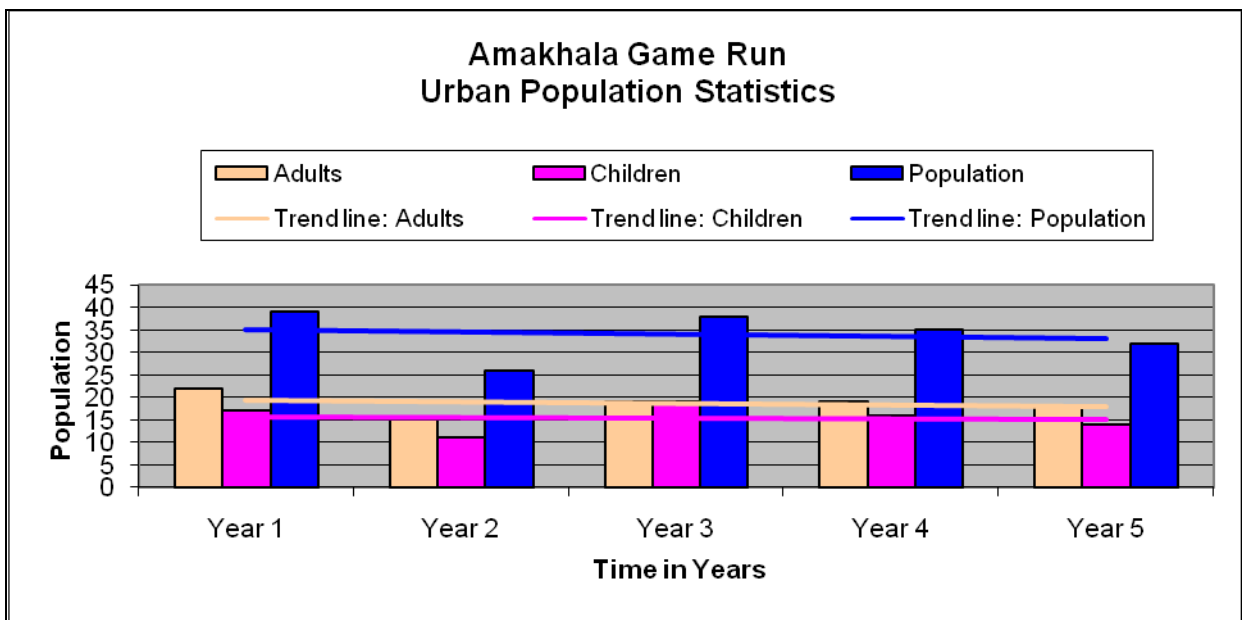
Figure 7.4 – Amakhala Dam Data: Water Levels Over a 5-Year Period

### 7.4.2 Population Statistics

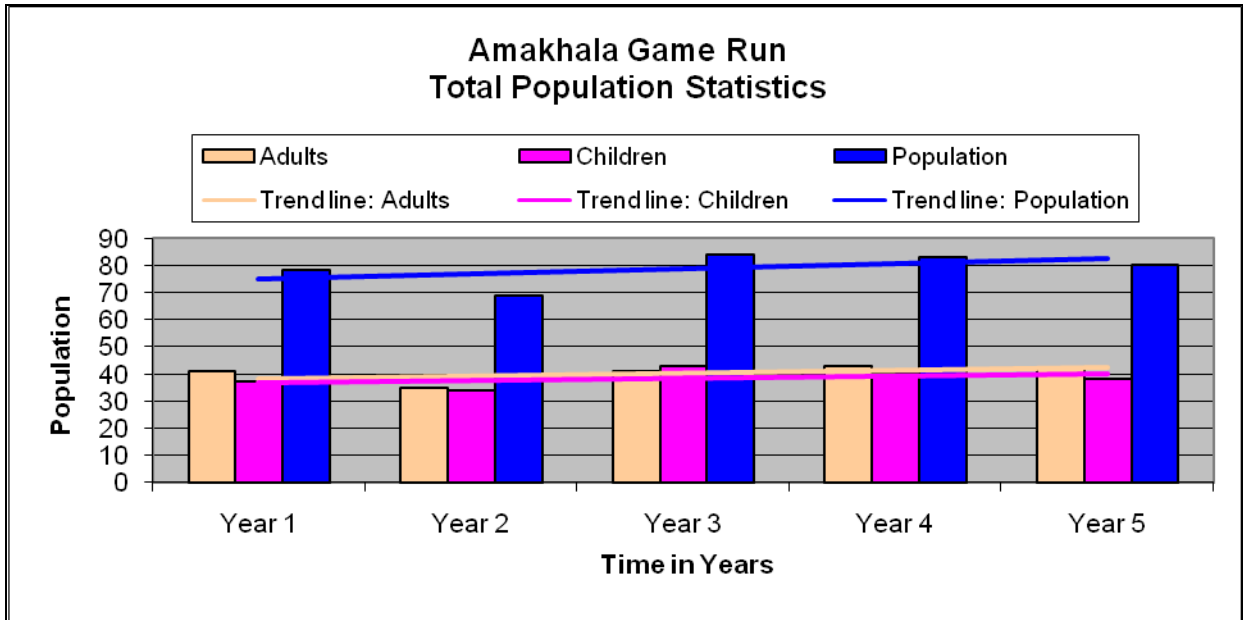
It was possible to group and compare population statistics between both the rural and urban sectors. This is displayed in Figures 7.5 to 7.7.



**Figure 7.5 – Amakhala Game Run: Rural Population Statistics**



**Figure 7.6 – Amakhala Game Run: Urban Population Statistics**



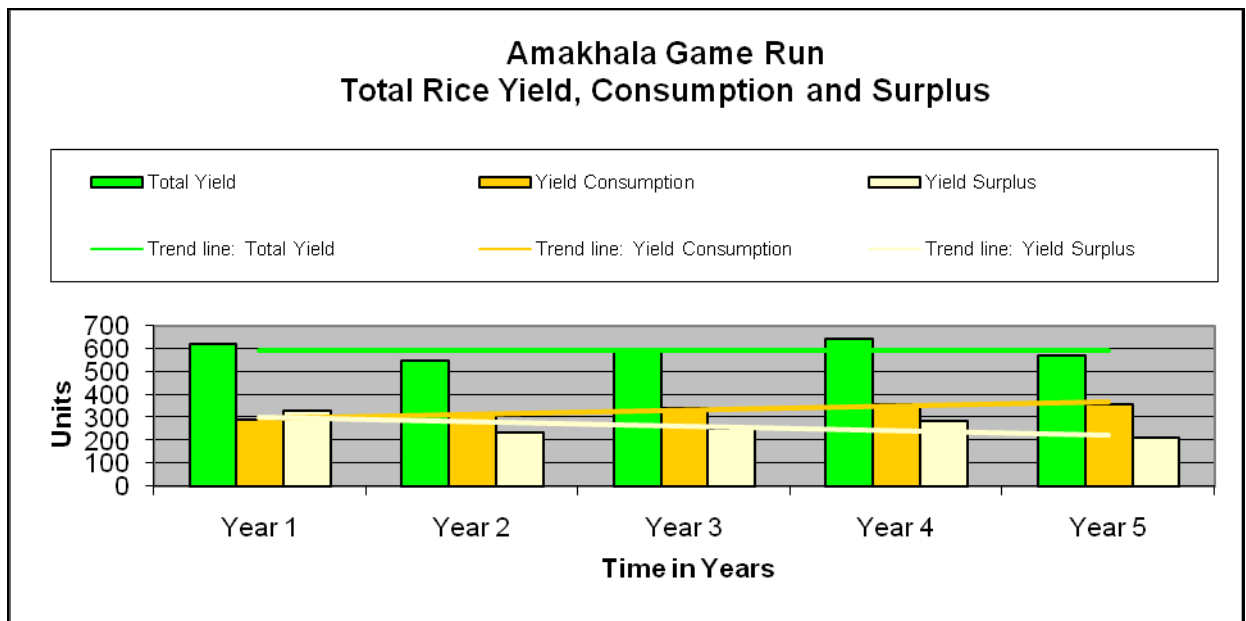
**Figure 7.7 – Amakhala Game Run: Total Population Statistics**

The trend lines show that there was an increase in population in the rural sector while a decline was experienced in the urban sector. This decline cancelled out the rural sector’s rather rapid growth resulting in a minimal increase for the country’s total population, 78 people in Year 1 to 80 people in Year 5. The rural sector’s rapid population growth, 39 people in Year 1 to 48 people in Year 5, together with the dam’s gradual decline in quantity, 400 units in at the beginning of Year 1 and ending with 204 units in Year 5, would have further stressed household and eventually national resources if population growth continued to increase and dam water continued to decrease.

This stress was further exacerbated by government implementing taxes in the second and not the first year. The reason the government was unable to pay back its debts to the banker for the dam construction and funding other develop initiatives was due taxes were not being implemented in the first game year. Players therefore did not budget for tax in the second year which either lead to tax not being paid or to a further limited capacity to buy assets that would increase rural productivity and improve living standards.

### 7.4.3 Productivity

In terms of productivity in the rural sector, displayed in the Figure 7.8, the total rice yield remained fairly constant. However, consumption rates increased as the population increased causing a sharp decline in the yield surplus. This decline affected players, especially commercial and peasant farmers, in terms of their ability to buy assets, i.e. water tanks, in an attempt to raise their annual rice yields.

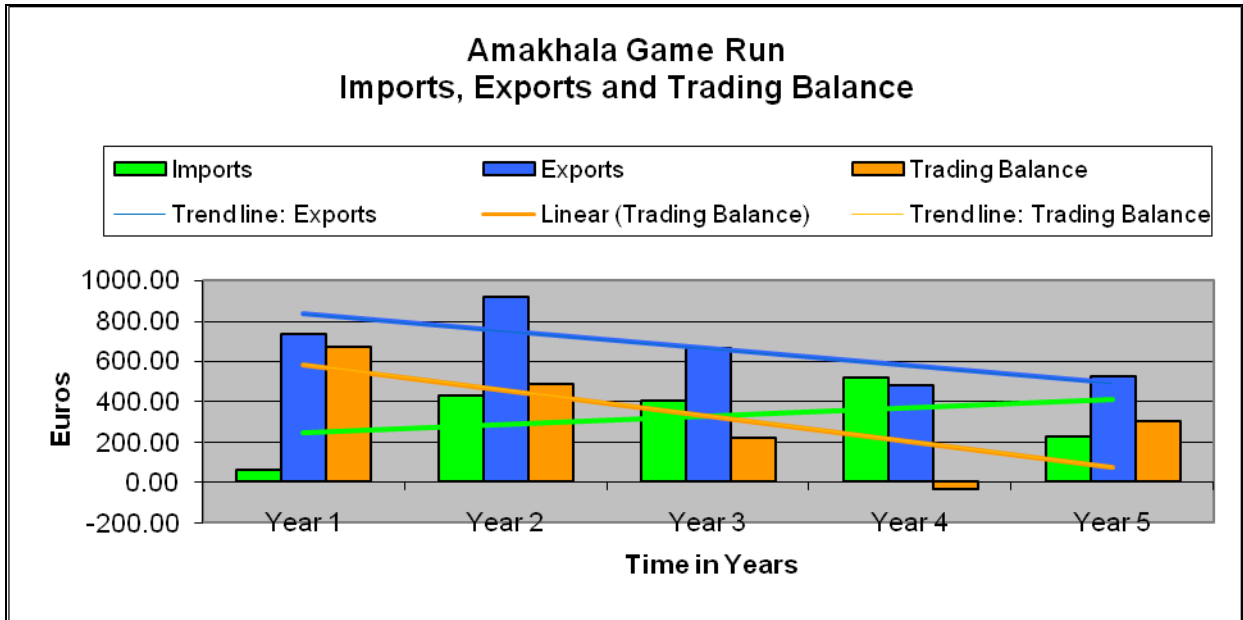


**Figure 7.8 – Amakhala Game Run: Total Rice Yield, Consumption and Surplus**

As for game strategies, law abiding citizens and civil peace was abandoned in the rural sector: theft took place during the negotiation period before the game had started. In addition, in Year 1 a farmer declared his intent to assassinate the president since the tri-presidency was not addressing the theft or the needs of the rural people. A major disagreement broke out between a commercial and peasant farmer, which the president unsuccessfully attempted to resolve. The source of this civil unrest is largely due to limited resources causing man, animal and crop to compete for survival.

During Year 4 and 5 there were six deaths which affected the respective sectors, rural and urban, as they had to produce rice for their funerals. This exacerbated already stressed

resources due to high population numbers in the form of large families and low rainfall that had a negative impact on rice yields. In addition, factories in the urban sector were experiencing numerous and major disruptions as well as complete machine failure causing a decline in productivity. This is reflected in the country's rapidly declining trading balance displayed in Figure 7.9.



**Figure 7.9 – Urban Sector: Imports, Exports and Trading Balance**

The government took action by asking for a 10 minute break in all activities in order to hold an indaba<sup>1</sup> with the people in the rural sector. The aim of this indaba was to address the imminent deaths due to low rice production and high unemployment rates. However, whatever strategies were agreed upon, they were not implemented due to the game ending after Year 5.

<sup>1</sup>Indaba: an isiXhosa word commonly used to refer to meetings that involve large numbers of people.

#### **7.4.4 Conclusion**

In short the game was rather stressful for players due to the limited resources as characterized by Diamond (2005) and Gleditsch (1998) (see section 2.6). This stress was evident in the players' interactions and the extent to which individuals invested themselves emotionally. It was noted by the visiting professor accompanying the

American summer school students that minimal facilitation of topic discussion was required during the focus group debriefing. There was a willingness amongst players to provide their insights and opinions without prompting. This indicates a high level of critical engagement displayed by players in still heated interactions as they unpacked for themselves what had happened during the game run and how players' strategies had affected them negatively or favourably.

#### **7.5 Participants' Learning: Southern African Context**

The following discussion presents the findings of the questions posed in the Pre- and Post- Game Questionnaires.

##### **7.5.1 Question 1: How is water used in a southern African context?**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 17 main themes. (See Appendix C, Table C.1.) In total there were 47 responses of which 20% (12/47) fell under *livestock/farming* theme followed by *industrial/business* with 17% (10/47) of the responses. The participants have thus highlighted the Economic Dimension of the environment as the predominant use of water in a southern African context.

Together the Economic and Social Dimensions received the most responses, 53% (31/47), and themes, 37% (12/47). When comparing the Social and Economic Dimensions, the Social Dimension had the most themes, 47% (8/17), and the Economic Dimension received the highest response rate, 53%.

- **Post -Game Questionnaire: Overview of Participants' Responses**

In total there were 66 responses of which 26% (17/66) fell under *livestock/farming*, followed by *industry/business* with 15% (10/66) of the responses. (See Appendix C, Table C.2.) Together the Economic and Social Dimensions received the most responses and themes: 93% and 76% (13/17) respectively. When comparing the Economic and Social Dimensions, the Economic Dimension received almost 50% of the total themes (8/17 or 47%) and the highest response rate, 67%. It can be concluded that for both the Pre- and Post- Game Questionnaire *livestock/farming*, as part of the Economic Dimension, is the predominant use of water in a southern African context. This is similar to both the Turku and Tammela participants who also highlighted the Economic Dimension in their Pre- and Post- Questionnaires.

### 7.5.2 Question 2: Who controls water?

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into nine main themes under the four environmental dimensions. (See Appendix C, Table C.3.) The participants are of the opinion that either the *local or national government*, as a Political Dimension of the environment, controls water use or that they *do not know* who controls water use in a southern African context. This is indicated by 51% (17/33) falling under *government: local & national*, followed by *I don't know* with 21% (7/33) of the responses.

Together the Political Dimension and Other received the most responses and themes: 69% and 21% respectively. The Political Dimension has the most themes, 63% (5/8), and the highest response rate, 69% (23/33). This is due to the major theme, *government: local & national*, as discussed above, having a significantly higher response rates than any of the other themes.

- **Post- Game Questionnaire: Overview of Participants' Responses**

There was an increase in the number of themes from nine in the Pre- Game Questionnaire to 11 in the Post- Game Questionnaire. In total, there were 34 responses of which 59% (20/34) fell under *government: storage/dam regulation*, followed by *Water Minister* with

nine percent (3/34) of the responses. (See Appendix C, Table C.4.) Both these themes fall under the Political Dimension which received 71% of the responses. This is similar to the Turku and Tammela Game Runs in which participants also highlighted the Political Dimension.

### **7.5.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in a southern African context.**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 17 main themes. (See Appendix C, Table C.5.) In total there were 46 responses of which 26% (12/46) fell under *drought/arid country/water shortages*, making it the most dominant theme followed by *I don't know* with 13% (6/46) of the responses. The participants are of the opinion the Biophysical Dimension of the environment is the main issue or challenge associated with water management in a southern African context. This is similar to the Tammela Game Run which participants highlighted drought as the most dominant issue and challenge in both the Pre- and Post-Game Questionnaires.

Together Biophysical, Social and Other received the most responses: 72% (34/46). When comparing these three dimensions, Biophysical has the highest response rate, 30% (14/46), and although the Social Dimension and Other have the same response rate, 22%, Other has half the number of themes, 12% (2/17).

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 26 main themes and that in total, there were 55 responses. (See Appendix C, Table C.6.) Participants are of the opinion that *price: accessibility & cannot pay* (20% of responses), as an Economic Dimension, and *lack of infrastructure*, as part of the Political Dimension (7% of responses), are the primary problems associated with water management in a southern African context.

When comparing the Economic with the remaining Environmental Dimensions, Economic had 35% (9/26) of the themes followed by Biophysical and Social both of

which had 23% (6/26). This accounts for 81% of the themes. Together Economic (40%) and Biophysical (29%) received the most responses: 69%.

In comparison the Political Dimension received the most responses in the Turku and Tammela Game Runs.

#### **7.5.4 Question 4: Why do you think these issues and challenges have emerged?**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

For this question 29 main themes were identified. (See Appendix C, Table C.7.) In total there were 52 responses of which 13% (17/52) fell under *government mismanagement*, as part of the Political Dimension, making it the most dominant theme followed by *droughts*, as part of the Biophysical Dimension, with 10% (10/52) of the responses. The Political Dimension has the highest response rate, 37%, as well as the highest number of themes, 43% (10/29). Interestingly, although *droughts* received the second highest response rate, the Dimension under which it falls, Biophysical, did not receive the second but the third highest response rate.

- **Post- Game Questionnaire: Overview of Participants' Responses**

In comparison to the Pre-Game Questionnaire, the number of main themes identified in the Post-Game Questionnaire were less (22). (See Appendix C, Table C.8.) In total there were 45 responses of which 16% (7/45), the majority, fell under *weather conditions: droughts, rain equals pests*, as a Biophysical Dimension. This was followed by *national control difficult: large population & limited resources*, as a Political Dimension, with nine percent (4/45) of the responses. The Political Dimension received the highest response rate, 47%, followed by Economic with 27% and Biophysical with 16%. Together this makes up 90% of the responses and accounts for more than two thirds (40%) of the themes. The conclusion is that for both the Pre- and Post- Game Questionnaire *droughts*, as a Biophysical Dimension, emerged as the major cause for concern. This would be in keeping with the participants game experience rainfall was at its lowest during the first three years resulting in drought related conditions. Similarly,

the Turku and Tammela participants also highlighted climatic dependency as a dominant issues and challenge.

The following questions were only posed in the Post-Game Questionnaire.

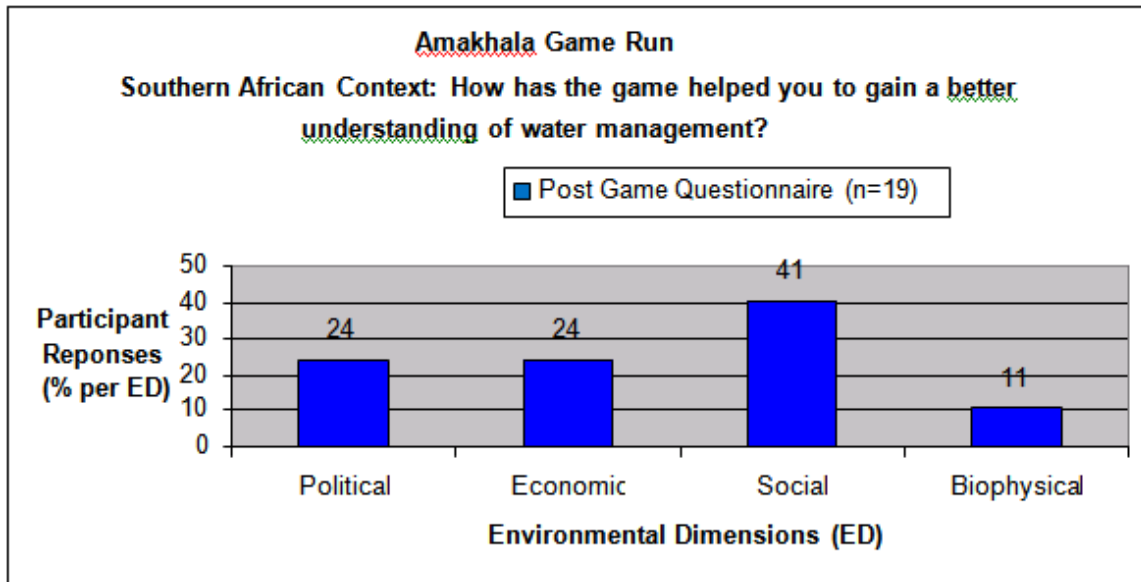
**7.5.5 Question 5: How has the game helped you to gain a better understanding of water management in a southern African context?**

- **Post- Game Questionnaire: Overview of Participants' Responses**

For this question the participants' responses were grouped into 18 main themes. (See Appendix C, Table C.9.) In total there were 37 responses of which 32% fell under *how desperate & dependent people were on water, especially farmers* (16%). This makes it the most dominant theme followed by *water as a resource is a necessity & limited* (16%). These two themes are followed by *Prices* and *difficulty obtaining & storing water* with a response rate of 8% each. Together, these top four themes account for almost half of the response rates (48%).

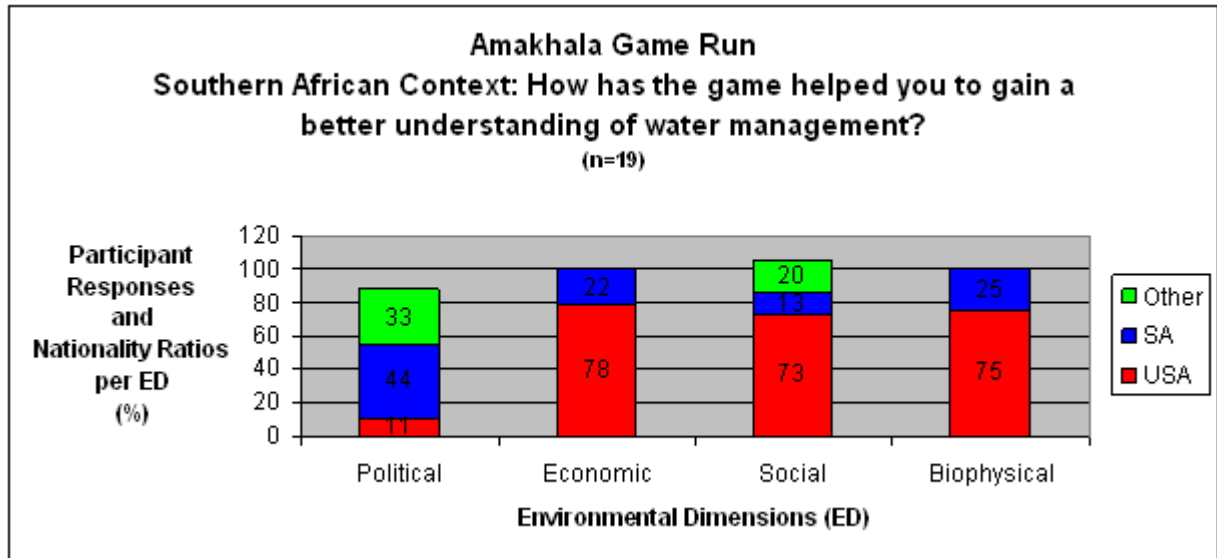
The response rates of the Environmental Dimensions and Other are compared and displayed in Figure 7.10 as percentages.

It is evident that the Social Dimension received the most responses, 41%. This is followed by the Political and Social Dimensions, each with 24% of the response. Of interest is that the Social Dimension received the highest responses, especially when one considers that the ACG is based on experiential learning. Experiential learning is rooted in social constructivism which claims that meaning is constructed in a social context.



**Figure 7.10 – Amakhala Post Game Questionnaire : Participant Responses per Environmental Dimension**

Figure 7.11 shows the nationality ratios per environmental dimension. Since the USA, and SA participants account for more than two thirds of the total participant nationalities (USA 38% and SA 29% respectively), the remaining seven participants were grouped together as Other. Figure 7.18 shows that the SA participants, 44%, as well as the rest of the nationalities grouped under Other, 33%, gained a better understanding of the political aspects associated with water management. In comparison, the USA participants gained a better understanding of the economic aspects, 78%, associated with water management. This is followed by biophysical and social aspects.



**Figure 7.11 – Amakhala Game Run: Nationality Ratios Per Environmental Dimension**

One can thus infer that after playing the ACG, the participants gained a better understanding of the Social Dimensions associated with water management in a southern African context since it received the highest response. However, when looking at the specific nationality ratio per environmental dimension, the SA and Other participants gained a better understanding of political aspects while USA participants gained a better understanding of economic aspects. Similarly, both Turku (section 5.5.5) and Tammela (section 6.5.5) participants gained a better understanding of political aspects.

### **7.6 Participants’ Learning: Their Own Context**

The section follows the same structure as the southern African context. However, as mentioned in the previous chapters, three additional questions were posed in the Post-Game Questionnaire for this context. They are examined later in sections 7.6.5, 7.6.6 and 7.6.7.

### **7.6.1 Question 1: How is water used in your local environment?**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 11 main themes. (See Appendix C, Table C.10.) In total there were 77 responses of which the largest percentage, 27% (21/77) fell under *domestic* followed by *industry* with 23% (10/77) of the responses.

The Economic Dimension received more than half of the responses, 57%, as well as more than half of the themes, 55% (6/11). This is followed by the Social Dimension with over a third of the responses, 38%, and just under a third of the themes, 27%.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were also grouped into 11 main themes in the Post-Game Questionnaire. (See Appendix C, Table C.11.) In total there were 43 responses of which 37% (16/43) fell under *domestic*, as part of the Social Dimension, followed by *recreational: personal*, as part of the Social Dimension, with 14% of the responses and *agriculture*, as part of the Economic Dimension, with 12%. As the Social Dimension received the most responses, 60%, one can conclude that it is viewed as the dominant means of water use in the participants' local environment. Similarly, the Turku Participants highlighted the Social Dimension while the Economic Dimension received the most responses in the Tammela Pre- and Post- Questionnaires.

### **7.6.2 Question 2: Who controls water?**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 14 main themes. (See Appendix C, Table C.12.) In total there were 52 responses of which 33% (17/52) fell under *Government*, making it the dominant theme followed by *Municipality/City Council* with 17% (9/52) of the responses. Together these two themes received more than one third of the responses, 40%.

The Political Dimension received the most responses and themes: 69% and 50% respectively. This is followed by the Social Dimension with only 15% of the responses and 20% of the themes, resulting in a difference of 54% and 30% respectively.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into nine main themes. (See Appendix C, Table C.13.) In total there were 24 responses of which 42% (10/24) fell under *Government: local*, making it the most dominant theme followed by *private water & purification* and *I don't know* making up 13% (3/24) of the responses.

*Government*, as a Political Dimension, received the most responses in the Pre- and Post-Questionnaires. Similarly, both the Turku and Tammela participants highlighted *government*, as a Political Dimension, in the respective Turku and Tammela Pre- and Post- Questionnaires.

### **7.6.3 Question 3: Please identify and explain what issues and challenges, if any, are associated with water management in your local context.**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 15 main themes. (See Appendix C, Table C.14.) In total there were 57 responses of which 19% (11/57) fell under *water quality*, making it the most dominant theme followed by *not conserving water*, *limited water supply*, and *low rainfall/droughts* with 12% (7/57) of the responses each. Together these top four themes make up almost two thirds of the response rate: 60%. This infers that the participants are of the opinion that *Water quality* and *not conserving water*, as part of the Social Dimension, and *limited water supply* and *low rainfall/droughts*, as part of the Biophysical Dimension, are the main issues or challenges associated with water management in their local environment.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 19 main themes. (See Appendix C, Table C.15.) In total there were 37 responses of which 24% (9/37) fell under *issues when people can't afford water*, making it the most dominant theme, followed by *government advising people to limit use, lack of conservation &/or waste water*, and *none* with 8% (3/37) each. In comparison to the other game runs, for both the Pre- and Post Questionnaires, Tammela and Turku participants have highlighted either quality and/or maintenance.

When comparing the Environmental Dimensions, Political had 47% (9/19) of the themes followed by the Social Dimension with 21% (4/19). Together this accounts for 68% of the themes. Interestingly, Economic has the highest response rate but the lowest number of themes together with Other and Biophysical: a mere 11% each.

#### **7.6.4 Question 4: Why do you think these issues and challenges have emerged?**

- **Pre- Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 14 main themes. (See Appendix C, Table C.16.) In total there were 44 responses of which 20% (9/44) fell under *incompetent municipality*, making it the most dominant theme followed by *ignorance* and *low rainfalls* with 14% (6/44) of the responses each.

Together the dimensions with the most responses received, namely the Social Dimension with 32%, the Political Dimension with 27% and the Biophysical Dimension with 20%, account for 77% of total responses.

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 29 main themes. (See Appendix C, Table C.17.) In total there were 22 responses of which 14% (4/23) fell under *attitude: entitled to water thus its infinite*, as part of the Social Dimension. This is the most dominant theme,

followed by *environmental problems*, with 10% of the responses, and *droughts*, with 7%, both of which are part of the Biophysical Dimension.

Of interest is that the Political Dimension received the highest response rates in the Post-Game Questionnaire for this question in each of the three game runs.

### **7.6.5 Question 5: How has the game helped you to gain a better understanding of water management?**

Question 5, together with Questions 6 and 7, were only posed in the Post-Game Questionnaire.

- **Post-Game Questionnaire: Overview of Participants' Responses**

The participants' responses were grouped into 16 main themes. (See Appendix C, Table C.18.) In total there were 25 responses of which 20% (5/25) fell under *gained appreciation: problems in ACG are not an issue in my environment, so it did not really change my understanding of my own environment since its so different* making it the most dominant theme. This is followed by *importance of government in managing water supply*, with 12% of the responses, as well as *considered survival & impact of price increases without subsidies & droughts* and *realised how valuable water is: finite resource* each with eight percent of the response rate.

In comparison to the Turku and Tammela Game Runs, participants in all three game runs gained a better understanding of water's role as a valuable resource.

### **7.6.6 Question 6: Do you think that you would be able to use insights from your game experience and if yes where?**

- **Post- Game Questionnaire: Overview of Participants' Responses**

The participants' responses grouped into 23 main themes. (See Appendix C, Table C.19.) In total there were 27 responses of which 14% (4/23) fell under *ways & need to conserve water: sustainability*, making it the most dominant theme followed by *shows complexities of running a country and business in the real world* and *advise own family on water use* with 7% (2/23) of the responses each. The dimensions under which these themes are categorised, namely the Political, Economical and Social Dimensions respectively, provide an indication of the areas in which the participants think that they would be able to use insights from their game experience.

### **7.6.7 Question 7: Now that you have played the ACG and discussed it as a group, do you have any recommendations for changes or improvements?**

- **Post- Game Questionnaire: Overview of Participants' Responses**

Table 7.1 shows the participants' responses grouped into 20 main themes. Since the question called for recommendations, it was decided to group these themes under the following five categories:

- *Game Rules,*
- *No Changes,*
- *Keep following in mind,*
- *Simulator Rules,* and
- *Imported Rules,*

In total there were 29 responses of which 21% fell under *no changes or improvements*, followed by *more time* with 14% of the responses and *shorter game* with 7% of the responses. The remaining 17 themes received the lowest response rates, 1 or 3% each, which together account for half of the responses: 51% (3% x 17 responses).

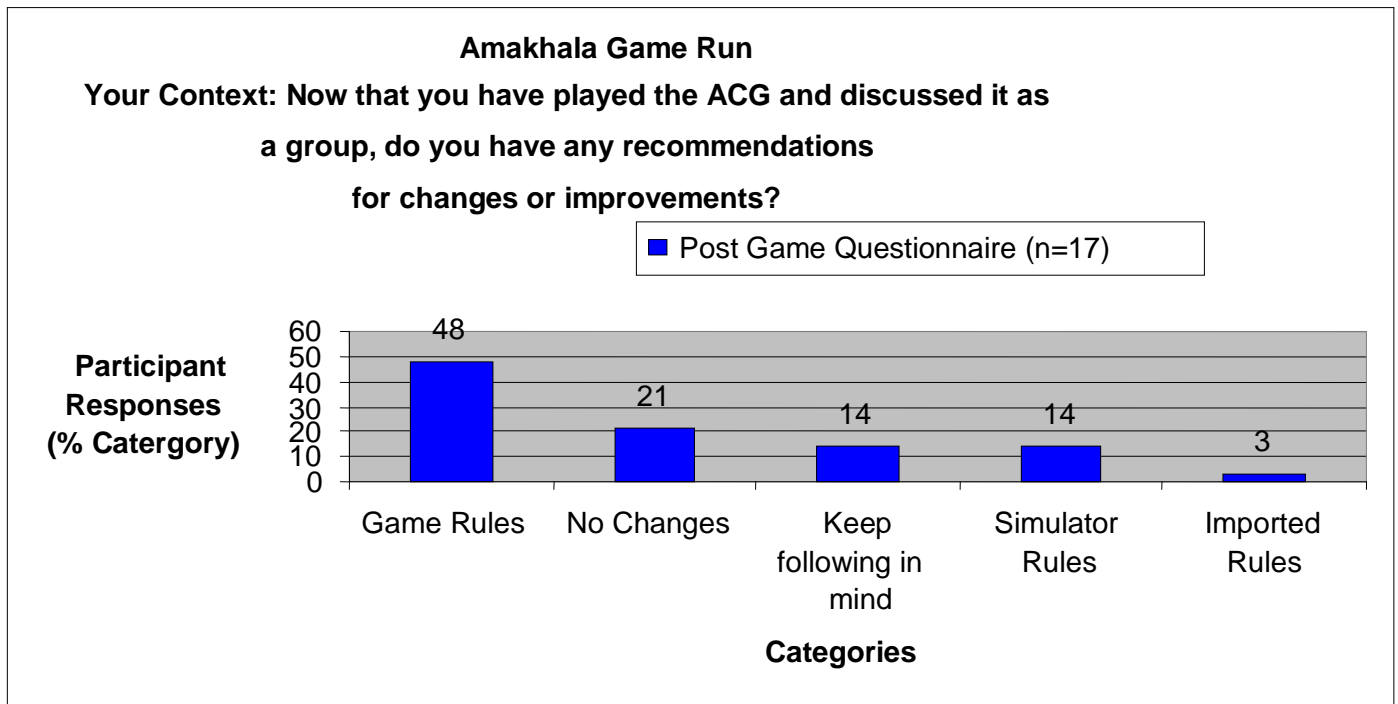
**Table 7.1 – Amakhala Post- Game Questionnaire: Now that you have played the ACG and discussed it as a group do you have any recommendations for changes or improvements?**

<b>Themes</b>	<b>Responses</b>	<b>% (n=17)</b>
<b>Game Rules</b>		
More time	4	14
Shorter game	2	7
Whistle to signal start & end of game & each year	1	3
15-20 minutes to strategise	1	3
Have practice year	1	3
Hour practice session	1	3
More time per cycle/btw cycles so people can gather thoughts	1	3
Pre-game or 1/2 yrs	1	3
Time for government, farmers & industrial sectors to review changes impacting outcome: not realistic	1	3
More years	1	3
<b>SUB-TOTALS: 10</b>	<b>14</b>	<b>48</b>
<b>Recommendations</b>		
No changes or improvements	6	21
<b>SUB-TOTALS: 1</b>	<b>6</b>	<b>21</b>
<b>Keep following in mind when changing aspects</b>		
Irrigation systems for poor are NB	1	3
Nationalisation of industry & bank effective	1	3
Needs determined thru community engagement	1	3
People know more due to family knowledge	1	3
<b>SUB-TOTALS: 4</b>	<b>4</b>	<b>14</b>
<b>Simulator Rules</b>		
Allow children to attend school, then they can work outside rural section	1	3
Bring in other sources: mineral extraction, tourism	1	3
Bulletin	1	3
Factoring in more "African issues, e.g. HIV/AIDs, political issues	1	3
<b>SUB-TOTALS: 4</b>	<b>4</b>	<b>14</b>
<b>Imported Rules</b>		
Carefully select roles based on work experience	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>20</b>	<b>29</b>	<b>100</b>

Since the question called for recommendations, as mentioned above, it was decided to group the themes under the following five categories:

- Game Rules,
- No Changes,
- Keep following in mind,
- Simulator Rules, and
- Imported Rules.

These themes are compared in Figure 7.12.



**Figure 7.12 - Now that you have played the ACG and discussed it as a group do you have any recommendations for changes or improvements?**

Game Rules and No Changes, two of the categories under which the themes are categorised, have the highest response rates, 48% and 21% each, which accounts for more than two thirds of the response rate: 69%.

Since the category, Game Rules, received the highest response rate, it is necessary to consider implementing the themes that fall under it. All of the ten themes focus on time in one of two ways: either to increase or to decrease it. Table 7.2 lists these themes and whether or not it is possible to implement the suggested game rules:

**Table 7.2 – Amakhala Game Run: Implementing Suggested Game Rules**

Time: Increase	Responses	Is it possible to implement these suggested game rules?	
		Yes or No	Why or why not?
More time	4, 14%	No	Not possible since 1 year = 1 hour, thus 6 years = 6 hours plus another 2 hours for debriefing and packing up. Need x amount of hours for players' decisions to be realised in the game
More Years	1, 3%	Yes	Possible, but then 1 year = less than 1 hour
15-20mins to strategise	1, 3%	Yes	This time is already provided
Pre game of 1 or 2 years	1, 3%	Yes	Possible when playing the game once with a group of participants. Would mean that 1 year = less than 1 hour
Have a practice year	1, 3%	Yes	Possible when playing the game once with a group of participants. Would mean that 1 year = less than 1 hour
Hour practice session	1, 3%	Yes	Possible when playing the game once with a group of participants. Would mean that 1 year = less than 1 hour
More time per cycle or between cycles so people can gather their thoughts	1, 3%	No	More time per cycle or between cycles not possible due to needing x years for players' decisions to be realized
Time for government, farmers & industrial sectors to review changes impacting outcome: not realistic	1, 3%	No	Not possible since its not realistic
Whistle to signal start & end of game & each year	1, 3%	Yes	Will be incorporated into the game rules
<b>Time: Decrease</b>			
Shorter game	2, 7%	No	Not possible since x amount of years/hours are needed for players' decisions to be realised in the game

One can therefore infer that after playing the ACG, participants felt that additional game time was the major change or improvement to be considered. It was decided to implement six of the suggested game rules.

### **7.7 Summary of Three Game Runs: Dominant Themes and Dimensions**

Table 7.3 provides a summary of the dominant themes and dimensions that participants highlighted for each question. In the following chapter these responses are viewed collectively, i.e. the responses from each game run are combined under each question. The Chi-Square Test is applied to each question in order to establish which ones are statistically significant. The most statistically significant questions are then analysed further to understand what participants had gained from their game experience.

**Table 7.3 – Summary of Three Game Runs: Dominant Patterns and Trends**

No.	Questions	Southern African Context	Participants Own Context
1	Please explain how water is used in your local environment?	Participants from all three game runs highlighted the Economic Dimension in their Pre- and Post-Game Questionnaires	The Turku and Amakhala participants highlighted the Social Dimension while the Economic Dimension received the most responses in the Tammela Pre- and Post-Questionnaires.
2	Please explain who controls water use?	Participants from all three game runs highlighted the Political Dimension in their respective Pre- and Post-Game Questionnaires	Participants from all three game runs highlighted <i>government</i> , as a Political Dimension, in their respective Pre- and Post- Questionnaires.
3	Please identify and explain what issues and challenges, if any, are associated with water management in your own environment.	The Political Dimension received the most responses in the Post-Game Questionnaires for the Turku and Tammela Game Runs while the Economic Dimension was highlighted in the Amakhala Post-Game Questionnaire.	For both the Pre- and Post Questionnaires, Turku, Tammela and Amakhala participants have highlighted either quality, maintenance and/or affordability issues and challenges.
4	Why do you think these issues and challenges have emerged?	Participants from all three game runs highlighted climatic dependency as a dominant issue and challenge.	Political Dimension received the highest response rates in the Post-Game Questionnaire for this question in each of the three game runs.
5	In your own words please explain how the game has or has not helped you to gain a better understanding of water management in a southern African context.	Most of the participants highlighted a better understanding of the political aspects associated with water management in a southern African context.	Participants in all three game runs gained a better understanding of water's role as a valuable resource.
6	Do you think that you would be able to use insights gained from your game?	Question not posed under Southern African context.	Turku participants highlighted research and training while the Tammela participants needed more time to consider the use of their insights but were sure that it would be used, and the Amakhala participants highlighted the need for both conservation and sustainability.
7	Now that you have played the game and discussed it as a group do you have any recommendations or improvements?	Question not posed under Southern African context.	Participants from all three game runs recommended to change or modify the game rules.

## **7.8 Reflecting on Modifications Implemented**

A starting dam level of 400 units and the provision of water pumps to commercial farmers were successfully implemented in this game run. Water levels were low enough to cause stress on water dependent and related activities and resources but not enough to result in a complete shut down. This stress was evident in the players' interactions with one another as well as during focus group debriefing.

## **7.9 Conclusion**

This chapter analysed the data generated in the Amakhala Game Run with regard to the ACG simulation. The participants were described as well as the changes and modifications made to the ACG and implemented in this game run. In addition, the findings of each question posed in the Pre- and Post- Questionnaires as well as a summary of the dominant themes and dimensions across the three game runs were presented. The following chapter identifies and provides a deeper analysis of the most statistically significant questions posed in these questionnaires.

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## CHAPTER EIGHT

### COMPARATIVE ANALYSIS OF THREE GAME RUNS

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#### **8.1 Chi-Square Test: Analysis and Findings**

In chapters 4, 5, 6 and 7 each game run was discussed and examined. The objective was to develop the ACG and to understand what, if any learning had taken place within each game run, namely the Assegai Trial, Turku, Tammela, and Amakhala Game Runs. This analysis satisfies Objective 5 by mapping the participants' development of understanding resulting from playing the modified ACG. The aim of this research is to evaluate the impact of the game and the effectiveness of the simulation.

This chapter analyses the data collected during the three game runs when viewed collectively. The analysis aims to illuminate patterns and trends of the learning enabled through the ACG. In order to do this the most statistically significant questions were first identified by applying the Chi-Square Test.

The response rates from each game run, Turku, Tammela and Amakhala were added together for each question posed in the Pre- and Post- Questionnaires. An example is provided in Table 8.1 and Appendix D.1 contains the summary of these calculations. Participants' responses were re-analysed and values were modified accordingly. The values in brackets are therefore the original values.

Data was combined for certain themes in order to meet the minimum requirement of five observations in each category. The Chi-Square Test was applied to each of these questions to determine if there was any statistical significance to different response rates before and after playing the game. For in depth calculations please see Appendix D.2. The results of the Chi-Square Test are displayed in Table 8.2 which ranks the results from most to least significant.

**Table 8.1 – Example: Sum of response rates for Question 1: Southern Africa**

Question 1: Southern African Context				
Political	Economic	Social	Biophysical	Other
21 (23)	56	20	6 (4)	11
8	109 (114)	48 (49)	7	9 (3)

**Table 8.2 – Questions ranked according to the Chi-Square Test Results**

(Questions alphabetically ranked for easy reference and differentiation)

Ranking	Context	Questions	Chi-Square Values		Degrees of Freedom	No. of Dimensions
A.	Your	1: How is water used in your local environment?	35.67	> 0.001	4	5
B.	Southern Africa	3: Please identify and explain what issues and challenges, if any, are associated with water management.	25.21	> 0.001	4	5
C.	Southern Africa	1: How is water used in a southern African context?	20.5	> 0.001	3	4
D.	Southern Africa	2: Who controls water?	15.89	> 0.001	3	4
E.	Your	3: Please identify and explain what issues and challenges, if any, are associated with water management.	12.84	> 0.005	3	4
F.	Southern Africa	4: Why do you think these issues & challenges have emerged?	10.17	> 0.025	3	4
G.	Your	4: Why do you think these issues & challenges have emerged?	10.17	> 0.025	3	4
H.	Your	2: Who controls water?	0.91	< 0.1	3	4

Table 8.2 shows that the most statistically significant answers were A through to D with probabilities of more than 0.001. This indicates that the pattern of responses to these questions in particular is very unlikely to be due to chance factors. Since the answers for A to D are the most statistically significant, it was necessary to evaluate the participants' responses to understand what participants had gained from the exercise. This is done in the following section.

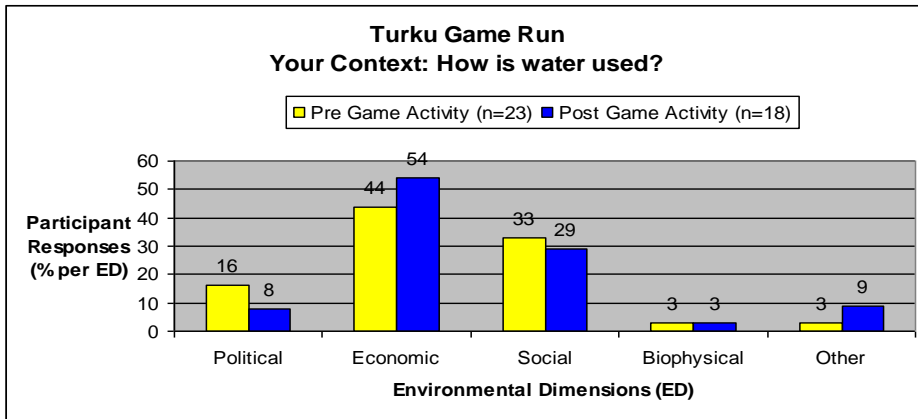
## **8.2 Analysis of the Most Statistically Significant Questions**

The following analysis looked at three sources of data from each of the three game runs in order to understand what participants had gained from their game experience:

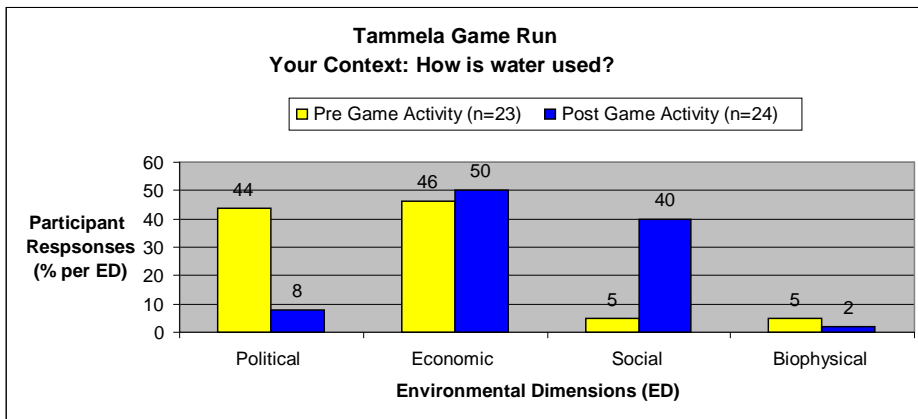
- 1) Changes in the participants' themes categorised into the environmental dimensions,
- 2) The similarities and differences between Pre- and Post- Game themes, and
- 3) The annotated environmental dimensions from the focus group debriefing.

### **8.2.1 Your Context, Question 1: How is water used in your environment?**

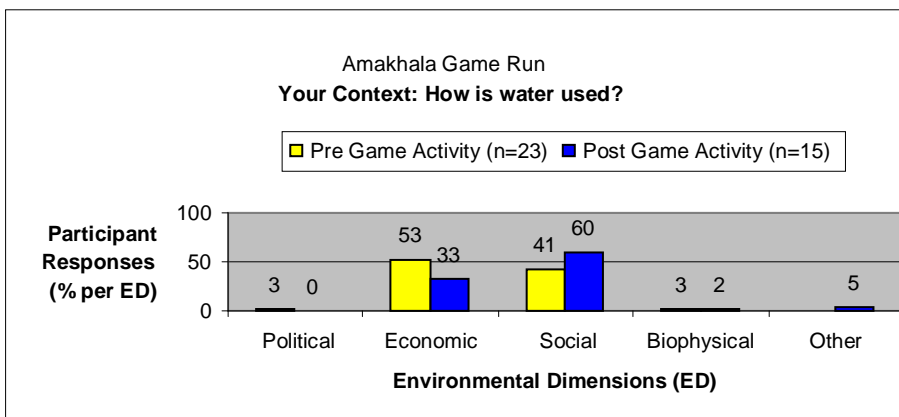
Figures 8.1 to 8.3 show the total response rates per environmental dimension. The Economic Dimension received the highest response rates in both the Pre- and Post- Game Questionnaire for the Turku (Figure 8.1) and Tammela (Figure 8.2) Game Runs. The Social Dimension received the highest responses rates, followed by the Economic Dimension in the Amakhala Game Run, see Figure 8.3. The Social Dimension received the highest response rate in the Turku Game Run while in the Tammela Game Run, its post- game responses increased by 35%. It is evident that the pre- and post- game responses show that in all three games the participants identified the Economic and Social Dimensions as playing a significant role in water use in their own environment.



**Figure 8.1 – Turku Game Run : Comparison of Pre- and Post- Environmental Dimensions**



**Figure 8.2 – Tammela Game Run: Comparison of Pre- and Post- Game Environmental Dimensions**



**Figure 8.3 – Amakhala Game Run: Comparison of Pre- and Post- Game Environmental Dimensions**

The Pre- and Post- Game themes for each game run were also compared for Question 1. Figures 8.4 to 8.6 show the similar and different themes for each game run. The repeated themes appear in the middle column under similarities while the unrepeated themes appear of the left, Pre- Game themes, and right, Post- Game themes.

Comparison of Figure 8.4 with Figures 8.5 and 8.6 shows that there were far more repeated themes in the Turku Game Run (11) than the Tammela (six) and Amakhala (six) Game Runs. These themes included a focus on the liberal use of water as well as for industrial, agricultural, domestic and recreational purposes.

The Turku and Amakhala Game Runs both had five Pre- Game themes that included a focus on geographical location as a determinant for water use. The Tammela Game Run had seven Pre- Game themes that focused on the common knowledge that while water was cheap, available and run by water companies in urban areas, the countryside experiences water shortages.

It is evident that while the Economic and Social Dimensions received the most responses in both the Pre- and Post- Game Questionnaires, the focus of the themes changed after participants had played the ACG. The Turku and Tammela Game Runs both had Post-Game themes that included acknowledgement of taking water for granted in the past and expressed a renewed sense of appreciation for well managed and available water. The Turku participants had thus shifted from geographical location as a determinant for water use to being appreciative of water that was well managed and available while the Tammela participants had shifted from knowing that water was cheap and available to admitting that these aspects had been taken for granted and would more appreciative thereof. The Amakhala Game Run also had five Post- Game themes but here they looked beyond participants' immediate environment and described the dominant types of water use as well as its availability.

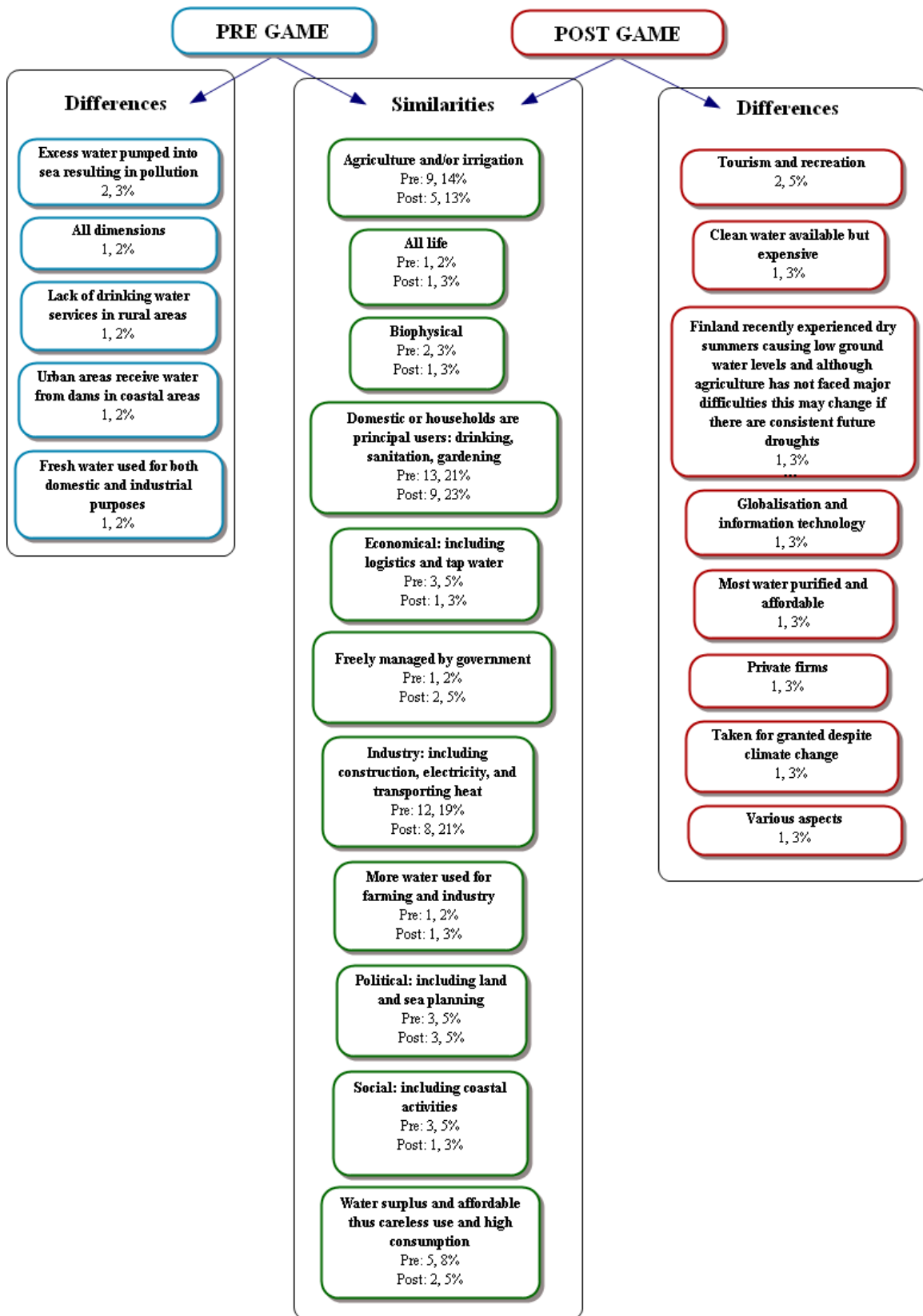


Figure 8.4 – Turku Game Run: Comparison of Pre- and Post- Game Themes

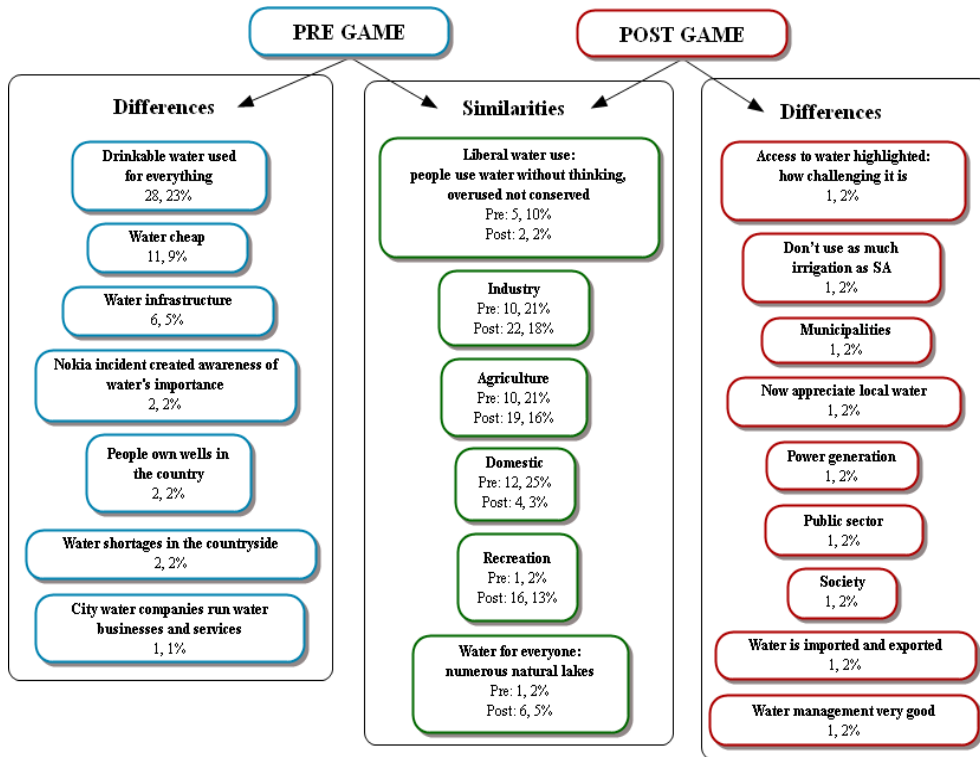


Figure 8.5 – Tammela Game Run: Comparison of Pre- and Post- Game Themes

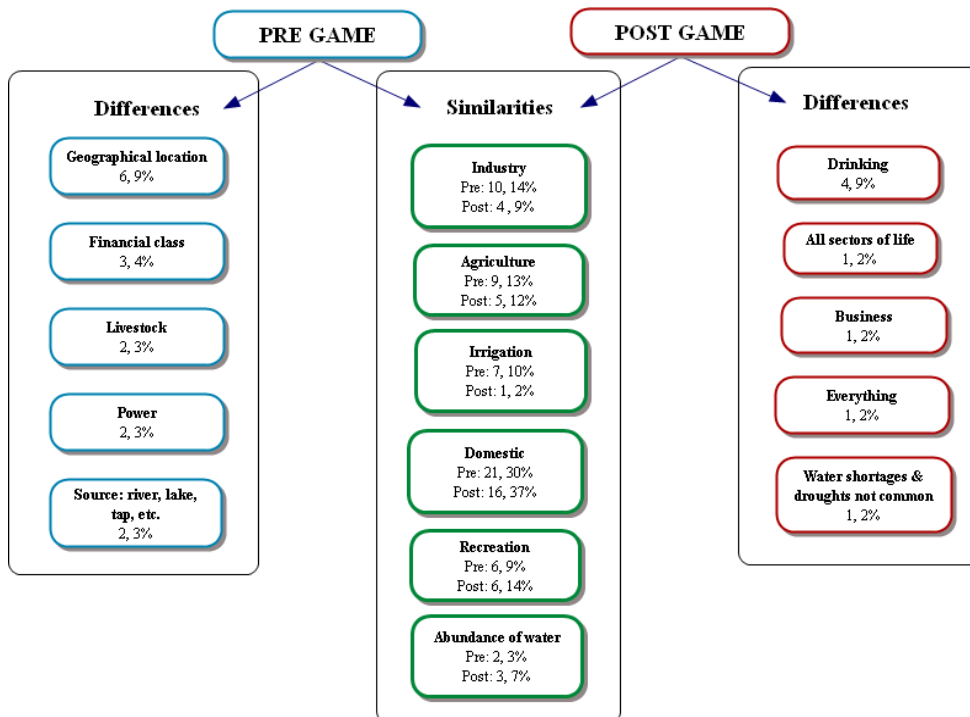
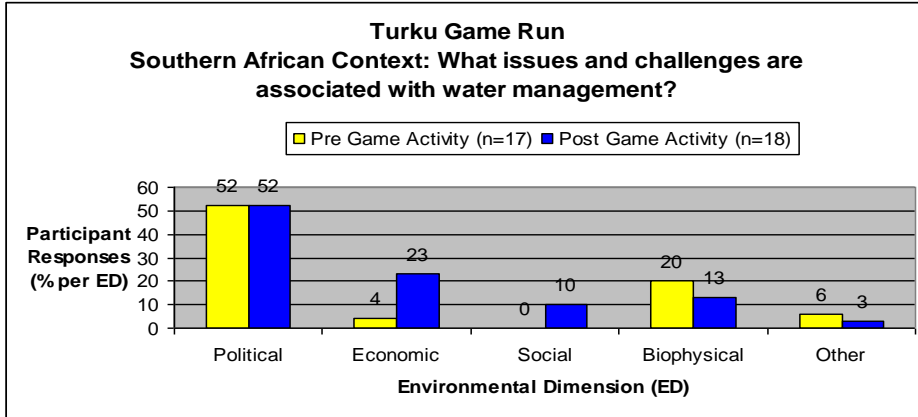


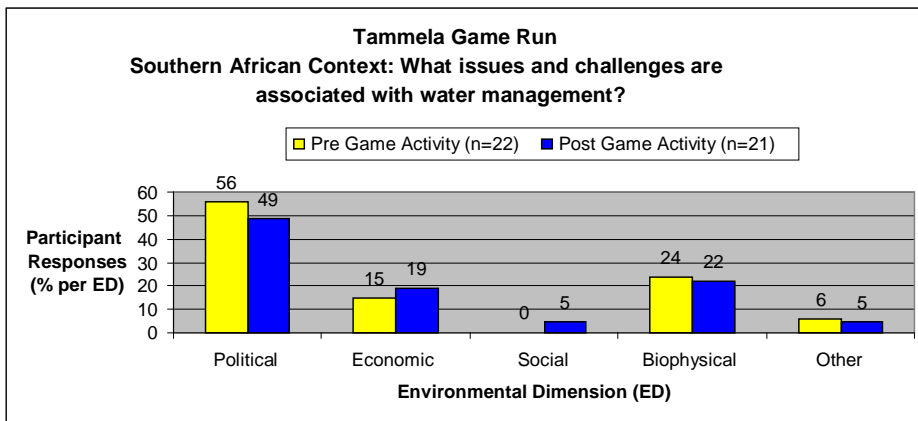
Figure 8.6 – Amakhala Game Run: Comparison of Pre- and Post- Game Themes

**8.2.2 Southern African Context, Question 3: Please identify and explain what issues and challenges, if any, are associated with water management.**

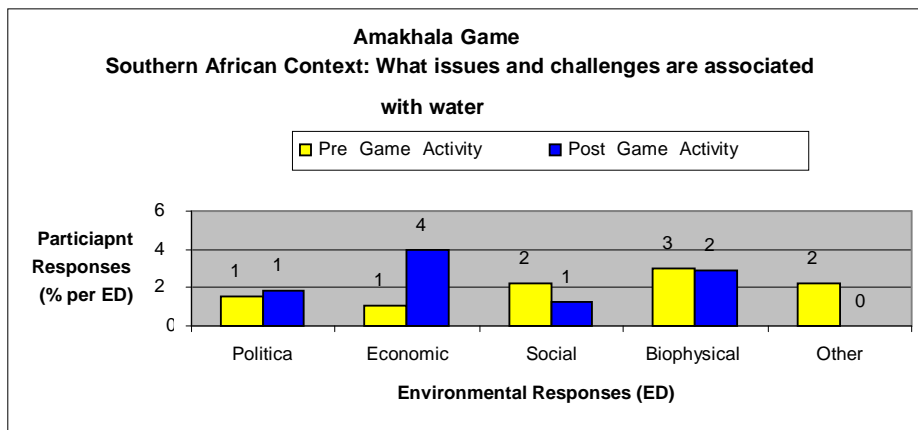
The second most significant question was related to issues and challenges in the southern African context. What Figures 8.7 and 8.8 show is that for both the Turku and Tammela Game Runs the Political Dimension, as opposed to the Economic Dimension for the previous question, received the highest response rates in the Pre- and Post- Game Questionnaires. This was followed by the Biophysical Dimension. However, in the Amakhala Game Run this pattern was reversed as the Biophysical Dimension received the highest response rate in the Pre- Game Questionnaire, followed by the Economic Dimension in the Post- Game Questionnaire, see Figure 8.9. The Social Dimension and Other were ranked second in the Amakhala Game Run. In the Post- Game Questionnaire participants' appreciation of the Economic Dimension is shown in the second highest response rates in the Turku and Amakhala Game Runs. In the Tammela Game Run it was the Economic Dimension. The participants have thus identified political, biophysical and economic issues and challenges associated with water management in the southern African Context whereas in their own context they identified economic and social issues and challenges. This infers that participants were able to transfer what they had learnt about water in a southern African context and were able to apply this learning to their own local environments.



**Figure 8.7 – Turku Game Run: Comparison of Pre- and Post- Game Activity Response; Rates per Environmental Dimension**



**Figure 8.8 – Tammela Game Run: Comparison of Pre- and Post- Game Activity Response; Rates per Environmental Dimension**



**Figure 8.9 – Amakhala Game Run: Comparison of Pre- and Post- Game Activity Response; Rates per Environmental Dimension**

The Pre- and Post- Game themes for each game run were also compared. Repeated and non-repeated themes for each game run are displayed in Figures 8.10 to 8.12.

The Turku Game Run had five (Figure 8.10) repeated themes and there were six and four repeated themes in the Tammela (Figure 8.11) and Amkhala (Figure 8.12) Game Runs respectively. The repeated themes include a focus on climate change, droughts and pollution.

The Turku Pre- Game themes focused on a lack of knowledge, corruption and limited biophysical resources while the Tammela Pre- Game themes focused predominantly on political and biological issues. The Amakhala Pre- Game themes were categorised under planning and practice, demand vs. supply, increasing demand, impact of past development policies and other. There was thus a similar focus between all three game runs on the increasing demand for limited biophysical resources as well as political issues in the form of corruption and past development policies.

The Turku Post- Game themes (Figure 8.10) were grouped under two headings, namely *vulnerability* and *future considerations*. *Vulnerability* focussed on political, economic, social and biophysical aspects that drastically impact on survival. In comparison the themes categorised under *future considerations* make note of significant political, economic, social and biophysical aspects that need to be addressed. The Tammela Post-Game themes (Figure 8.11) were also further grouped but this time into four sub-headings: *government regulated issues*, *natural resources*, *ability to work together* and *other*. The majority of the Amakhala Post- Game themes (Figure 8.12) were grouped under *planning & practices* and *demand versus supply*, with *vulnerability* as an additional heading.

Once again the focus of the Post- Game themes changed after participants had played the ACG. The Political Dimension remained the dominant one in both the Turku and Tammela Pre- and Post Game Questionnaires while the dominant dimension shifted from the Biophysical to the Economic Dimension in the Amakhala Game Run. Regardless of dimensions remaining the same or shifting in dominance, the focus of the Post- Game themes changed. Similarities between the three game runs included vulnerability and future planning with regard to biophysical resources. In addition, themes tended to acknowledge practical issues and challenges, which can account for the heightened sense of personalisation and urgency in the Post- Game themes, whereas the Pre- Game themes seem more abstract, hierarchical and devoid of agency.

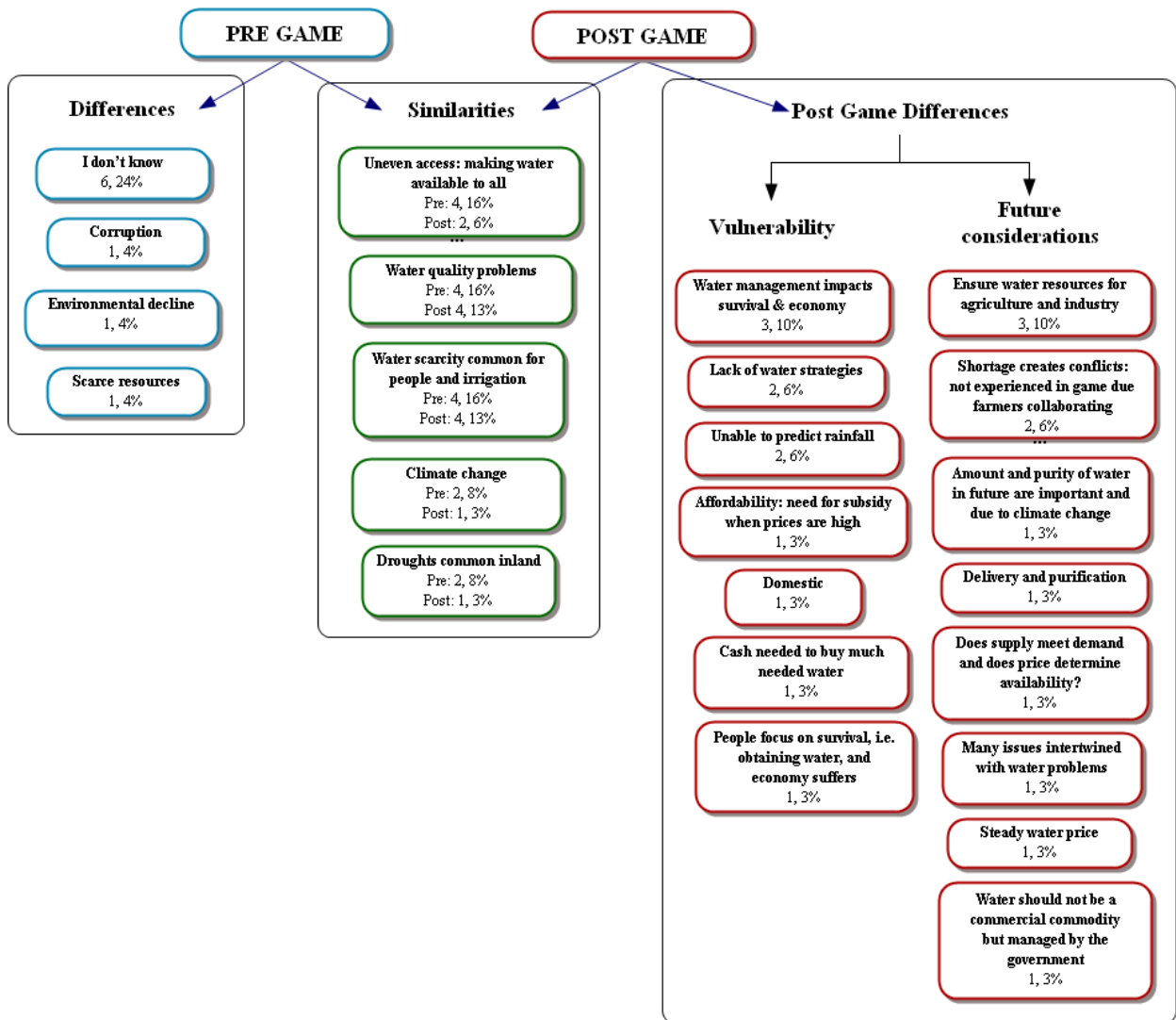


Figure 8.10 – Turku Game Run: Comparison of Pre- and Post- Game Themes

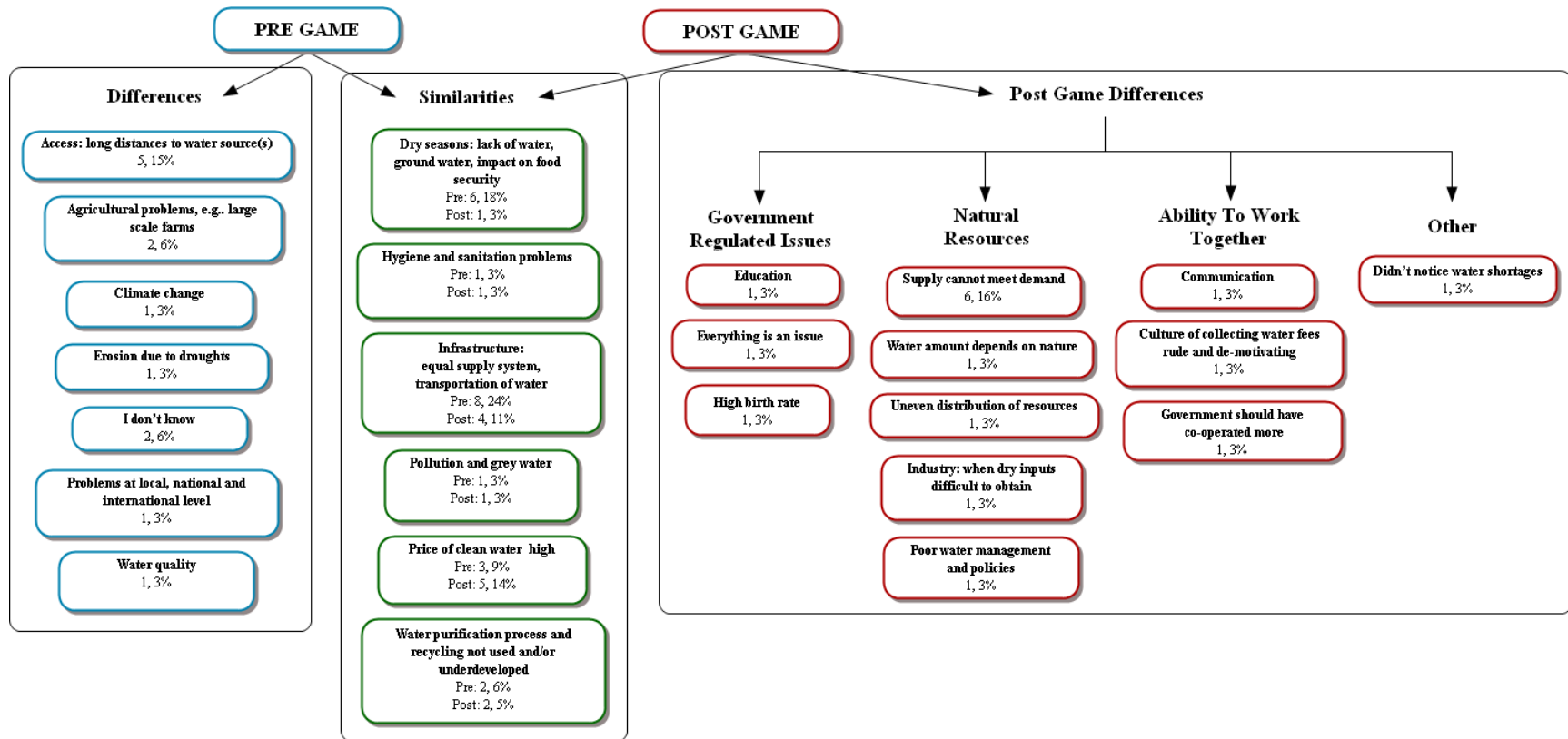


Figure 8.11 – Tammela Game Run: Comparison of Pre- and Post- Game Themes

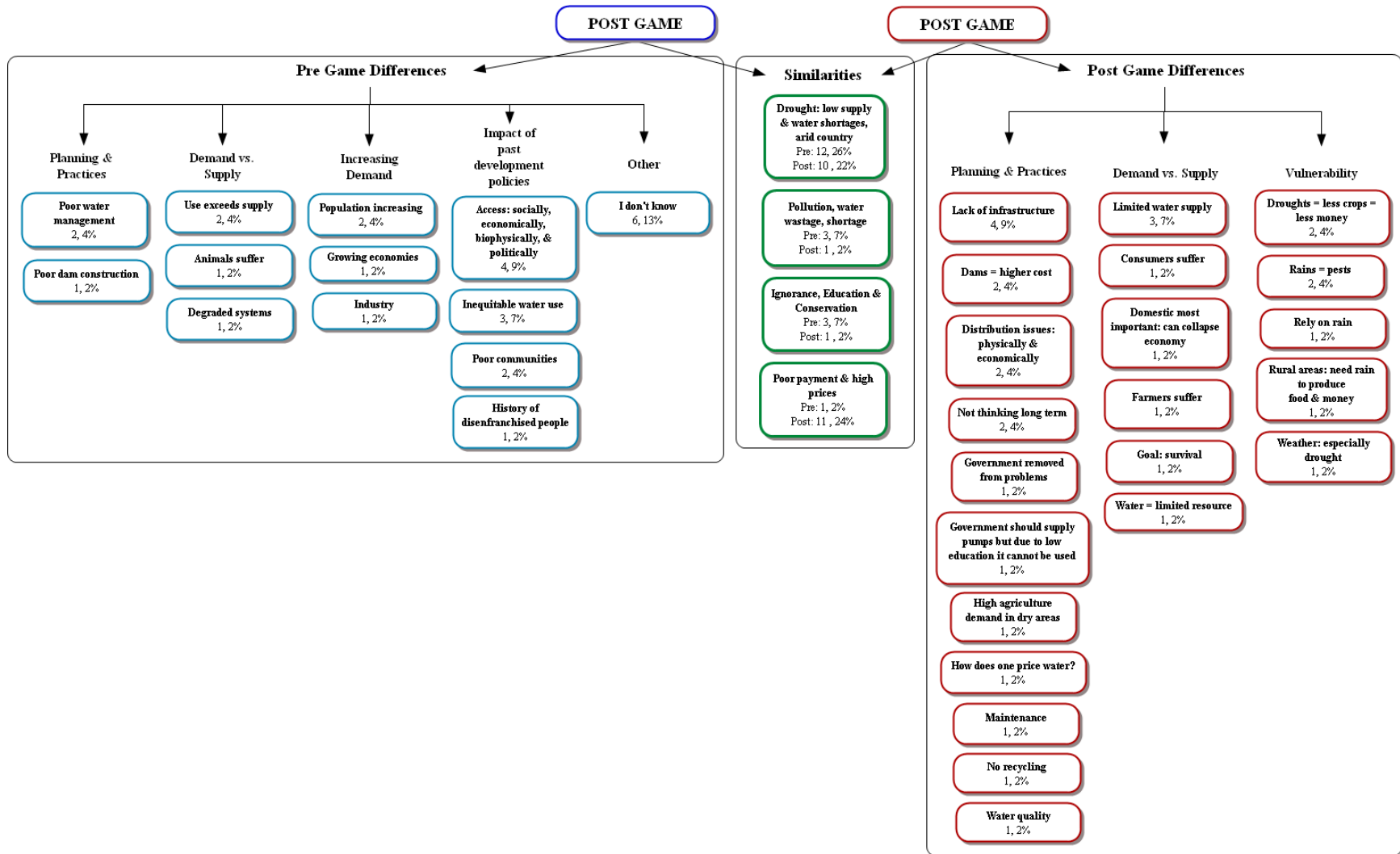
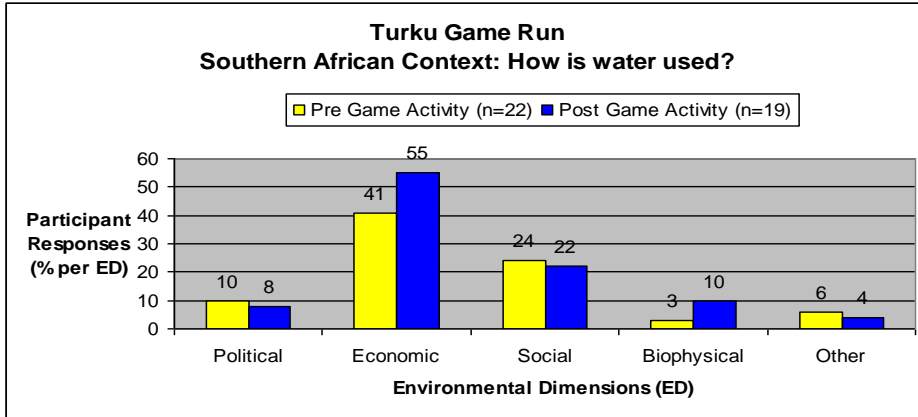


Figure 8.12 – Amakhala Game Run: Comparison of Pre- and Post- Game Themes

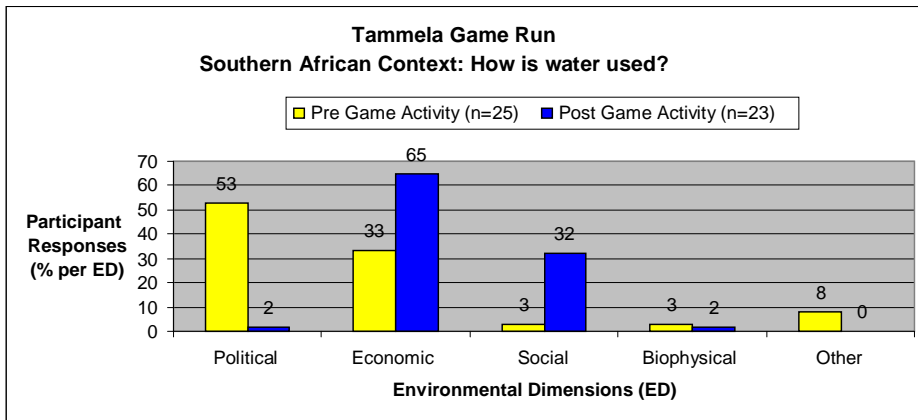
### **8.2.3 Southern African Context, Question 1: How is water used in a southern African Context?**

In comparison to their own context analysed above, for the southern African context we find that in both the Turku (Figure 8.13) and Amakhala (Figure 8.15) Game Runs the Economic Dimension received the highest response rates for the Pre- and Post- Game Questionnaires. The Political Dimension received the highest response rate in Tammela's Pre- Game Questionnaire (Figure 8.14), while the Economic Dimension was ranked the highest in the Post- Game Questionnaire. Therefore, in all three post-game questionnaires the Economic Dimension was the most dominant. The Social Dimension ranked second highest in both the Turku and Amakhala Pre- and Post- Questionnaires. Although the Economic Dimension ranked second in Tammela's Pre- Game Questionnaire, the Social Dimension was ranked second in the Post- Game Questionnaire. Therefore, in all three game runs the Social Dimension received the second highest response rates.

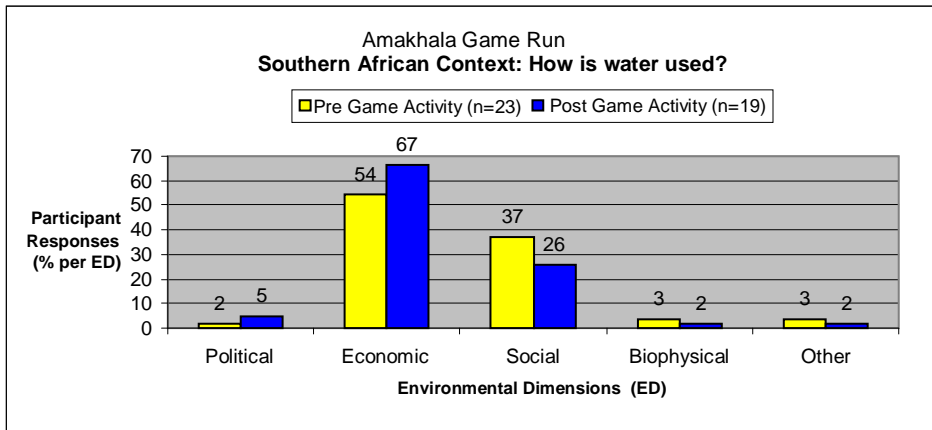
Of interest is that the difference between the Pre- and Post- Game response rates of the different dimensions in the Turku and Amakhala Game runs remained fairly constant. However, those of the Tammela Game Run show noticeable increases and decreases, i.e. the 50% decrease in the Political Dimension, the 32% increase in the Economic Dimension, and the 19% increase in the Social Dimension.



**Figure 8.13 – Turku Game Run: Comparison of Pre- and Post- Game Environmental Dimension**



**Figure 8.14 – Tammela Game Run: Comparison of Pre- and Post- Game Environmental Dimensions**



**Figure 8.15 – Amakhala Game Run: Comparison of Pre- and Post- Game Environmental Dimensions**

In comparison to the previous questions, the number of repeated themes was lower for this question. The Turku (Figure 8.16) and Tammela Game Runs (Figure 8.17) had only four and two themes respectively while the Amakhala Game Run (Figure 8.18) had the most repeated themes, eight. All of these themes included the domestic, agricultural and industrial use of water.

All three game runs included a focus on water as a scarce or limited resource, not easily accessed and again there was a shift between the pre- to post- questionnaires from the use of water in an immediate geographical context to include non-immediate uses as well as the acknowledgement that water is important for survival.

The Turku Pre- Game themes focused on the *use of water for agriculture and industry*, that *water is scarce* and *Used sparingly in both social and domestic contexts* while the Tammela Pre- Game themes focused on access, be it due to economic, historical or infrastructural and political reasons. The Amakhala Pre- Game themes focused on the participants' immediate environment, i.e. *household*, the detrimental effects on this environment i.e. *limited supply* and *poor water*, and what entertainment value exists, i.e. *recreational* and *game reserve*.

In comparison to the Pre- Game themes the Turku Post Game themes focused on how expensive and important water is for survival as well as that *chance plays a significant role in survival strategies*. The Tammela Post- Game themes included a focus on the participants' immediate surroundings: domestic, non-immediate surroundings: government management and the use of water as a trading commodity. In addition, there was a heightened sense of urgency and perhaps desperation since participants realised through playing the game that water is crucial for survival. The Amakhala Post Game themes, however, had a broader focus that included the interdependent relationship between the economy and the biophysical dimensions of the environment, i.e. *acknowledge link between water and the economy*, that *government makes money* and that *drought equals high prices*. There was also a sense of urgency and desperation, i.e.

survival, as well as a broader list of living things that require water to survive, i.e. *humans, everyone* and *ecosystems*. Therefore, in all three game runs there was a noticeable shift between the pre- and post- questionnaires from the use of water in an immediate geographical context to include non-immediate uses as well as the acknowledgement that water is important for survival.

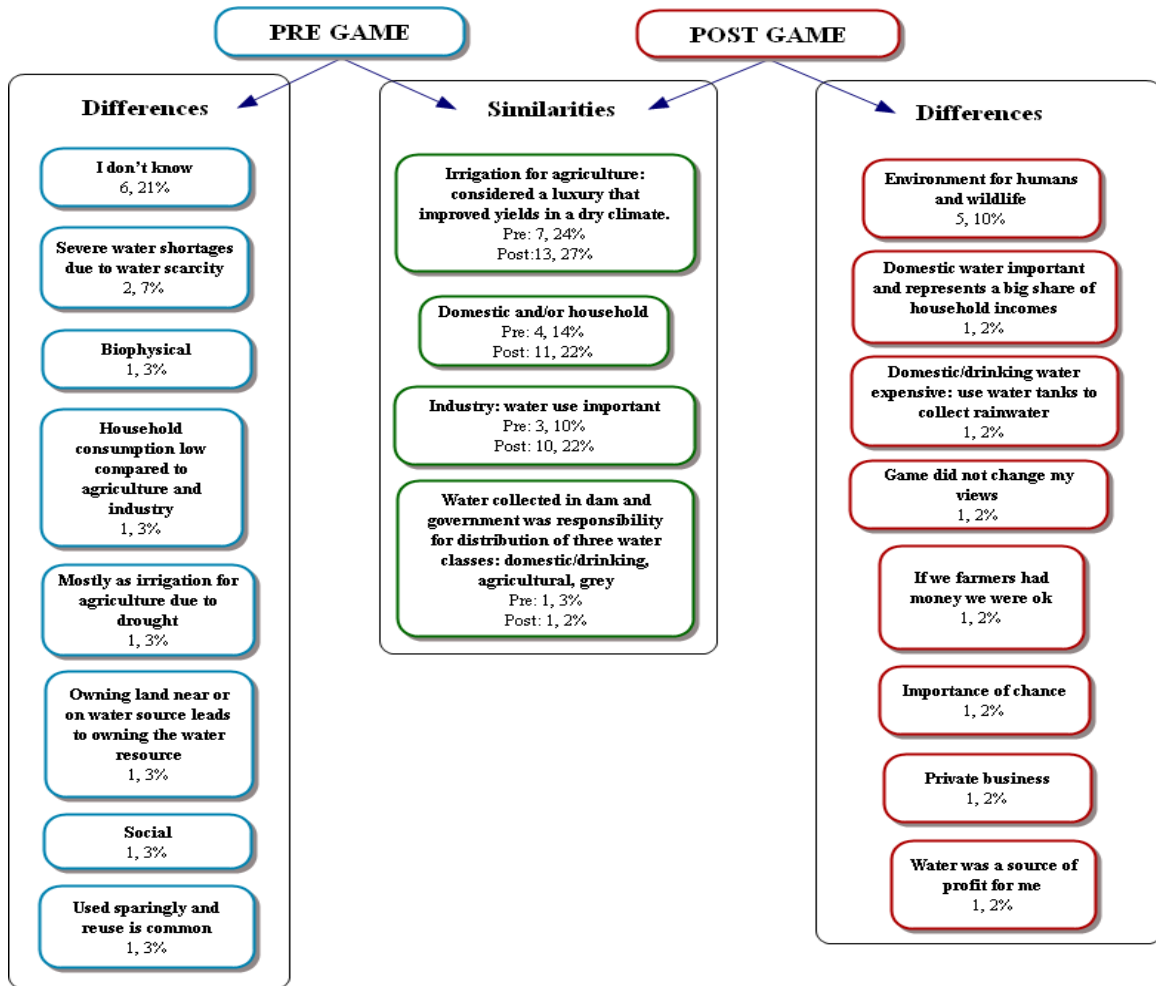


Figure 8.16 - Turku Game Run: Comparison of Pre- and Post- Game Themes

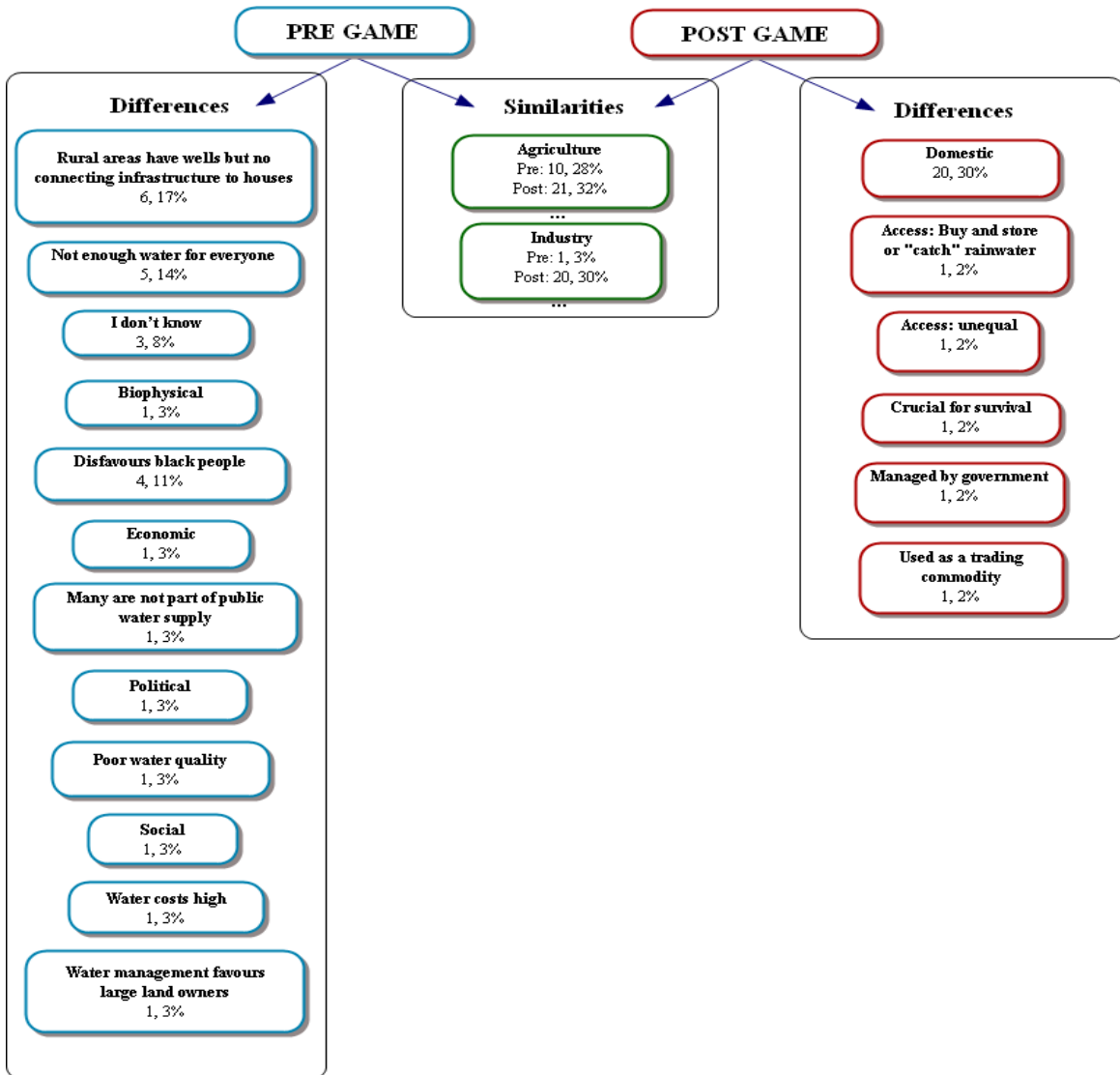
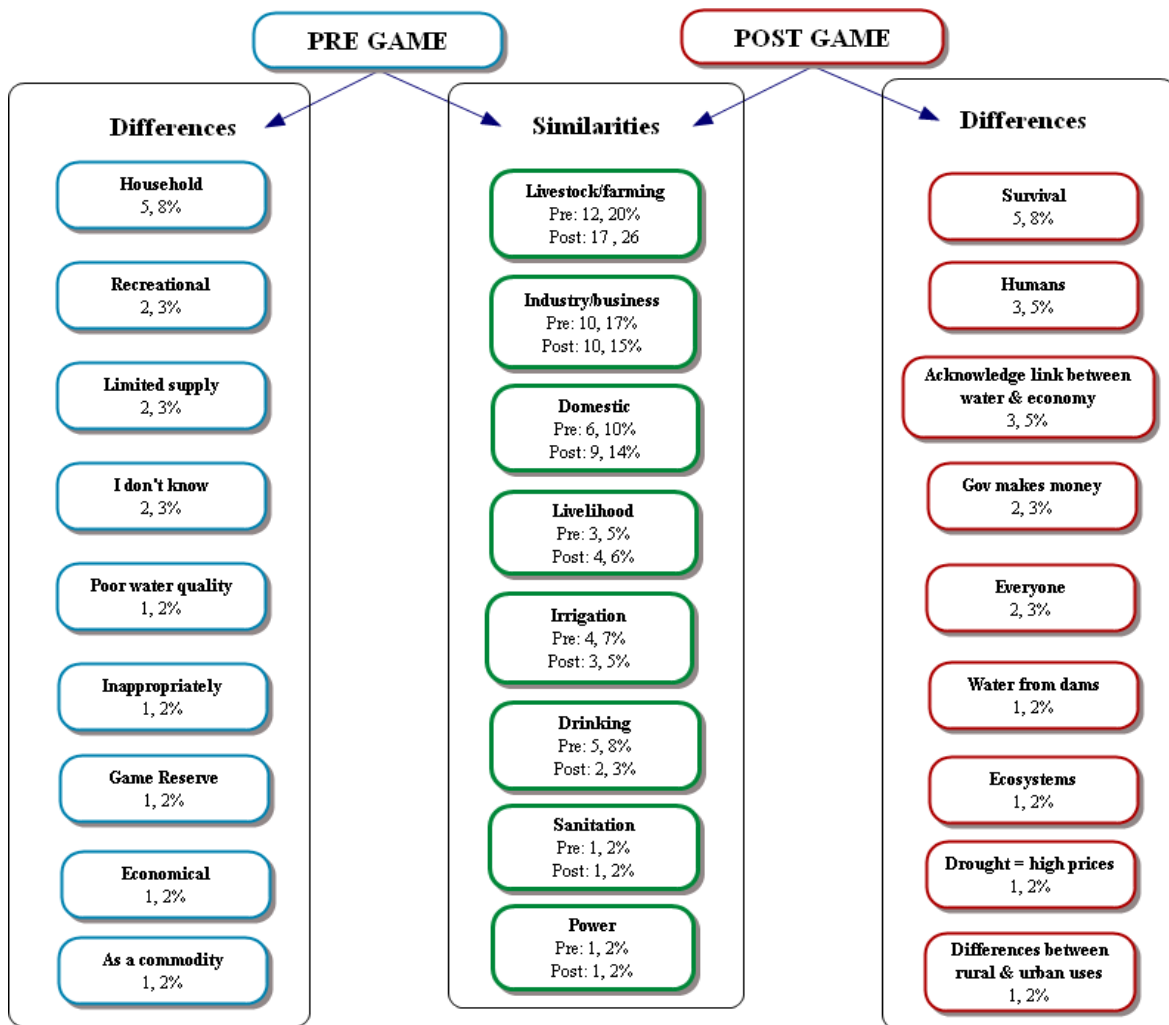


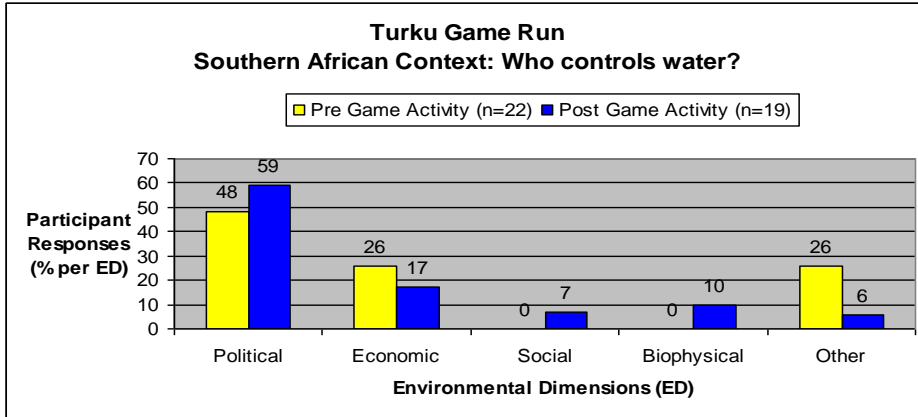
Figure 8.17 - Tammela Game Run: Comparison of Pre- and Post- Game Themes



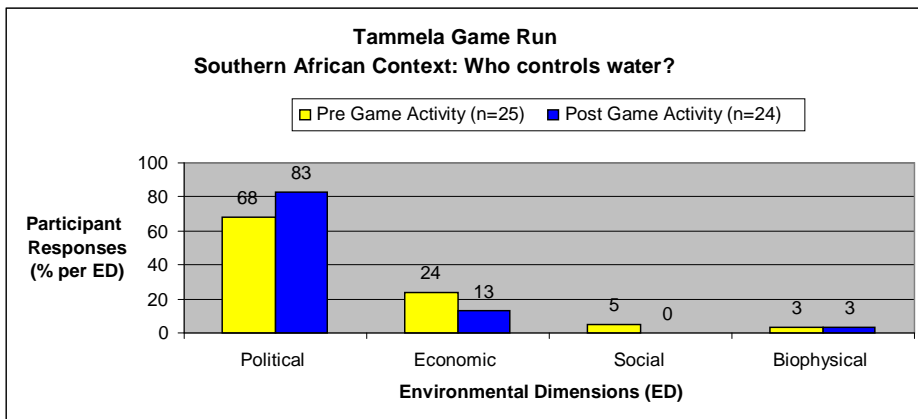
**Figure 8.18 - Amakhala Game Run: Comparison of Pre- and Post- Game Themes**

### 8.2.4 Southern Africa, Question 2: Who controls water?

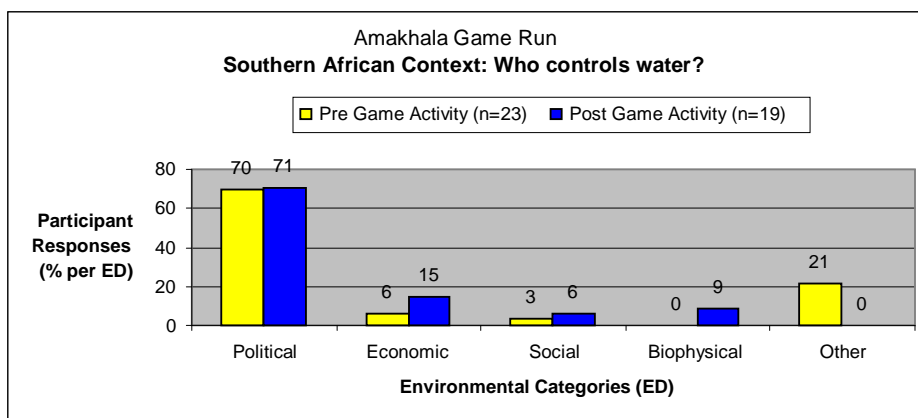
This is the last question analysed for a degree of significance higher than 0.001. In the Turku (Figure 8.19), Tammela (Figure 8.20) and Amakhala (Figure 8.21) Game Runs the Political Dimension received the highest response rates in both the Pre- and Post- Game Questionnaires. For both the pre- and post-game responses participants indicated that political agents, factors and processes control water in a southern African context.



**Figure 8.19 – Turku: Comparison of Pre- and Post- Game Activity Response Rates per Environmental Dimension**



**Figure 8.20 – Comparison of Pre- and Post- Game Activity Response Rates per Environmental Dimension**



### **Figure 8.21 – Comparison of Pre- and Post- Game Activity Response Rates per Environmental Dimension**

In terms of the second most responses, the Pre- Turku Game Run responses highlighted the Economic Dimension and Other while only the Economic Dimension was highlighted in the post-game responses. In the Tammela Game Run the Economic Dimension received the second most responses in both the pre- and post-game questionnaires while responses shifted from Other to the Economic Dimension in the Amakhala Game Run.

All three game runs had less repeated themes in comparison to the questions discussed earlier. The Turku Game Run (Figure 8.22) had the most repeated themes, five, followed by the Amakhala Game Run (Figure 8.23) with three themes and the Tammela Game Run (Figure 8.24) with only one theme. *I don't know* was a repeated theme in both the Turku and Amakhala Game Runs. For all game runs the themes included a focus on the governmental control of water.

The pre-game themes for the three game runs included an economic focus on land ownership as a means of controlling access to a water resource. The Turku Pre- Game had only two themes, *landowner* and *corruption: highest bidder*, while the Tammela Pre-Game themes had a general focus that included all the environmental dimensions. The Amakhala Pre- Game themes had a general focus that centred on Political organisations, i.e. the *municipality* and *water associations*, as well as social agents, i.e. *people*, *landowners with water sources*, and *private companies*.

There were nine Turku Post- Game themes that had a general focus on Biophysical aspects of the environment, i.e. *nature* and *rainfall*, the importance of water prices, i.e. as a tool, how it is determined, its reliability, the impact of private ownership and the impact of the economic situation, as well as misinformation and the complexity beyond government management. In contrast, the Tammela Post- Game themes excluded the Social Dimension and focused heavily on economic factors. The Amakhala Post- Game themes had a more detailed and arguably personalised focus that not only includes a wider list of organisations and agents, i.e. *farmers*, *industries*, and *communities*, but

identifies their specific practices, i.e. *farmers: crops and water tanks, industries: technologies, and communities: practices* such as *entertainment, interests and hobbies*. In addition, the Biophysical Dimension is included in the Post- Game themes, i.e. *nature and rain*.

As mentioned the Political Dimension remained dominant in both the Pre- and Post-Game Questionnaires for all three game runs while themes shifted in focus after the AG was played. In the Turku Game Run participants' opinions of water control changed from ownership and management as agents of control, to Biophysical aspects, pricing, misinformation and complexity. This infers that participants had acknowledged the interconnected impacts of water control. Participants from the Tammela and Amakhala Game Runs showed a shift in their understanding of water control from a general to a more centralised focus. In the Tammela Game Run the shift was from including all environmental dimensions, to focusing on economic agents and reasons. Participants from the Amkhala Game Run shifted from a focus on organisations and agents to a detailed and personalised focus on the practices of these organisations and agents that included the Biophysical Dimension of the environment.

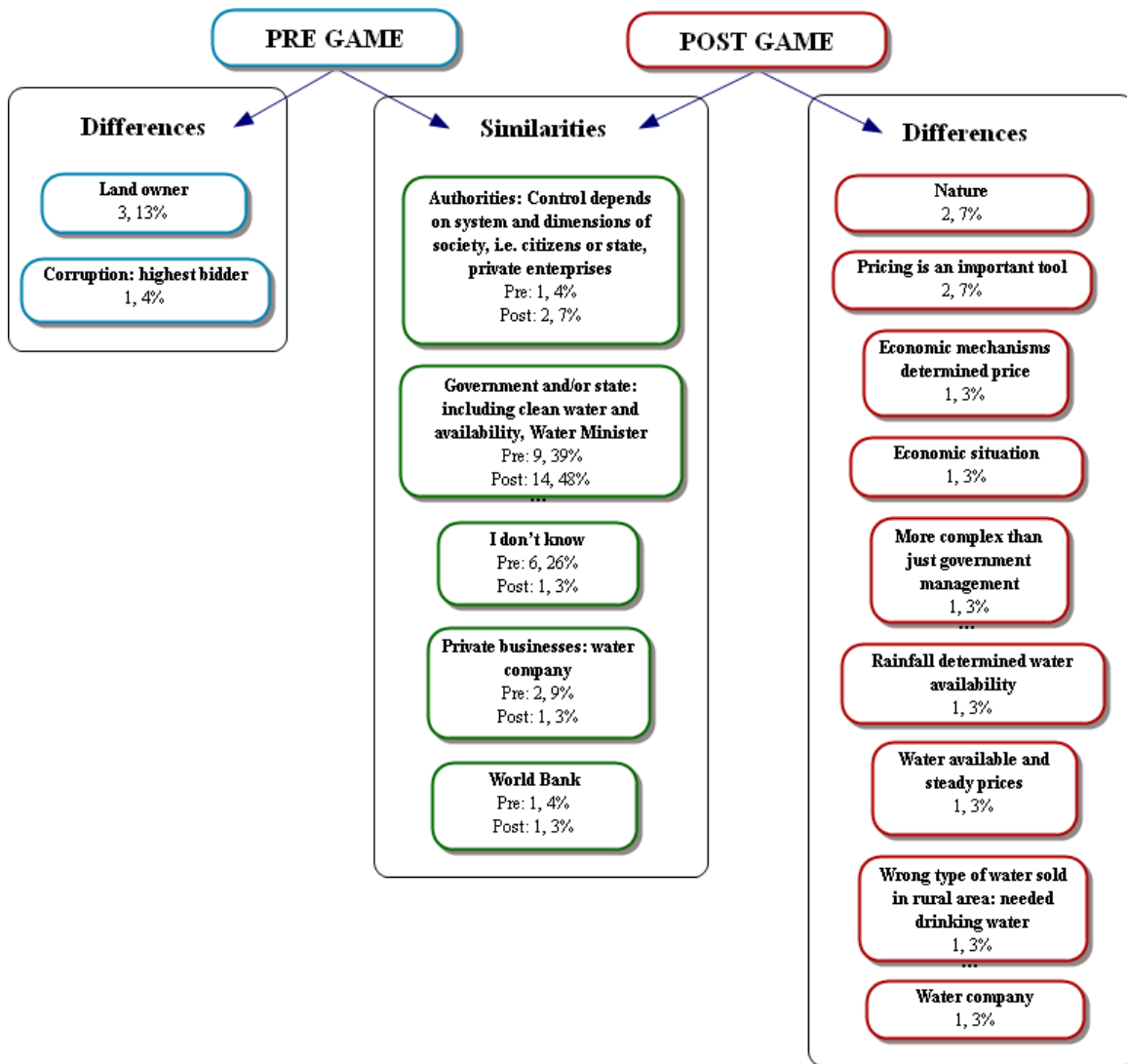


Figure 8.22– Turku Game Run: Comparison of Pre- and Post- Game Themes

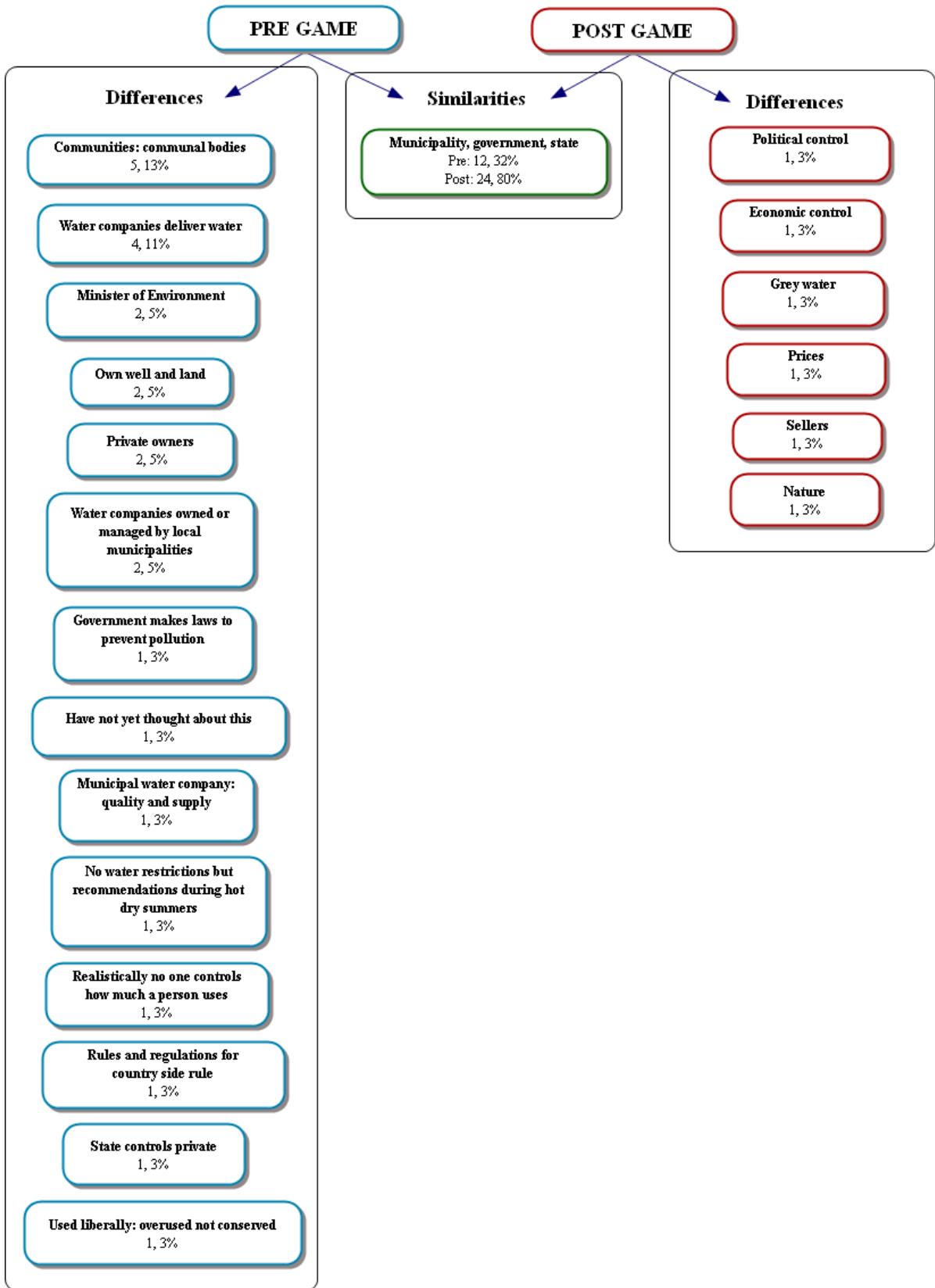
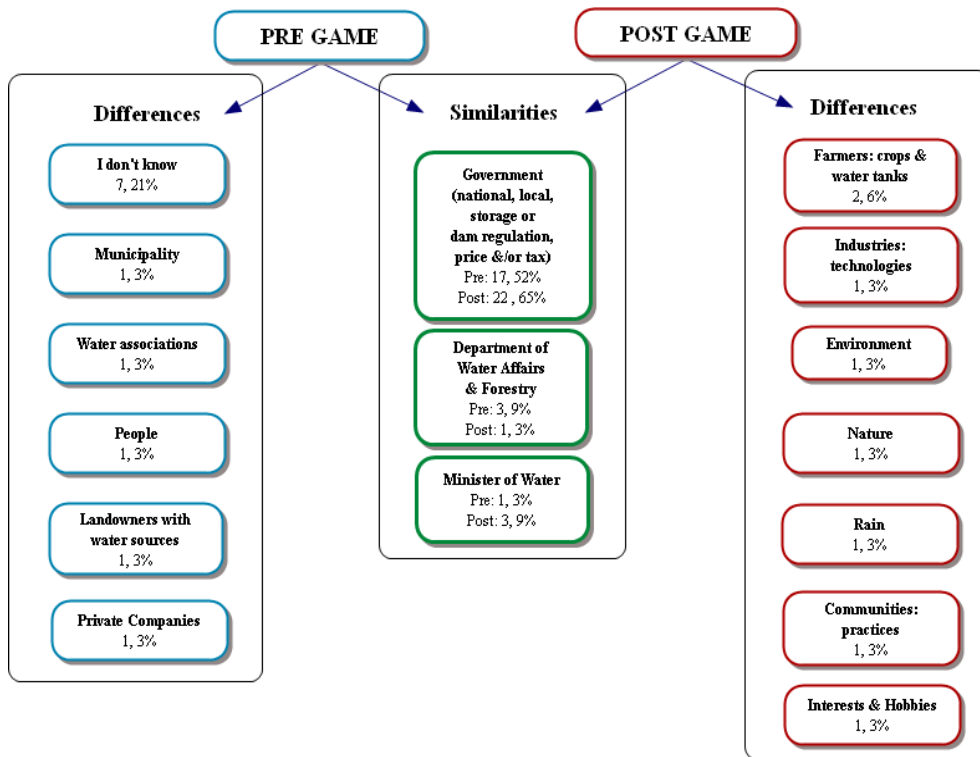


Figure 8.23 – Tammela Game Run: Comparison of Pre- and Post- Game Themes



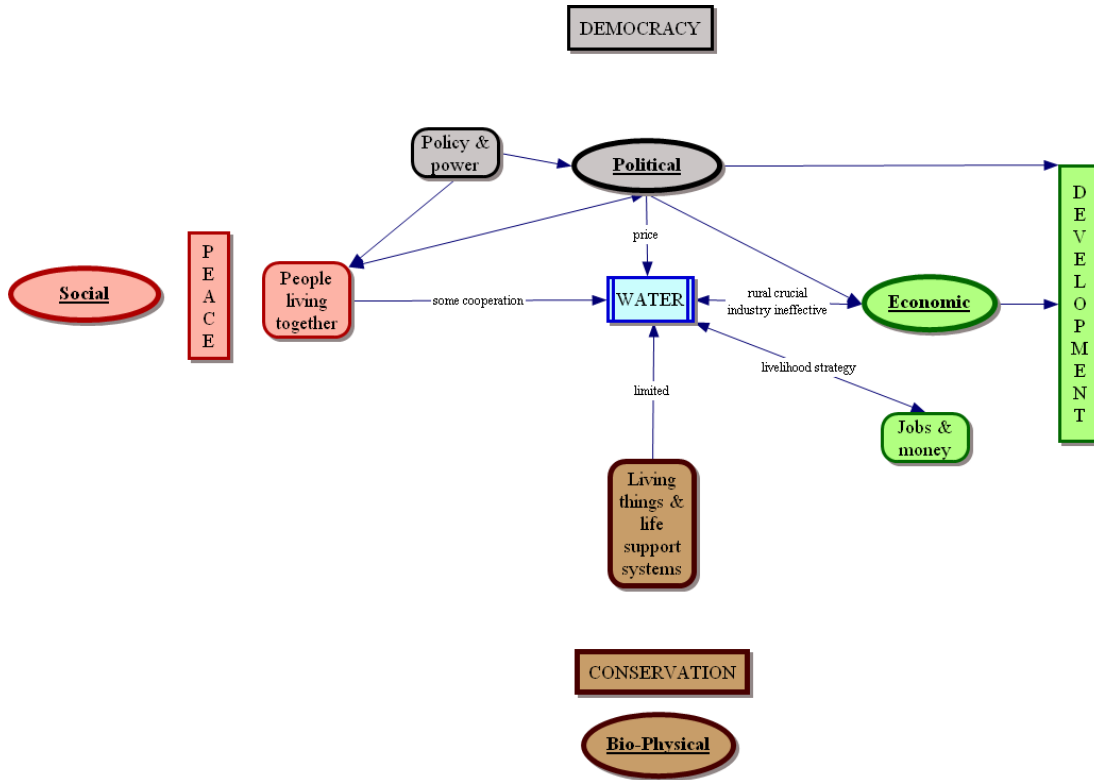
**Figure 8.24 – Amakhala Game Run: Comparison of Pre- and Post- Game Themes**

### 8.2.5 Annotated Environmental Dimension Diagram

This section discusses the annotations made to the environmental dimension (ED) diagrams; see Figures 8.25 and 8.26, during the focus group debriefings. These annotations are significant in that they allow the managers to see how participants have linked the dimensions together by means of identifying key relationships and systems that they have experienced. This framework allows the participant's to consolidate their learning by providing them with a visual space to reflect on their observations and to conceptualise not only their game experience but also new understandings gained from this experience. Due to time constraints it was not possible to make these annotations in the Tammela focus group debriefing.

- **Turku Game Run: Environmental Dimension Diagram**

Figure 8.25 shows the annotations made to the environmental diagram after playing the ACG.

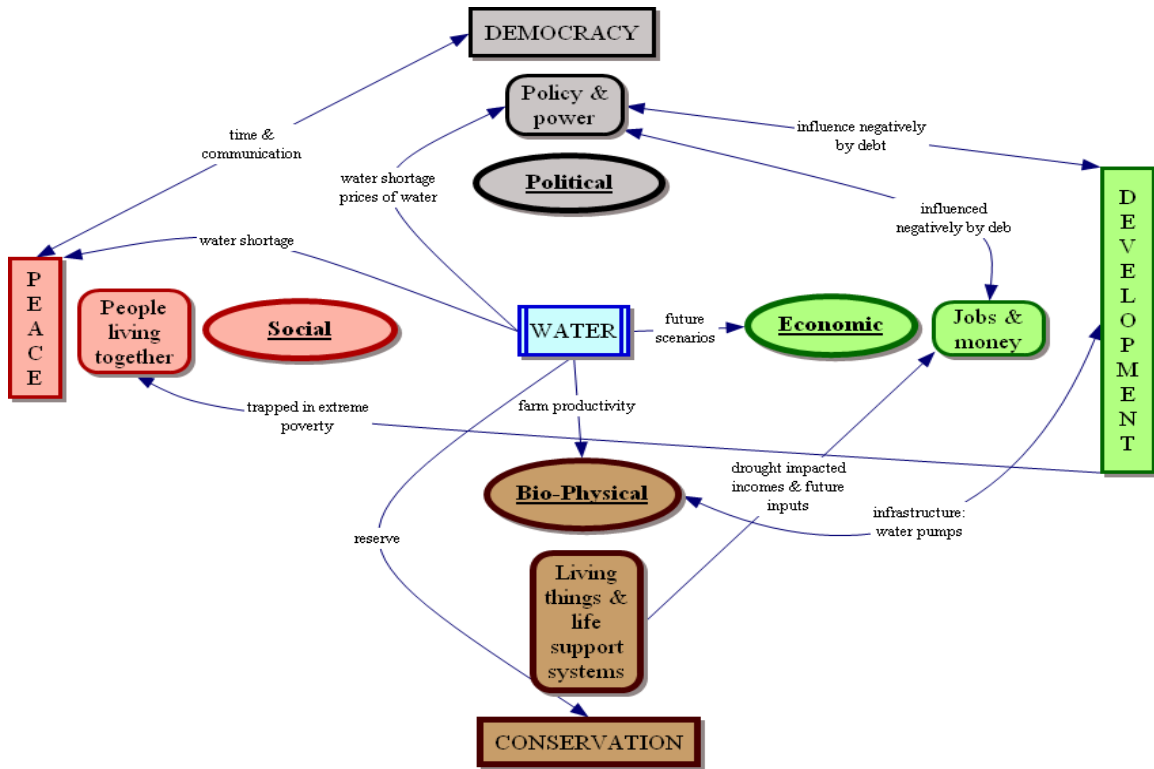


**Figure 8.25 – Turku Game Run: Annotations Made to Environmental Dimension Diagram**

The annotations show that the participants saw how political policy and power impacts on water prices as well as economic development and society. In return, social cooperation impacts on water while the economy impacts on development, rural areas, industry and vice versa. Living things and life support systems also impact on water. This is in keeping with the response rates for the questions discussed above since the Political, Economic and Social Dimensions received the most responses. These responses also acknowledged the complexity of water issues and a renewed appreciation for water as a crucial asset for survival. In addition, participants identified vulnerability and future consequences of the relationships identified in the ED diagram.

- **Amakhala Game Run: Environmental Dimension Diagram**

The annotations made to the Diagram during the Amakhala focus group discussion are displayed in Figure 8.26.



**Figure 8.26 – Amkhala Game Run: Annotations Made to Environmental Dimension Diagram**

It is immediately apparent that there are more annotations in the form of arrows in this diagram. The lower education level of the Amakhala participants, mostly undergraduate students, in comparison with postgraduate and doctoral graduates in the Turku Game Run, could account for this distinction and perhaps the South African and undergraduate participants were more used to this type of debriefing. The Turku participants would be more knowledgeable due to the issues discussed being part of their research and teaching disciplines. As discussed in chapter 7, the Amakhala students were eager to investigate for themselves what had happened during their game run. These arrows show how the interconnected relationships between water and the four environmental dimensions are combined. Water impacts on policy, power and conservation. Living things and life

support impact on jobs and money, and this influences and is influenced by policy and power. Similarly development influences and is influenced by the Biophysical Dimension in the form of infrastructure as well as policy and power through debt. Development also influences people living together in extreme poverty. Social peace is affected by the availability of water as well as effective communication with a democratic government. This is similar to the responses received for the statistically significant questions discussed above in that the Economic, Social and Political Dimensions received the most post-game responses. As for the repeated and non-repeated themes, these are similar to the annotations above in that participants acknowledged the interdependency of relationships between dimensions, especially that of the Economic and Bio-physical. Participants were able to identify impacts both in their immediate environment and beyond. What was significant is that participants acknowledged that these broader issues eventually put pressure on their immediate environment. Participants themes thus included descriptive and personalized aspects. A sense of urgency and desperation was also evident as well as the recognition of one's vulnerability.

### **8.2.6 Synthesis of the Findings**

The above comparison of the Pre- and Post- Game dimensions and themes for the most statistically significant questions has shown that regardless of dimensions remaining dominant or not in both the Pre- and Post- Game Questionnaires, the focus of themes either change or are adapted in some form to either include or exclude aspects. According to Kuusisto (2008), change is a product of interaction which influences a system's information, structure and activity. It can be argued that the Pre- and Post- Questionnaires, the game experience and the focus group debriefings have allowed for interaction that would influence participants' knowledge of, i.e. information, and ultimately their interaction with, i.e. activity, water. In addition, the data generation methods and the simulation game has allowed participants to pass through the four interconnecting stages of Kolb's learning cycle (see Figure 2.1, chapter 2). In so doing, the Pre-Game Questionnaire has allowed participants to actively reflect on what they know about water management and consumption before playing the ACG, while the Post-Game Questionnaire allowed participants to reflect on their game observations and to

conceptualise their understanding of their experiences. One can infer that both collectively, i.e. in their focus group debriefing, and individually, i.e. in their Post- Game Questionnaire, participants were able to identify, compare and then reprioritise which dimensions and themes were dominant after playing the ACG.

It is evident that learning has been enabled through the use of a role playing simulation as an innovative learning strategy. In this case the learning has been associated with water in a southern African context. In addition, the players' game experience has allowed for self-development in that they have not only enhanced their ability to learn, but that they are also conscious of this learning. The focus group debriefings have indicated that participants were able to unpack for themselves what had happened during their respective game runs.

### **8.3 Conclusion**

This chapter has analysed and presented findings concerning the comparison of each game's pre- and post-response rates and the pre- and post-game themes. A third data set, in the form of the environmental dimension diagram annotated during the focus group debriefings, was included in this analysis. The following chapter consolidates the modifications made to the ACG as well as the findings in terms of participants' learning.

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## **CHAPTER 9**

### **CONCLUSION AND RECOMMENDATION**

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#### **9.1 Introduction**

This chapter consolidates both the modifications made to the ACG and discusses the findings concerning participants' understanding of water across the three game runs.

This study seeks firstly to modify, develop and implement new water processes in the ACG and secondly to understand what, if any, learning subsequently occurred

#### **9.2 Synthesis of Findings and Recommendations**

As outlined in the methodology (see chapter 3, section 3.2), there were two main objectives for this research study. The first was to modify, develop and implement new water processes that would simulate dry weather conditions indicative of a southern African context. The second was to understand what, if any, learning subsequently occurred after participants had played the modified ACG. The modification and development of the new water processes were therefore workshopped. Data generation techniques were designed in an additional workshop in an attempt to capture this learning.

##### **9.2.1 Synthesis of Modifications**

By modifying the existing water processes in the ACG for a southern African context, I was able to see how fluctuations in the availability of water impacted on water management, food security and ultimately, development and the economy. Modifications included a dam in the urban sector as well as the debt incurred to build it, the starting water level in the dam, the different rainfall regimes for the upper and lower catchments, tokens that represented agricultural, domestic, industrial and drinking water, rain tanks for collecting rain water, the starting distribution of water pumps to commercial and peasant farmers and the additional rule "drink water or die". As mentioned, change is a

product of interaction that has the potential to influence the information, structure and activity of a system (Kuusisto 2008). The influence of this change is not always predictable and in terms of the water modifications, it was therefore necessary to trial them.

It is evident that while there was far too little water in the Assegaai Trial run, the water modification implemented worked well with the existing game structure and procedures. Further modifications relating to the starting water level in the dam had to be implemented.

In the Turku Game Run water was readily available resulting in minimal flooding. Although these water conditions were not necessarily indicative of a southern African context, the experience did provide the possibility of simulating extreme weather conditions. A recommendation was that various degrees of floods, as well as their impact on both agriculture and the economy, should be modelled. Further investigation of the ACG as a tool to model climate variability and its impact should therefore be conducted.

The Tammela Game Run had less water than the previous game runs. However, rainfall and water availability remained consistent and readily accessible throughout the game. Therefore agriculture and ultimately food security was not negatively impacted.

Dry conditions and limited water availability indicative of a southern African context was simulated in the Amakhala Game Run. Appropriate stress was placed on water dependent processes such as agriculture. In addition, there was a knock-on effect on water related processes. This included decreasing food security, soaring food and commodity prices, decreasing production and increasing debts.

It is evident that the modifications of the existing water processes were successful in the final game run by negatively impact on water management, food security and ultimately, development and the economy.

### **9.2.2 Synthesis of Participants Learning**

The interactive nature of the game allows each player to experience the impact limited water availability described above as well as the impact created by his or her reaction to it. Faced with these circumstances the participants needed to implement strategies to deal with such adverse climatic and economic conditions.

Both pre- and post-questionnaires were used to identify and track patterns and trends both within and across each of the three game runs in order to reveal whether a deeper understanding of water resulted from playing the ACG. The findings generated from the analysis of the pre- and post- questionnaires showed that for each of the game runs participants were able to acknowledge additional themes and environmental dimensions and revealed that a shift from one theme to another or and adaptation of a particular theme and environmental dimension to another as the dominant cause, agent, factor, process, challenge or issue.

The responses to these questions were analysed in terms of their probability through the application of the Chi Square Test. Four questions were identified as the most statistically significant and subsequently analysed. Findings corroborated those from the pre- and post-game questionnaire in that the focus of the participants' broadened to include an acknowledgement of feedback influences within a wider geographical location as well as a more descriptive outline of these wide-ranging relationships and influences.

The environmental dimension diagram used allowed participants to map relationships and processes between dimensions during the focus group debriefing. The post-game discussion proved very significant in that it allowed participants to understand for themselves what the direct and indirect impact of these relationships and processes were. The implication is that the participants themselves were key drivers in the construction of new knowledge associated with water in a southern African context.

Findings indicated that participants' demonstrated a deeper understanding of water related issues in a southern African context. This is evident through the participants'

acknowledgement of the complex relationships between environmental dimensions. In addition to this, participants identified that these relationships and their impact have the potential to threaten one's well being and ultimately, one's survival. Participants acknowledged that while improving one's living conditions is a long-term goal, day to day living and survival is more of a reality for many. The environmental ethics raised concerned the ability to survive to be sustainable in the process. Participants are thus able to identify the planning and practices that need to be addressed and implemented in order to improve their living conditions in a sustainable manner. This implies not only an acknowledgement but also an understanding of complex water related environmental relationships and how they influence each other. What is also significant is that while participants gained a deeper understanding of these processes and relationships for a southern African context, questions relating to their own environment revealed that while some felt that the differences between the two contexts were too vast, most acknowledged a newfound appreciation of water as a finite resource. Therefore, the goal of enabling participants to gain both a deeper understanding of the role of water in the environment, and to transfer this learning from a southern African context to that of their own was achieved.

### **9.3 Conclusion**

This research employed the case study method in order to modify, develop and implement new water processes indicative of a southern African context in the ACG. The modification process took the spiral form of an action research process (see Figure 2.4, chapter 2) so that the modifications implemented in one game run could be improved for the next.

An interpretive orientation was employed in order to understand what, if any, learning had taken place as result of playing the ACG. Since this type of research study is uncommon in geographical education it was necessary to design data generation techniques that would allow for the capture of the modification process as well as what, if any, learning had taken place. Both qualitative and quantitative data was captured by

means of Pre- and Post- Game Questionnaires, participant observations as well as spreadsheet data from the three game managers, as well as recordings of the focus group debriefings.

The Turku, Tammela and Amakhala game runs were analysed separately in order to gain an understanding of both the impact of the modifications as well as what the participants had highlighted as dominant themes and environmental dimensions. The modifications implement were adjusted accordingly for the each game run and dry climate conditions and limited water availability indicative of a southern African context was simulated in the Amkhala Game Run.

In terms of the Pre- and Post- Game responses, these were viewed collectively and then analysed by applying the Chi-Square Test in order to establish which responses were statistically significant. Further analysis of these responses has revealed that participants had gained a deeper understanding of water both in a southern African context as well as in their own local environment. It is evident that role playing simulations can be used as innovative teaching tools for enabling learning. In addition, this learning not only enhances the students' ability to learn but allows them to be conscious of this learning. It is hoped that this form of teaching would not only encourage, but enable the practice of sustainable resource utilization.

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## APPENDICES

### Appendix A: Chapter 5: Turku Game Run

#### Biographical Data: Figures A.1 to A.7

The biographical data is summarised in Figures A.1 to A.7 are expressed as percentages rounded off to the nearest whole number.

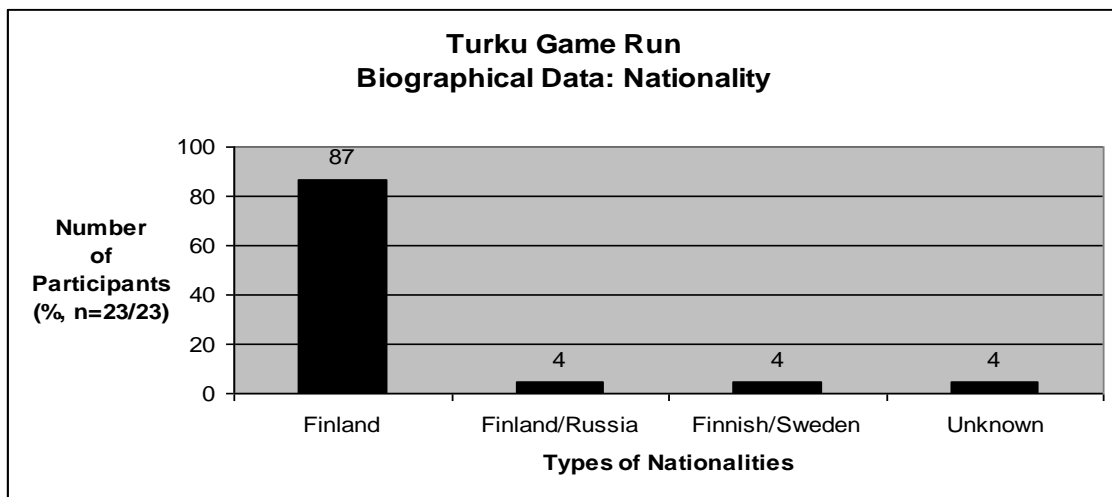


Figure A.1 – Turku Game Run: Nationality of Participants

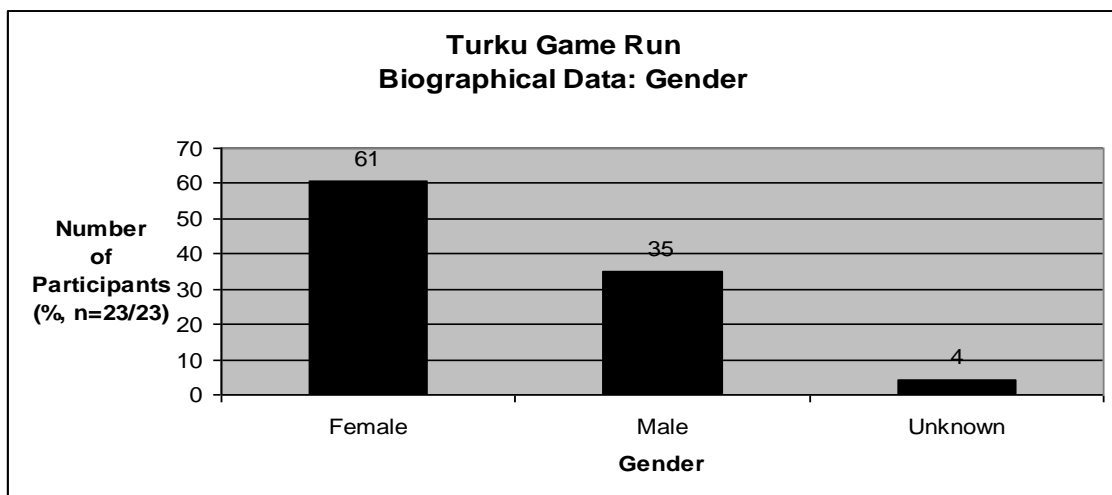
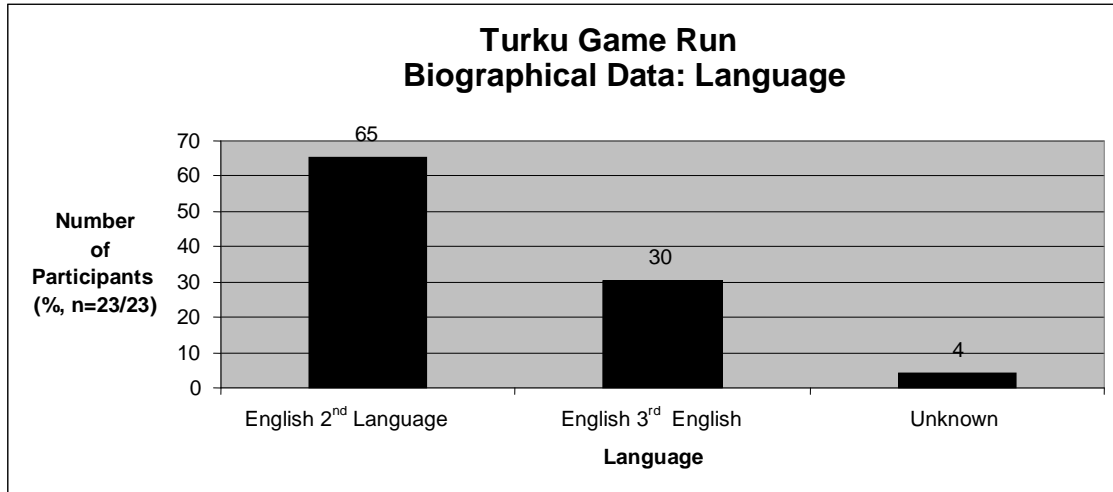
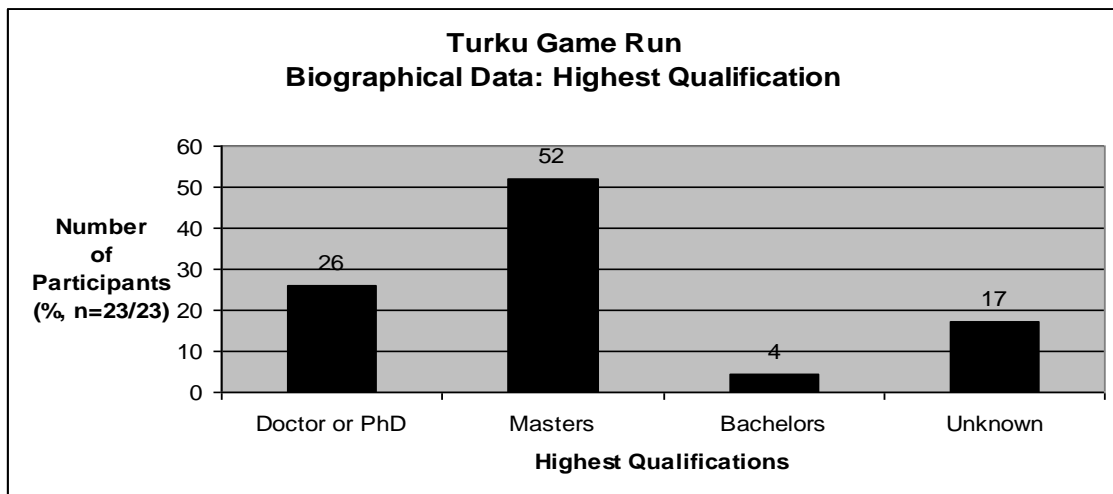


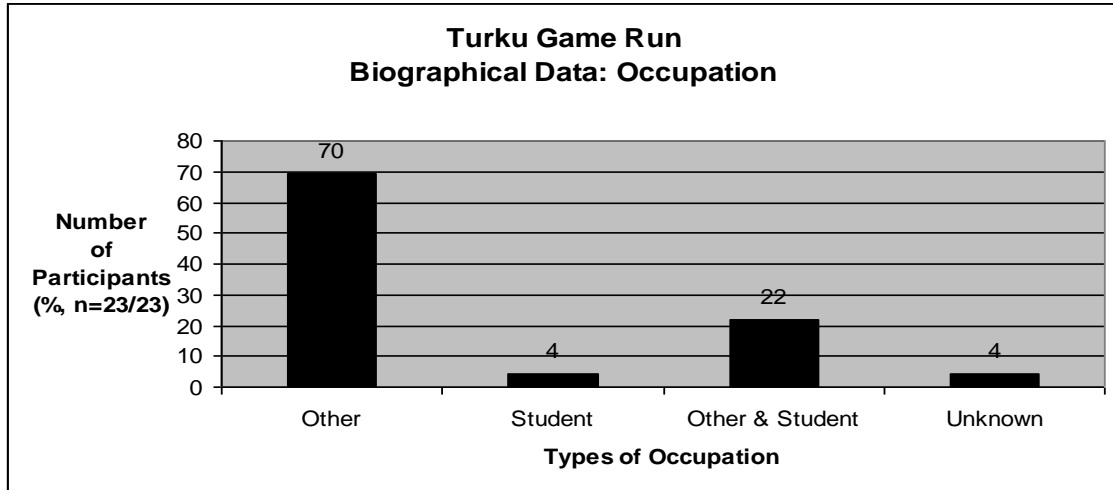
Figure A.2 – Turku Game Run: Gender of Participants



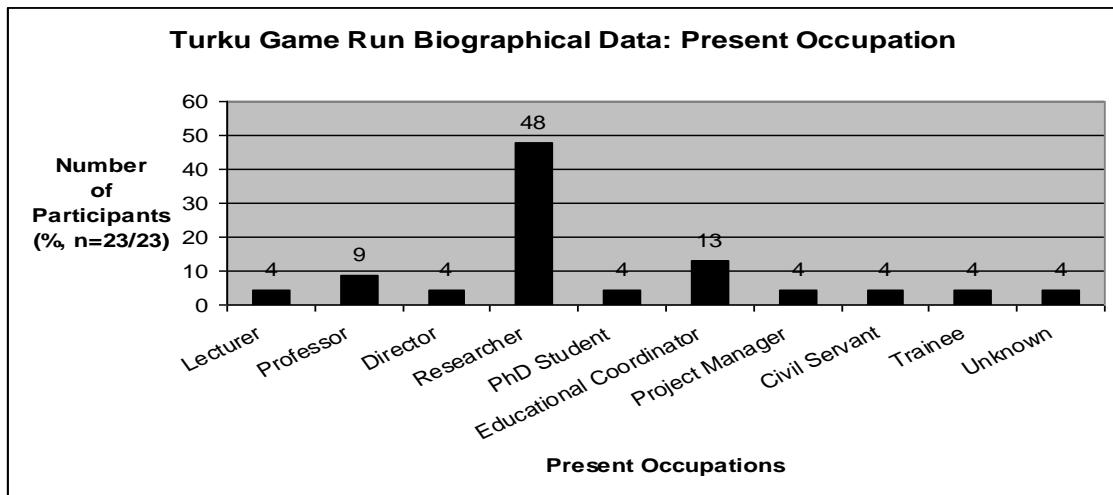
**Figure A.3 – Turku Game Run: Language of Participants**



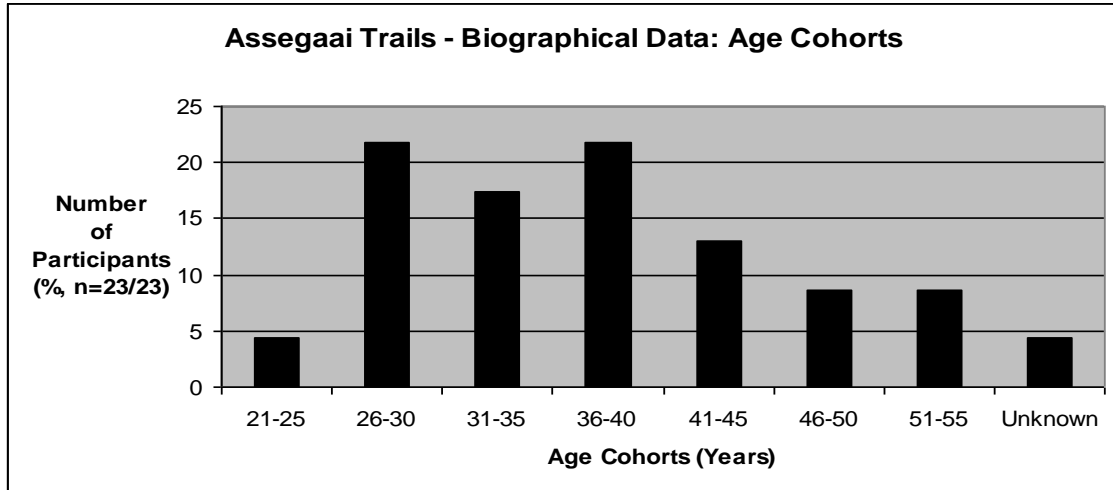
**Figure A.4 – Turku Game Run: Highest Qualification of Participants**



**Figure A.5 – Turku Game Run: Types of Participants’ Occupation**



**Figure A.6 – Turku Game Run: Present Occupation of Participants**



**Figure A.7 – Turku Game Run: Ages of Participants**

**Pre- and Post-Questionnaires: Tables A.1 to A.18**

Please note that each table in the Appendices figures have been rounded off to the nearest whole number. Furthermore, a given participant's response was layered and could be grouped under more than one theme.

**Table A.1 - Turku Pre-Game Questionnaire: How is water used in a southern African context?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=22)</b>
Severe water shortages due to water scarcity	2	7
Rain is collected, stored and distributed to community	1	3
<b>SUB-TOTALS: 2</b>	<b>3</b>	<b>10</b>
<b>Economic</b>		
Agriculture and/or irrigation	7	24
Industry	3	10
Mostly as irrigation for agriculture due to drought	1	3
Owning land near or on water source leads to owning the water resource	1	3
<b>SUB-TOTALS: 4</b>	<b>12</b>	<b>41</b>
<b>Social</b>		
Household and/or domestic activities	4	14
Household consumption low compared to agriculture and industry	1	3
Social	1	3
Used sparingly and reuse is common	1	3
<b>SUB-TOTALS: 4</b>	<b>7</b>	<b>24</b>
<b>Biophysical</b>		
Biophysical	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Other</b>		
I don't know	6	21
<b>SUB-TOTALS: 1</b>	<b>6</b>	<b>21</b>
<b>Totals</b>		
<b>12</b>	<b>29</b>	<b>100</b>

**Table A.2 – Turku Post-Game Questionnaire: How is water used in a southern African context?**

<b>Themes</b>	<b>Responses</b>	<b>% (n=19)</b>
<b>Political</b>		
Domestic water important and represents a big share of household incomes	3	6
Water collected in dam and government was responsibility for distribution of three water classes: domestic/drinking, agricultural, grey	1	2
<b>SUB-TOTALS: 2</b>	<b>4</b>	<b>8</b>
<b>Economic</b>		
Irrigation for agriculture: considered a luxury that improved yields in a dry climate.	13	27
Industry: water use important	10	20
Domestic/drinking water expensive: use water tanks to collect rainwater	1	2
If we farmers had money we were ok	1	2
Private business	1	2
Water was a source of profit for me	1	2
<b>SUB-TOTALS: 6</b>	<b>27</b>	<b>55</b>
<b>Social</b>		
Domestic and/or household	11	22
<b>SUB-TOTALS: 1</b>	<b>11</b>	<b>22</b>
<b>Biophysical</b>		
Environment for humans and wildlife	5	10
<b>SUB-TOTALS: 1</b>	<b>5</b>	<b>10</b>
<b>Other</b>		
Game did not change my views	1	2
Importance of chance	1	2
<b>SUB-TOTALS: 2</b>	<b>2</b>	<b>4</b>
<b>Totals</b>	<b>14</b>	<b>100</b>

**Table A.3 – Turku Pre-Game Questionnaire: Who controls water?**

<b>Themes</b>	<b>Responses</b>	<b>% (n=22)</b>
<b>Political</b>		
Government and/or state: including clean water and availability	9	39
Authorities	1	4
World Bank	1	4
<b>SUB-TOTALS: 3</b>	<b>11</b>	<b>48</b>
<b>Economic</b>		
Land owner	3	13
Private businesses	2	9
Corruption: highest bidder	1	4
<b>SUB-TOTALS: 3</b>	<b>6</b>	<b>26</b>
<b>Other</b>		
I don't know	6	26
<b>SUB-TOTALS: 1</b>	<b>6</b>	<b>26</b>
<b>Totals</b>		
<b>7</b>	<b>23</b>	<b>100</b>

**Table A.4 – Turku Post Game Questionnaire: Who controls Water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=19)</b>
Government: Minister of Water controlled water distribution not the resource	14	48
Water available and steady prices	1	3
World Bank	1	3
Wrong type of water sold in rural area: needed drinking water	1	3
<b>SUB-TOTALS: 4</b>	<b>17</b>	<b>59</b>
<b>Economic</b>		
Pricing is an important tool	2	7
Economic mechanisms determined price	1	3
Economic situation	1	3
Water company	1	3
<b>SUB-TOTALS: 4</b>	<b>5</b>	<b>17</b>
<b>Social</b>		
Control depends on system and dimensions of society: citizens or state, private enterprises	2	7
<b>SUB-TOTALS: 1</b>	<b>2</b>	<b>7</b>
<b>Biophysical</b>		
Nature	2	7
Rainfall determined water availability	1	3
<b>SUB-TOTALS: 2</b>	<b>3</b>	<b>10</b>
<b>Other</b>		
I don't know	1	3
More complex than just government management	1	3
<b>SUB-TOTALS: 2</b>	<b>2</b>	<b>6</b>
<b>Totals</b>		
<b>13</b>	<b>29</b>	<b>100</b>

**Table A.5 – Turku Pre-Game Questionnaire: Issues and challenges associated with water management**

	<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>			<b>(n=17)</b>
	Uneven access	4	16
	Water quality problems	4	16
	Water scarcity for people and irrigation	4	16
	Scarce resources	1	4
	<b>SUB-TOTALS: 4</b>	<b>13</b>	<b>52</b>
<b>Economic</b>			
	Corruption	1	4
	<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>4</b>
<b>Biophysical</b>			
	Climate change	2	8
	Droughts inland	2	8
	Environ decline	1	4
	<b>SUB-TOTALS: 1</b>	<b>5</b>	<b>20</b>
<b>Other</b>			
	I don't know	6	24
	<b>SUB-TOTALS: 1</b>	<b>6</b>	<b>24</b>
<b>Totals</b>			
	<b>9</b>	<b>25</b>	<b>100</b>

**Table A.6 – Turku Post-Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=18)</b>
Scarcity common	4	13
Ensure water resources for agriculture and industry	3	10
Lack of water strategies	2	6
Making water available to all	2	6
Amount and purity of water in future are important and due to climate change	1	3
Delivery and purification	1	3
Steady water price	1	3
Water quality	1	3
Water should not be a commercial commodity but managed by the government	1	3
<b>SUB-TOTALS: 9</b>	<b>16</b>	<b>52</b>
<b>Economic</b>		
Water management impacts survival & economy	3	10
Affordability: need for subsidy when prices are high	1	3
Cash needed to buy much needed water	1	3
Does supply meet demand and does price determine availability?	1	3
People focus on survival, i.e. obtaining water, and economy suffers	1	3
<b>SUB-TOTALS: 5</b>	<b>7</b>	<b>23</b>
<b>Social</b>		
Shortage creates conflicts: not experienced in game due farmers collaborating	2	6
Domestic	1	3
<b>SUB-TOTALS: 2</b>	<b>3</b>	<b>10</b>
<b>Biophysical</b>		
Unable to predict rainfall	2	6
Climate change	1	3
Drought common	1	3
<b>SUB-TOTALS: 3</b>	<b>4</b>	<b>13</b>
<b>Other</b>		
Many issues intertwined with water problems	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>20</b>	<b>31</b>	<b>100</b>

**Table A.7 – Turku Pre-Game Questionnaire: Why do you think these issues and challenges have emerged?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=14)</b>
Absolute and relative scarcity of water resources	2	10
Resources not fairly distributed	2	10
Confliction political interests	1	5
Government	1	5
People are more conscious about the situations of developing countries	1	5
Poor infrastructure for clean water distribution	1	5
Population growth means higher consumption rates	1	5
Poverty	1	5
Problems in political system	1	5
<b>SUB-TOTALS: 9</b>	<b>11</b>	<b>55</b>
<b>Social</b>		
Overuse	1	5
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>5</b>
<b>Biophysical</b>		
Climate Change	1	5
Natural conditions	1	5
<b>SUB-TOTALS: 2</b>	<b>2</b>	<b>10</b>
<b>Other</b>		
I don't know	6	30
<b>SUB-TOTALS: 1</b>	<b>6</b>	<b>30</b>
<b>Totals</b>		
<b>13</b>	<b>20</b>	<b>100</b>

**Table A.8 – Turku Post-Game Questionnaire: Why have these issues and challenges emerged?**

Themes	Responses	%
<b>Political</b>		<b>(n=17)</b>
Lack of cooperation and co-ordination within and between sectors	2	6
Lack of sufficient technology as well as access to such technical equipment	2	6
Corruption	1	3
Difficult circumstances: problems associated with limited or no finances to produce water systems	1	3
Government does not realise all the aspects of water usage and does prioritises incorrectly	1	3
Government regulates price	1	3
High costs of producing clean water	1	3
Inability to create, finance or maintain water infrastructure	1	3
Inequity between welfare sates and development countries	1	3
Planning without knowledge of climate change is a crucial issue	1	3
Poor water management	1	3
Price unpredictability	1	3
Rural and industrial management by government is important and private is not the best solution	1	3
Unfair division of resource leads to problems	1	3
Water is a crucial resource for survival and production, i.e. rural and industrial sector	1	3
Water supply regulated if need be	1	3
Weak water policy	1	3
<b>SUB-TOTALS: 17</b>	<b>19</b>	<b>61</b>
<b>Economic</b>		
Holder of resource will ask high price and resort to violence	1	3
Low production means limited money to buy water	1	3
Problems in industrial sector	1	3
<b>SUB-TOTALS: 3</b>	<b>3</b>	<b>9</b>
<b>Social</b>		
Globalization and information technology	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Biophysical</b>		
Natural climatic conditions	3	10
Geographical location of farms determine low or high rainfall	2	6
Droughts leading to shortage of water resources	1	3
Environmental issues	1	3
<b>SUB-TOTALS: 4</b>	<b>7</b>	<b>22</b>
<b>Other</b>		
I don't know	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>25</b>	<b>31</b>	<b>99 or 100</b>

**Table A.9 – Turku Post Game Questionnaire: How has the game helped you to gain a better understanding of water management?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=17)</b>
Understand importance of water and water management: associated dependencies, challenges and complexity	9	41
Control problems with water	1	5
Do not understand how and when government received water & how it was transported for distribution	1	5
Importance of chance and cooperation	1	5
Lack of information, water and food	1	5
<b>SUB-TOTALS: 5</b>	<b>13</b>	<b>61</b>
<b>Economic</b>		
Material economy system as whole is a dynamic processes	2	9
<b>SUB-TOTALS: 1</b>	<b>2</b>	<b>9</b>
<b>Social</b>		
Strategy needed for obtaining food and water for family: requires sacrifices and time	1	5
Understood demands of people in rural sector relative to my urban sector after group discussion	1	5
<b>SUB-TOTALS: 2</b>	<b>2</b>	<b>10</b>
<b>Biophysical</b>		
Strengthened understanding of the importance of water for life and should not be treated as any other type of commodity	1	5
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>5</b>
<b>Other</b>		
Cannot trust game accurately representing reality and realised there is no information to base this judgment	1	5
Don't think I got an overall picture as a peasant	1	5
Initial conditions different but developed into conditions similar to Finland	1	5
No changes in thinking	1	5
<b>SUB-TOTALS: 4</b>	<b>4</b>	<b>20</b>
<b>Totals</b>		<b>105 or</b>
<b>13</b>	<b>22</b>	<b>100</b>

**Table A.10 – Turku Pre-Game Questionnaire: How is water used in your local environment?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=22)</b>
Political (including land and sea planning)	3	5
Excess water pumped into sea resulting in pollution	2	3
Freely managed by government	1	2
Fresh water used for both domestic and industrial purposes	1	2
Lack of drinking water services in rural areas	1	2
More water used for farming and industry	1	2
Urban areas receive water from dams in coastal areas	1	2
<b>SUB-TOTALS: 7</b>	<b>10</b>	<b>16</b>
<b>Economic</b>		
Industry (including construction, electricity, transporting heat)	12	19
Agriculture and/or irrigation	9	14
Tourism and recreation	4	6
Economical (including logistics and tap water)	3	5
<b>SUB-TOTALS: 4</b>	<b>28</b>	<b>44</b>
<b>Social</b>		
Domestic or households are principal users: drinking, sanitation, gardening	13	21
Social (including coastal activities)	3	5
Water surplus thus careless use	5	8
<b>SUB-TOTALS: 3</b>	<b>21</b>	<b>33</b>
<b>Biophysical</b>		
Biophysical	2	3
<b>SUB-TOTALS: 1</b>	<b>2</b>	<b>3</b>
<b>Other</b>		
All dimensions	1	2
All life	1	2
<b>SUB-TOTALS: 2</b>	<b>2</b>	<b>3</b>
<b>Totals</b>		
<b>16</b>	<b>63</b>	<b>100</b>

**Table A.11 – Turku Post-Game Questionnaire: How is water used in your local context?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=18)</b>
Local government	2	5
Finland recently experienced dry summers causing low ground water levels and although agriculture has not faced major difficulties this may change if there are consistent future droughts	1	3
<b>SUB-TOTALS: 2</b>	<b>3</b>	<b>8</b>
<b>Economic</b>		
Industrial	8	21
Agricultural	5	13
Most water purified, abundant and affordable: high consumption rates	3	8
Tourism and recreation	2	5
Clean water available but expensive	1	3
Economical (including logistics and tap water)	1	3
Private firms	1	3
<b>SUB-TOTALS: 8</b>	<b>21</b>	<b>54</b>
<b>Social</b>		
Domestic	9	23
Social (including coastal activities)	1	3
Taken for granted despite climate change	1	3
<b>SUB-TOTALS: 3</b>	<b>11</b>	<b>29</b>
<b>Biophysical</b>		
Biophysical	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Other</b>		
All life	1	3
More water used for farming and industry	1	3
Various aspects	1	3
<b>SUB-TOTALS: 1</b>	<b>3</b>	<b>9</b>
<b>Totals</b>		
<b>17</b>	<b>39</b>	<b>100</b>

**Table A.12 – Turku Pre-Game Questionnaire: Who controls water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=22)</b>
National, state, city, local government and/or municipality	9	25
Laws: society and environment authorities	3	8
Water department	3	8
City department	1	3
Political power: decision making and infrastructure	1	3
Water loosely controlled and cheap	1	3
<b>SUB-TOTALS: 6</b>	<b>18</b>	<b>50</b>
<b>Economic</b>		
Local water companies, owned by community/town, control price	4	11
Private enterprise, commercial authorities	2	6
Local energy company	1	3
Market mechanisms control price	1	3
Owner of building	1	3
<b>SUB-TOTALS: 5</b>	<b>9</b>	<b>22</b>
<b>Social</b>		
Households and consumers	4	11
Community	1	3
Country: wells	1	3
<b>SUB-TOTALS: 3</b>	<b>6</b>	<b>17</b>
<b>Biophysical</b>		
Local environment	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Other</b>		
Biophysical and social environmental degradation of Baltic Sea is due to Political and Economic reasons	1	3
Difficult to identify	1	3
<b>SUB-TOTALS: 2</b>	<b>2</b>	<b>6</b>
<b>Totals</b>		
<b>17</b>	<b>36</b>	<b>98</b>

**Table A.13 – Turku Post-Game Questionnaire: Who controls water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=17)</b>
National, state, city, local government, municipality, water department	11	48
Laws: society and environment authorities	2	9
City department	1	4
Political power: decision making and infrastructure	1	4
<b>SUB-TOTALS: 4</b>	<b>15</b>	<b>65</b>
<b>Economic</b>		
Local energy company	1	4
Market mechanisms controls price	1	4
Private sector, e.g. water companies	1	4
Well owners	1	4
<b>SUB-TOTALS: 4</b>	<b>4</b>	<b>17</b>
<b>Social</b>		
Households and consumers	2	9
<b>SUB-TOTALS: 1</b>	<b>2</b>	<b>9</b>
<b>Biophysical</b>		
Nature	1	4
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>4</b>
<b>Other</b>		
Biophysical and social environmental degradation of Baltic Sea is due to Political and Economic reasons	1	4
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>4</b>
<b>Totals</b>		
<b>11</b>	<b>23</b>	<b>100</b>

**Table A.14 – Turku Pre-Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=22)</b>
Main issue: quality	9	26
Purification of waste water not efficient: system requires large energy amounts & produces non-renewable resources	4	11
More regulations in south west of Finland	2	6
Conflicting opinions of stakeholders to use eskers to filter water	1	3
Infrastructure building for better access creates environmental issues	1	3
Poor international management of water pollution associated with Baltic Sea	1	3
Promotion of fair payments	1	3
Provide drinking water to rural population	1	3
Sustainable criteria for water management	1	3
Sustainable sources of water for urban areas	1	3
<b>SUB-TOTAL: 10</b>	<b>22</b>	<b>64</b>
<b>Economic</b>		
Baltic Sea impacts on tourism and recreation and vice versa	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Social</b>		
Water abundant: use drinking water for sanitation, etc. which leads to careless use	3	9
Population and consumption increasing	2	6
<b>SUB-TOTAL: 2</b>	<b>5</b>	<b>15</b>
<b>Biophysical</b>		
Dry periods impact quantity and quality	5	14
Alien species in Baltic Sea	1	3
Environmental issues	1	3
<b>SUB-TOTAL: 3</b>	<b>7</b>	<b>20</b>
<b>Totals</b>		
<b>16</b>	<b>35</b>	<b>100</b>

**Table A.15 – Turku Post-Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=17)</b>
Sea pollution: polluters should pay hefty fines	4	13
Water quality	4	13
Conflicting opinions of stakeholders to use eskers to filter water	1	3
Force to pay then those who use more have to pay	1	3
Include true costs that reflect value of scarce resource	1	3
Purification of waste water not efficient: system requires large energy amounts & produces non-renewable resources	1	3
Reduce corruption	1	3
Unsure of where to take grey domestic water	1	3
<b>SUB-TOTALS: 8</b>	<b>14</b>	<b>47</b>
<b>Economic</b>		
Firms use more water than necessary	2	7
<b>SUB-TOTALS: 1</b>	<b>2</b>	<b>7</b>
<b>Social</b>		
Water abundant: use drinking water for sanitation, etc. which leads to careless use	3	10
Waste water	1	3
<b>SUB-TOTALS: 2</b>	<b>4</b>	<b>13</b>
<b>Biophysical</b>		
Nature	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Other</b>		
Water shortages especially during summer <sup>2</sup>	4	13
Alien species in Baltic Sea	3	10
Dry periods impact quantity and quality*	2	7
<b>SUB-TOTALS: 3</b>	<b>9</b>	<b>30</b>
<b>Totals</b>		
<b>15</b>	<b>30</b>	<b>100</b>

<sup>1</sup> and <sup>\*</sup> These two themes fall under both the Political and Biophysical Dimensions. Since participants did not indicated strongly towards a particular dimension, the themes were placed under Other.

**Table A.16 – Turku Post-Game Questionnaire: Why do you think these issues and challenges have emerged?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=22)</b>
Areas without or decreasing ground water	2	7
Political decisions unable to curb eutrophication of the Baltic Sea	2	7
Poor water resources within towns thus imported	2	7
Water quality	2	7
Bad planning due to short sightedness	1	3
Household and industrial consumption too high	1	3
Human errors	1	3
Lack of strong institutions	1	3
Pipelines are too old	1	3
Sea shared as a global commons which is very polluted	1	3
Shortages of water	1	3
Water moved away from towns to generate much needed energy	1	3
<b>SUB-TOTALS: 12</b>	<b>16</b>	<b>55</b>
<b>Economic</b>		
Water availability taken for granted	2	7
Actions such as rd building, industry, etc. impacts water, especially ground water	1	3
Cycle of poverty	1	3
Modernisation over last 50 years	1	3
<b>SUB-TOTALS: 4</b>	<b>5</b>	<b>17</b>
<b>Social</b>		
Use water freely as a public commodity	2	7
Increasing consumption	1	3
Role of agriculture traditionally important while environmental issues are regarded as secondary	1	3
<b>SUB-TOTALS: 3</b>	<b>4</b>	<b>14</b>
<b>Biophysical</b>		
Climate change	2	7
Water is important for life	1	3
<b>SUB-TOTALS: 2</b>	<b>3</b>	<b>10</b>
<b>Other</b>		
God He initially invented humans	1	3
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>22</b>	<b>29</b>	<b>100</b>

**Table A.17 – Turku Post-Game Questionnaire: Issues and challenges associated with water management**

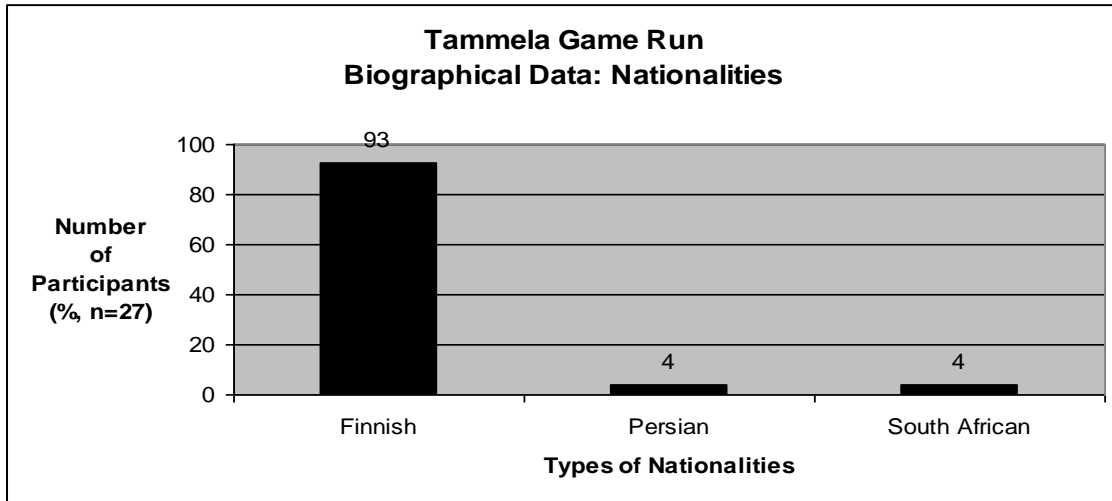
<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=17)</b>
Political decisions unable to curb eutrophication of the Baltic Sea	2	11
Ground water level is too low	2	11
Bad planning due to short sightedness	1	5
Conservation issues & water management not properly considered	1	5
Household and industrial consumption too high	1	5
Human errors	1	5
Non-visionary planning and preparation.	1	5
Pipelines are too old	1	5
Poor water resources within towns thus imported	1	5
Purification station outdated	1	5
Quality control	1	5
Water is a public good and managed by veiled interests of politicians	1	5
Water moved away from towns to generate much needed energy	1	5
<b>SUB-TOTALS: 13</b>	<b>15</b>	<b>79</b>
<b>Social</b>		
Careless use	1	5
Use water freely as a public commodity	1	5
<b>SUB-TOTALS: 2</b>	<b>2</b>	<b>10</b>
<b>Biophysical</b>		
Climate change	1	5
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>5</b>
<b>Other</b>		
God He initially invented humans	1	5
<b>SUB-TOTALS: 1</b>	<b>1</b>	<b>5</b>
<b>Totals</b>		
<b>17</b>	<b>19</b>	<b>100</b>

**Table A.18 – Turku Post Game Questionnaire: How has the game helped you to gain a better understanding of water management in a southern African context?**

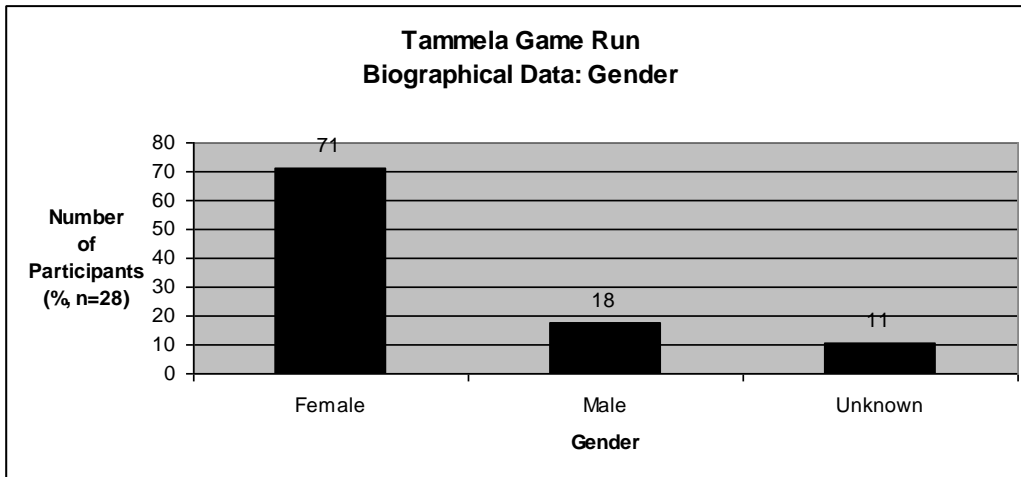
<b>Themes</b>	<b>Responses</b>	<b>% (n=19)</b>
<b>Political</b>		
Strengthened understanding of water's essential role, its management, complexity of associated issues and how crucial water resources are in all regions and countries	6	29
If we Finns import water from countries that have water problems we are thus part of the high consumption problem	1	5
Key variables not included: e.g. corruption of public providers, etc.	1	5
Water management will be the most important issue for humankind in the 21 <sup>st</sup> century	1	5
Water measuring equipment should be installed in houses so that payment reflects total amount used	1	5
<b>SUB-TOTALS: 5</b>	<b>10</b>	<b>48</b>
<b>Social</b>		
Will give more attention to water issues especially shortages during dry summers	3	14
Use water as a non-limited resource and should appreciate it more	2	10
Realise water can be scarce in both Finland and other countries	1	5
Realised how fortunate we Finns are in terms of water	1	5
Water so readily and abundantly available in Finland that I cannot see same African problems happening here	1	5
<b>SUB-TOTALS: 5</b>	<b>8</b>	<b>38</b>
<b>Other</b>		
Already teaching thus topic familiar	1	5
Game different to local reality: it has not helped	1	5
Various aspects	1	5
<b>SUB-TOTALS: 3</b>	<b>3</b>	<b>14</b>
<b>Totals</b>		
<b>13</b>	<b>21</b>	<b>100</b>

**Appendix B: Chapter 6: Tammela Game Run**

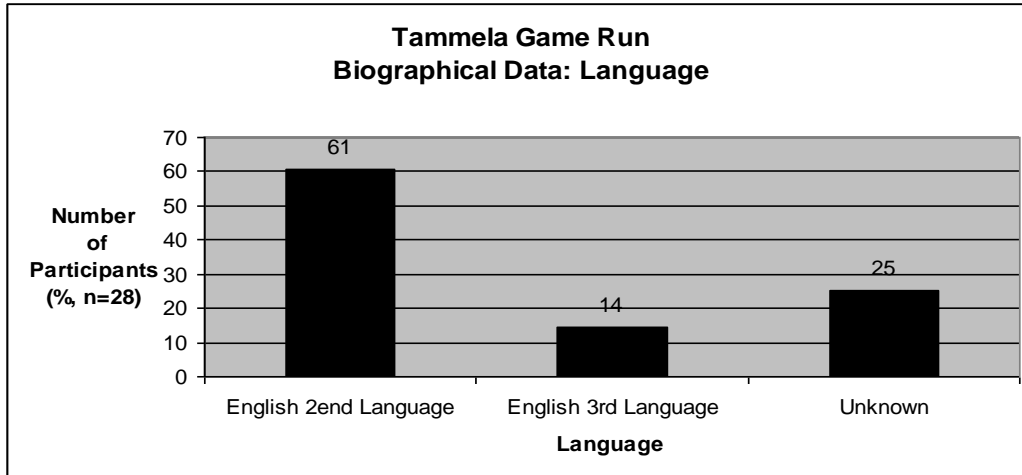
**Biographical Data: Figure B.1 to B.7**



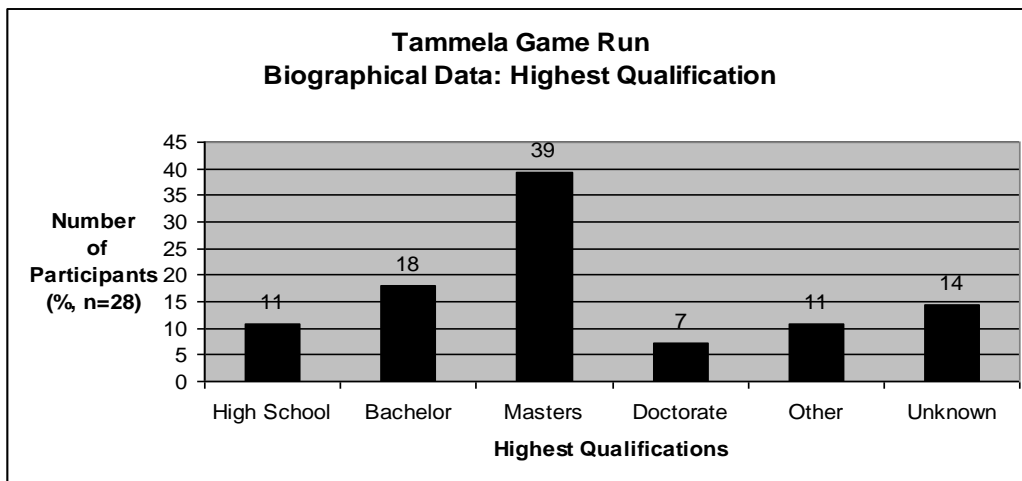
**Figure B.1 – Tammela Game Run: Nationality of Participants**



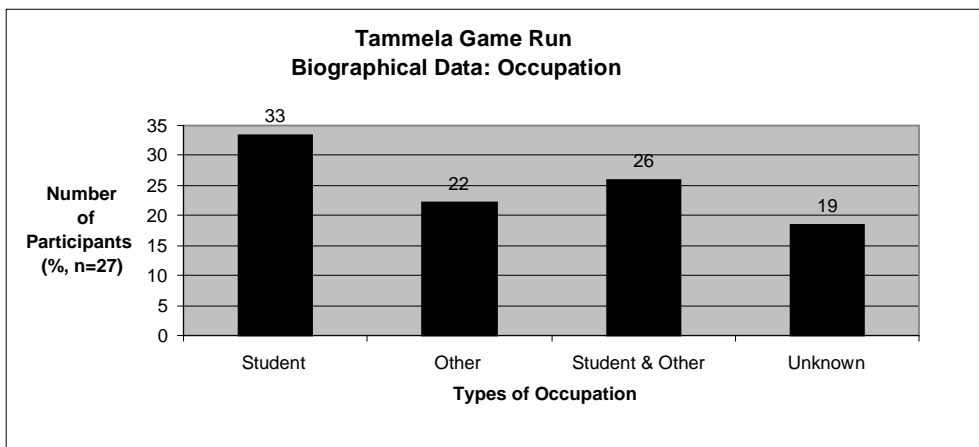
**Figure B.2 - Tammela Game Run: Gender of Participants**



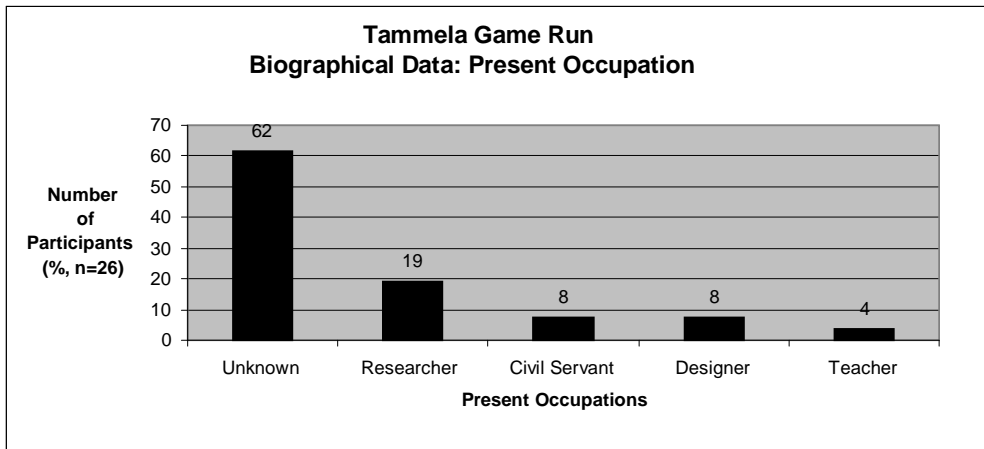
**Figure B.3 – Tammela Game Run: Language of Participants**



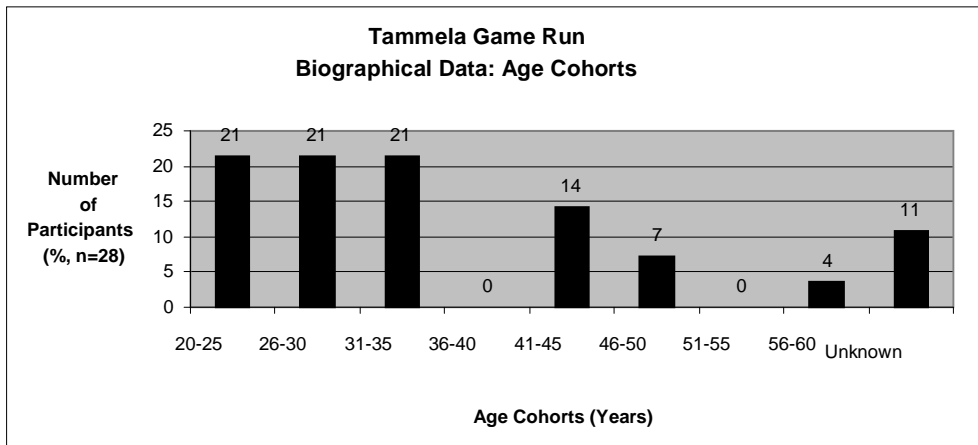
**Figure B.4 – Turku Game Run: Highest Qualification of Participants**



**Figure B.5 - Tammela Game Run: Types of Participants' Occupation**



**Figure B.6 - Tammela Game Run: Present Occupation of Participants**



**Figure B.7 - Tammela Game Run: Ages of Participants**

**Pre- and Post-Questionnaires: Tables 6.1 to 6.19**

**Table B.1 - Tammela Pre- Game Questionnaire: How is water used in a southern African context?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Rural areas have wells but no connecting infrastructure to houses	6	17
Not enough water for everyone	5	14
Disfavours black people	4	11
Many are not part of public water supply	1	3
Political	1	3
Poor water quality	1	3
Water management favours large land owners	1	3
<b>SUB-TOTAL: 7</b>	<b>19</b>	<b>53</b>
<b>Economic</b>		
Agriculture	10	28
Economic	1	3
Industry	1	3
Water costs high	1	3
<b>SUB-TOTAL: 4</b>	<b>13</b>	<b>36</b>
<b>Social</b>		
Social	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Biophysical</b>		
Biophysical	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Other</b>		
I don't know	3	8
<b>SUB-TOTAL: 1</b>	<b>3</b>	<b>8</b>
<b>Totals</b>		
<b>14</b>	<b>37</b>	<b>103</b>

**Table B.2 – Tammela Post- Game Questionnaire: How is water used in a southern African context?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=25)</b>
Managed by government	1	2
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>2</b>
<b>Economic</b>		
Agriculture	21	32
Industry	20	30
Access: Buy and store or "catch" rainwater	1	2
Used as a trading commodity	1	2
<b>SUB-TOTAL: 4</b>	<b>43</b>	<b>65</b>
<b>Social</b>		
Domestic	20	30
Crucial for survival	1	2
<b>SUB-TOTAL: 2</b>	<b>21</b>	<b>32</b>
<b>Biophysical</b>		
Access: unequal	1	2
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>2</b>
<b>Totals</b>		
<b>8</b>	<b>66</b>	<b>100</b>

**Table B.3 – Tammela Pre- Game Questionnaire: Who controls water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=20)</b>
Government, state, municipality, and/or local authorities	10	37
Political system: aims to be fair and equal	2	7
Water authorities	1	4
<b>SUB-TOTAL: 3</b>	<b>13</b>	<b>48</b>
<b>Economic</b>		
Private sector: companies	3	11
Owners of water storage	2	7
Economic sectors	1	4
Wealthy people	1	4
<b>SUB-TOTAL: 4</b>	<b>7</b>	<b>26</b>
<b>Social</b>		
People living in the area, e.g. communes	2	7
Social sectors	1	4
<b>SUB-TOTAL: 2</b>	<b>3</b>	<b>11</b>
<b>Other</b>		
I don't know	4	15
<b>SUB-TOTAL: 1</b>	<b>4</b>	<b>15</b>
<b>Totals</b>		
<b>10</b>	<b>27</b>	<b>100</b>

**Table B.4 – Tammela Post- Game Questionnaire: Who controls Water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=24)</b>
Government: state, water minister, municipalities	24	80
Political control	1	3
<b>SUB-TOTAL: 2</b>	<b>26</b>	<b>83</b>
<b>Economic</b>		
Economic control	1	3
Grey water	1	3
Prices	1	3
Sellers	1	3
<b>SUB-TOTAL: 4</b>	<b>4</b>	<b>13</b>
<b>Biophysical</b>		
Nature	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>7</b>	<b>30</b>	<b>100</b>

**Table B.5 – Tammela Pre- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=22)</b>
Infrastructure: equal water supply system	8	24
Access: long distances to water source(s)	5	15
Water purification process not used and/or underdeveloped	2	6
Hygiene and sanitation problems	1	3
Pollution	1	3
Problems at local, national and international level	1	3
Water quality	1	3
<b>SUB-TOTAL: 7</b>	<b>19</b>	<b>56</b>
<b>Economic</b>		
Price of clean water	3	9
Agricultural problems, e.g. large scale farms	2	6
<b>SUB-TOTAL: 2</b>	<b>5</b>	<b>15</b>
<b>Biophysical</b>		
Dry seasons: lack of water, ground water, impact on food security	6	18
Erosion due to droughts	1	3
Climate Change	1	3
<b>SUB-TOTAL: 3</b>	<b>8</b>	<b>24</b>
<b>Other</b>		
I don't know	2	6
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>6</b>
<b>Totals</b>		
<b>13</b>	<b>34</b>	<b>100</b>

**Table B.6 – Tammela Post- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=20)</b>
Supply cannot meet demand	6	16
Infrastructure: transportation of water	4	11
Recycling water	2	5
Education	1	3
Government should have co-operated more	1	3
High birth rate	1	3
Hygiene	1	3
Poor water management and policies	1	3
Uneven distribution of resources	1	3
<b>SUB-TOTAL: 9</b>	<b>18</b>	<b>49</b>
<b>Economic</b>		
High water fees	5	14
Grey water	1	3
Industry: when dry inputs difficult to obtain	1	3
<b>SUB-TOTAL: 3</b>	<b>7</b>	<b>19</b>
<b>Social</b>		
Communication	1	3
Culture of collecting water fees rude and de-motivating	1	3
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>5</b>
<b>Biophysical</b>		
Droughts	6	16
Water amount depends on nature	2	5
<b>SUB-TOTAL: 2</b>	<b>8</b>	<b>22</b>
<b>Other</b>		
Didn't notice water shortages	1	3
Everything is an issue	1	3
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>5</b>
<b>Totals</b>		
<b>18</b>	<b>37</b>	<b>100</b>

**Table B.7 – Tammela Pre- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=20)</b>
Historical reasons: apartheid	7	18
Poor management: over-use and mis-control	5	13
Supply not meeting demand	5	13
Limited or poor infrastructure	3	8
Policies	2	5
Uneven resource of welfare	2	5
Contamination causes diseases	1	3
Country "behind" in development: level of water quality, education, ignorance	1	3
Large gaps in standard of living	1	3
<b>SUB-TOTAL: 9</b>	<b>27</b>	<b>68</b>
<b>Economic</b>		
Agriculture focused on export	1	3
Enough water needed for production: agricultural and industrial	1	3
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>5</b>
<b>Social</b>		
Attitude: cultural differences, greed	3	8
Lack of awareness	2	5
<b>SUB-TOTAL: 2</b>	<b>5</b>	<b>13</b>
<b>Biophysical</b>		
Climate change and/or global warming	3	8
Climate and geography	1	3
<b>SUB-TOTAL: 2</b>	<b>4</b>	<b>10</b>
<b>Other</b>		
I don't know	2	5
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>5</b>
<b>Totals</b>		
<b>16</b>	<b>40</b>	<b>100</b>

**Table B.8 – Tammela Post- Game Questionnaire: Why have these issues and challenges emerged**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=20)</b>
Government distribution and management problems	6	19
Lack of cooperation	5	16
Supply cannot meet demand	3	10
Access and associated loss	1	3
Historical background	1	3
Limited infrastructure	1	3
No birth control	1	3
State of industrialization	1	3
<b>SUB-TOTAL: 8</b>	<b>19</b>	<b>61</b>
<b>Economic</b>		
High prices	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Social</b>		
Water is a fatal necessity	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Biophysical</b>		
Depend on climate that is challenging	8	26
Geographical location	1	3
<b>SUB-TOTAL: 2</b>	<b>9</b>	<b>29</b>
<b>Other</b>		
I don't know	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>13</b>	<b>31</b>	<b>100</b>

**Table B.9 – Tammela Post- Game Questionnaire: How has the game helped you to gain a better understanding of water management?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
How sectors work together	4	12
Lack of routine and control in SA	4	12
Realise importance of water and water management	2	6
Avoiding possible future droughts	1	3
Basic needs not met	1	3
Better view of micro history	1	3
State makes major role in decision making that sharply impacts on living conditions	1	3
<b>SUB-TOTAL: 7</b>	<b>14</b>	<b>42</b>
<b>Economic</b>		
Access: difficult to get money to pay for domestic water	3	9
Problems small farmers face was authentic	3	9
Commercial farmers didn't play significant role	1	3
<b>SUB-TOTAL: 3</b>	<b>7</b>	<b>21</b>
<b>Social</b>		
Changing survival strategies	1	3
Ignorance	1	3
Very different to Finland: water abundant and don't appreciate it	1	3
<b>SUB-TOTAL: 3</b>	<b>3</b>	<b>9</b>
<b>Biophysical</b>		
Heavy rains means more pests	1	3
Impact of drought	1	3
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>6</b>
<b>Other</b>		
Don't see added value of this game	2	6
Yes	2	6
Helped in some ways	1	3
I don't know	1	3
Water issue not clear due to no lack of water in game	1	3
<b>SUB-TOTAL: 5</b>	<b>7</b>	<b>21</b>
<b>Totals</b>		
<b>20</b>	<b>33</b>	<b>100</b>

**Table B.10 – Tammela Pre- Game Questionnaire: How is water used?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=20)</b>
Drinkable water used for everything	28	23
Water infrastructure	6	5
Recreation	16	13
Water shortages in the countryside	2	2
<b>SUB-TOTAL: 5</b>	<b>52</b>	<b>43</b>
<b>Economic</b>		
Industry	22	18
Agriculture	19	16
Water cheap	11	9
People own wells in the country	2	2
City water companies run water businesses and services	1	1
Energy: power generation	1	1
<b>SUB-TOTAL: 6</b>	<b>56</b>	<b>47</b>
<b>Social</b>		
Domestic	4	3
Used liberally: overused not conserved	2	2
<b>SUB-TOTAL: 2</b>	<b>6</b>	<b>5</b>
<b>Biophysical</b>		
Water available for all: numerous natural lakes	6	5
<b>SUB-TOTAL: 1</b>	<b>6</b>	<b>5</b>
<b>Other</b>		
Nokia incident created awareness of water's importance	2	2
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>2</b>
<b>Totals</b>		
<b>14</b>	<b>122</b>	<b>100</b>

**Table B.11 – Tammela Post- Game Questionnaire: How is water used?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Access to water highlighted: how challenging it is	1	2
Don't use as much irrigation as SA	1	2
Municipalities	1	2
Water management very good	1	2
<b>SUB-TOTAL: 4</b>	<b>4</b>	<b>8</b>
<b>Economic</b>		
Agriculture	10	21
Industry	10	21
Recreation	1	2
Power generation	1	2
Public sector	1	2
Water is imported and exported	1	2
<b>SUB-TOTAL: 6</b>	<b>24</b>	<b>50</b>
<b>Social</b>		
Domestic	12	25
Liberal water use: people use water without thinking	5	10
Now appreciate local water	1	2
Society	1	2
<b>SUB-TOTAL: 4</b>	<b>19</b>	<b>40</b>
<b>Biophysical</b>		
Water for everyone: spare water in lakes	1	2
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>2</b>
<b>Totals</b>		
<b>15</b>	<b>48</b>	<b>100</b>

**Table B.12 – Tammela Pre- Game Questionnaire: Who controls water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=25)</b>
Municipality, government, state	14	37
Communities: communal bodies	5	13
Water companies owned or managed by local municipalities	2	5
Government makes laws to prevent pollution	1	3
Municipal water company: quality and supply	1	3
No water restrictions but recommendations during hot dry summers	1	3
Rules and regulations for country side rule	1	3
State controls private	1	3
<b>SUB-TOTAL: 9</b>	<b>26</b>	<b>68</b>
<b>Economic</b>		
Water companies deliver water	4	11
Own well and land	2	5
Private owners	2	5
Market prices	1	3
<b>SUB-TOTAL: 4</b>	<b>9</b>	<b>24</b>
<b>Social</b>		
Realistically no one controls how much a person uses	1	3
Used liberally: overused not conserved	1	3
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>5</b>
<b>Other</b>		
Have not yet thought about this	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>16</b>	<b>38</b>	<b>100</b>

**Table B.13 – Tammela Post- Game Questionnaire: Who controls water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=22)</b>
National and communal government, minister of environmental science, state, city, municipality	19	56
Companies owned or managed by local municipalities	2	6
Quality controlled by officials	1	3
Through rules and regulations	1	3
<b>SUB-TOTAL: 4</b>	<b>23</b>	<b>68</b>
<b>Economic</b>		
Private owners, e.g. water companies	6	18
No payment means no water	1	3
<b>SUB-TOTAL: 2</b>	<b>7</b>	<b>21</b>
<b>Social</b>		
Communities	2	6
Every single person	1	3
<b>SUB-TOTAL: 2</b>	<b>3</b>	<b>9</b>
<b>Biophysical</b>		
Nature	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>9</b>	<b>34</b>	<b>100</b>

**Table B.14 – Tammela Pre- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=20)</b>
Quality assurance	7	20
Maintenance: plumbing	6	17
Pollution: industrial waste	5	14
Nokia incident involving the contamination of domestic water	3	9
Securing water supply without damaging the environment	3	9
Anticipating society's needs	1	3
Decreasing groundwater	1	3
Issues concerning water generated power	1	3
Long term planning	1	3
Purification	1	3
Worker's education	1	3
<b>SUB-TOTAL: 11</b>	<b>30</b>	<b>86</b>
<b>Economic</b>		
Price: monopoly of Scandinavian energy companies	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Social</b>		
People careless about water use	2	6
Human errors	1	3
<b>SUB-TOTAL: 2</b>	<b>3</b>	<b>9</b>
<b>Other</b>		
None really	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Totals</b>		
<b>15</b>	<b>35</b>	<b>100</b>

**Table B.15 – Tammela Post- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=20)</b>
Maintenance: freezing water pipes, sewage control in country houses, 1995 technology used	4	14
Pollution in Baltic Sea	4	14
Waste water management is state regulated	3	11
Green policy application	2	7
Water quality: Nokia incident and future needs	2	7
Lack of groundwater	1	4
Minor concerns that involve obtaining water in a environmentally friendly manner	1	4
Not aware of management problems	1	4
Strict rules	1	4
Water delivery	1	4
<b>SUB-TOTAL: 10</b>	<b>20</b>	<b>71</b>
<b>Economic</b>		
Price monopoly of Scandinavian energy companies	1	4
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>4</b>
<b>Social</b>		
Citizens	1	4
During dry periods people use wells	1	4
Liberal use as well as misuse of water	1	4
Water crisis due to human errors	1	4
<b>SUB-TOTAL: 4</b>	<b>4</b>	<b>14</b>
<b>Biophysical</b>		
Droughts during growing season	1	4
Soil nutrients washed away	1	4
"Sweet" water readily available: lakes	1	4
<b>SUB-TOTAL: 3</b>	<b>3</b>	<b>11</b>
<b>Totals</b>		
<b>18</b>	<b>28</b>	<b>100</b>

**Table B.16 – Tammela Pre- Game Questionnaire: How have these issues and challenges emerged?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Water quality: contamination	2	8
Difficult to inspect and maintain underground parking	1	4
Growing population and decreasing	1	4
Increase water use through power generation	1	4
Lack of relevant legislation concerning the environment	1	4
Need for clean, available water	1	4
People in decision making must realise risks	1	4
Environmental conditions within the Gulf of Finland and impact on neighbouring countries	1	4
<b>SUB-TOTAL: 8</b>	<b>9</b>	<b>36</b>
<b>Economic</b>		
Forestry industry uses lots of paper to manufacture paper	2	8
Agriculture pollutes environment	1	4
Industrialisation and modern practices	1	4
<b>SUB-TOTAL: 3</b>	<b>4</b>	<b>16</b>
<b>Social</b>		
Used liberally: overused not conserved	4	16
Low level of environmental awareness	3	12
Desire for comfort	1	4
Human errors	1	4
<b>SUB-TOTAL: 4</b>	<b>9</b>	<b>36</b>
<b>Biophysical</b>		
Climate change	3	12
<b>SUB-TOTAL: 1</b>	<b>3</b>	<b>12</b>
<b>Totals</b>		
<b>16</b>	<b>25</b>	<b>100</b>

**Table B.17 – Tammela Post- Game Questionnaire: How have these issues and challenges emerged?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=18)</b>
Maintenance: underground piping difficult to inspect, maintenance problems emerge slowly, misuse and poor management	2	10
Countries have different pollution policies	1	5
Government concerned that every citizen will have access to water	1	5
Growing energy consumption	1	5
Human failure in governance	1	5
Location outside normal sewage systems	1	5
No quality assurance systems	1	5
<b>SUB-TOTAL: 7</b>	<b>8</b>	<b>40</b>
<b>Economic</b>		
Accidents associated with water systems are expensive	1	5
Use of fertilizers and nutrients in farming	1	5
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>10</b>
<b>Social</b>		
Desire for comfort	1	5
Lack of knowledge on environmental issues: naivety regarding pollution	1	5
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>10</b>
<b>Biophysical</b>		
Nature and/or climate	4	20
Blessed with an abundance of water	1	5
Ecological footprint bigger than Finns think	1	5
Pollution, e.g. produced by transportation	1	5
Unpredictable rainfall	1	5
<b>SUB-TOTAL: 5</b>	<b>8</b>	<b>40</b>
<b>Totals</b>		
<b>16</b>	<b>20</b>	<b>100</b>

**Table B.18 – Tammela Post- Game Questionnaire: How has the game helped you to gain a better understanding of water management?**

Themes	Responses	%	Yes	No	Unsure
<b>Social</b>					
More frustrated with people who buy bottled water when Finnish water is the cleanest in the world	1	4	4	-	-
Understand how demoralising greed and careless attitudes towards clients are	1	4	4	-	-
Desire for comfort	1	4	4	-	-
Lack of knowledge on environmental issues: naivety regarding pollution	1	4	4	-	-
<b>SUB-TOTAL: 4</b>	<b>7</b>	<b>16</b>	<b>16</b>	<b>-</b>	<b>-</b>
<b>Biophysical</b>					
African context so very different that it didn't make a difference	4	17	-	17	-
Have more of an interest in Finnish irrigation system	1	4	-	4	-
<b>SUB-TOTAL: 2</b>	<b>5</b>	<b>22</b>	<b>-</b>	<b>22</b>	<b>-</b>
<b>Other</b>					
Raised awareness: water has social, economic and biophysical value and should be appreciated	4	17	17	-	-
Not really	3	13	-	-	13
Difficult to say: need more time to think about it	2	9	-	-	9
Happy to live in Finland where there is positive land to water ratio	2	9	9	-	-
Better understanding due to comparing situation in two countries	1	4	4	-	-
No	1	4	-	4	-
See connection between resources, policy and culture	1	4	4	-	-
<b>SUB-TOTAL: 7</b>	<b>14</b>	<b>60</b>	<b>34</b>	<b>4</b>	<b>20</b>
<b>Totals</b>					
<b>14</b>	<b>23</b>	<b>100</b>	<b>50</b>	<b>30</b>	<b>20</b>

**Table B.19 – Tammela Post- Game Questionnaire: Do you think that you would be able to use insights from your game experience?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=24)</b>
Government's role to openly help	1	4
How to build a constructive and motivating "water culture"	1	4
In crisis management and in the field	1	4
When I become a union labourer	1	4
<b>SUB-TOTAL: 4</b>	<b>4</b>	<b>15</b>
<b>Economic</b>		
Can use idea of ACG in my job and in lectures	2	7
Never interested in economics but gained understanding of its functioning	1	4
Tool to model agricultural and/or dairy markets	1	4
<b>SUB-TOTAL: 3</b>	<b>4</b>	<b>15</b>
<b>Social</b>		
General knowledge and discussions	1	4
Insights in my own life: been to shy in the past to try new things	1	4
Research and/or studies: dissertation on systems thinking and importance of keeping things simple, development studies, redesign management and/or development process	1	4
Social dynamics discovered in game can be used in work	1	4
<b>SUB-TOTAL: 4</b>	<b>4</b>	<b>15</b>
<b>Other</b>		
Need more time to think and reflect	6	22
Yes	6	22
Global understanding of different dimensions	1	4
How different the two countries are and the impact of "water systems" in each country	1	4
Skeptical insights	1	4
<b>SUB-TOTAL: 5</b>	<b>15</b>	<b>56</b>
<b>Totals</b>		
<b>16</b>	<b>27</b>	<b>100</b>

## Appendix C: Chapter 7: Amakhala Game Run

### Biographical Data: Figures C.1 to C.7

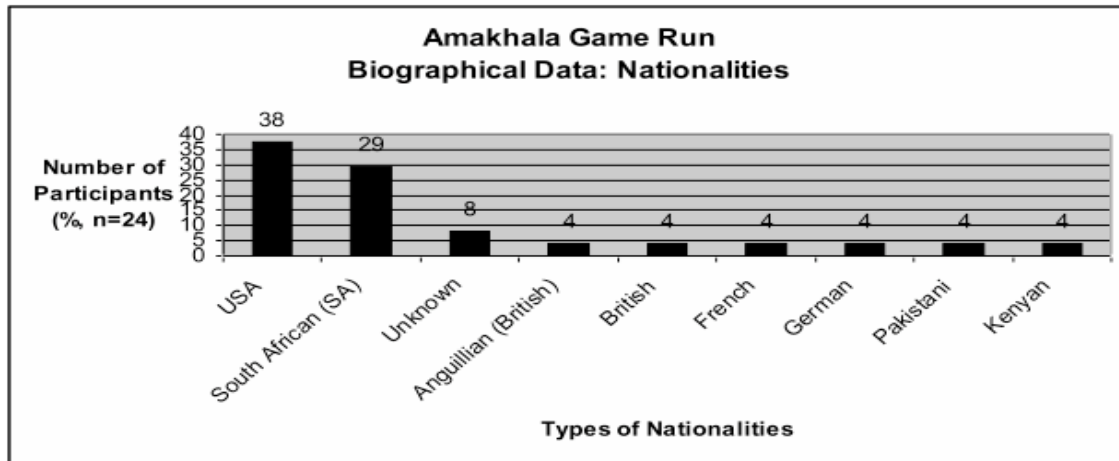


Figure C.1 – Amakhala Game Run: Nationality of Participants

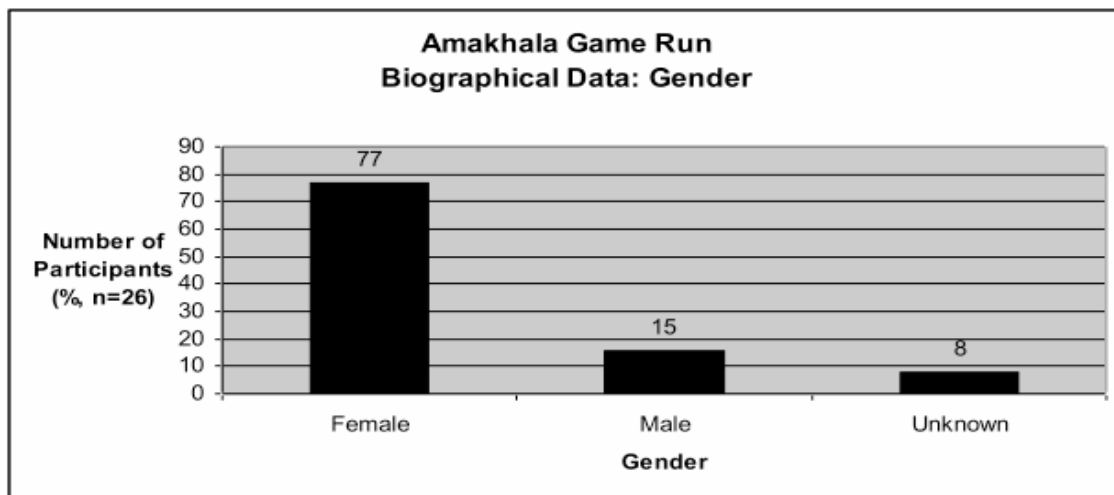


Figure C.2 – Amakhala Game Run: Gender of Participants

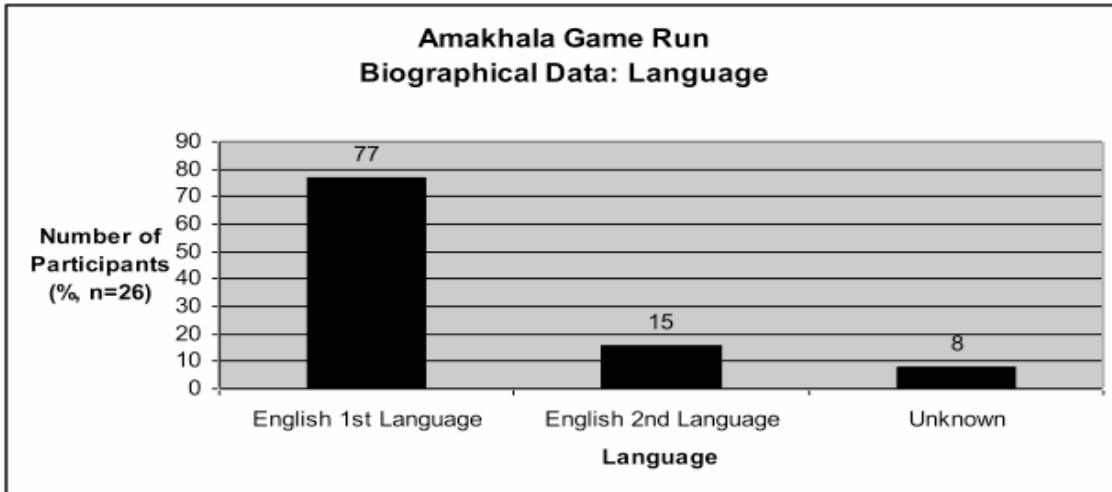


Figure C.3 – Amakhala Game Run: Language of Participants

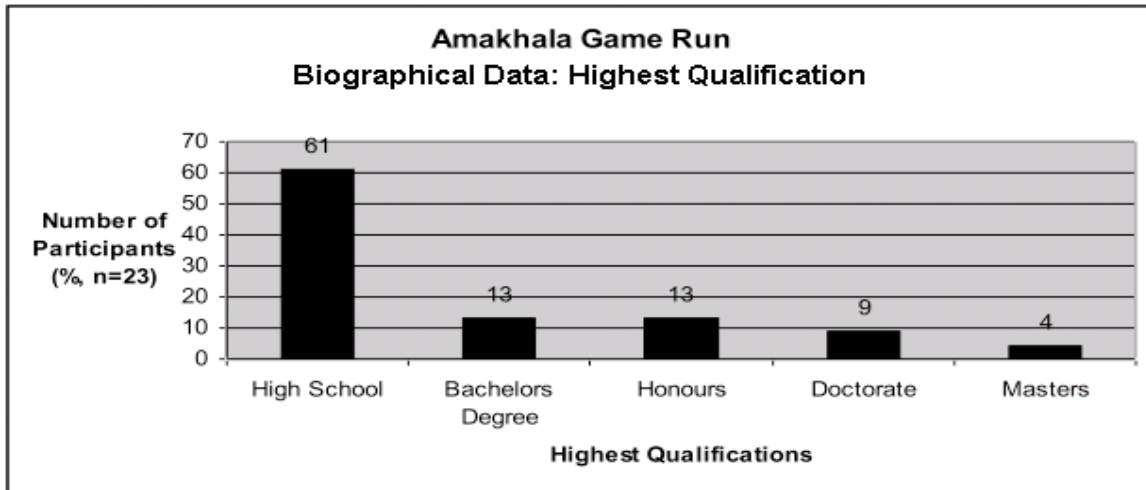


Figure C.4 – Amakhala Game Run: Highest Qualification of Participants

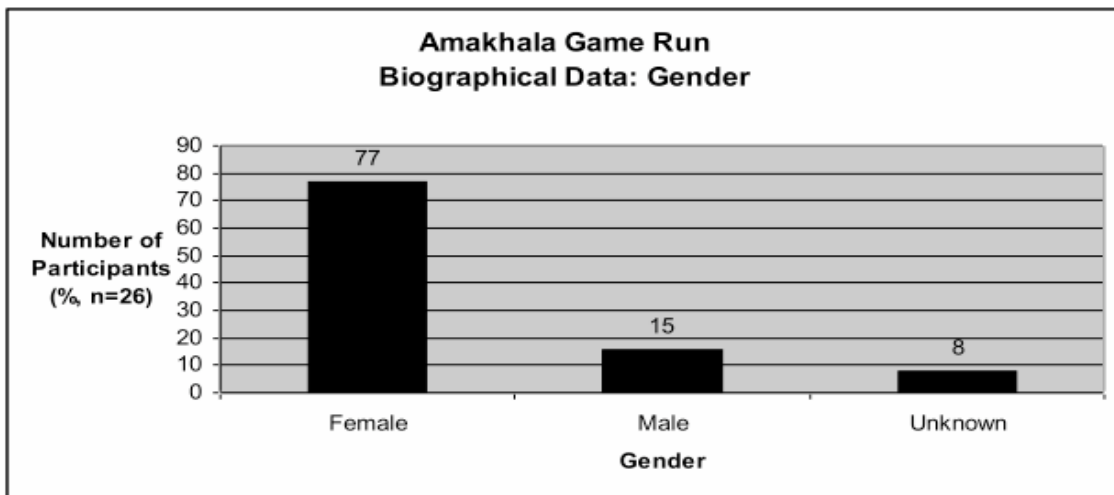
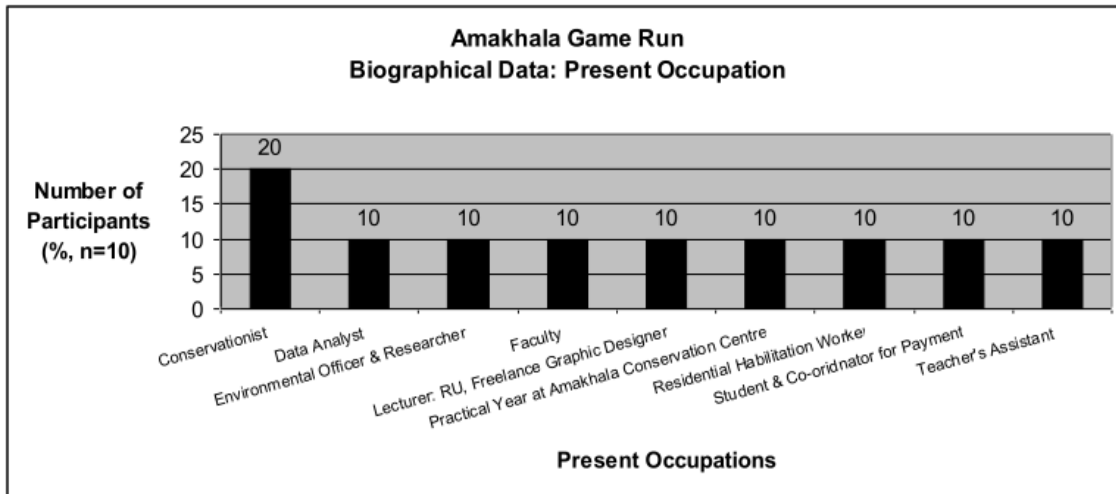
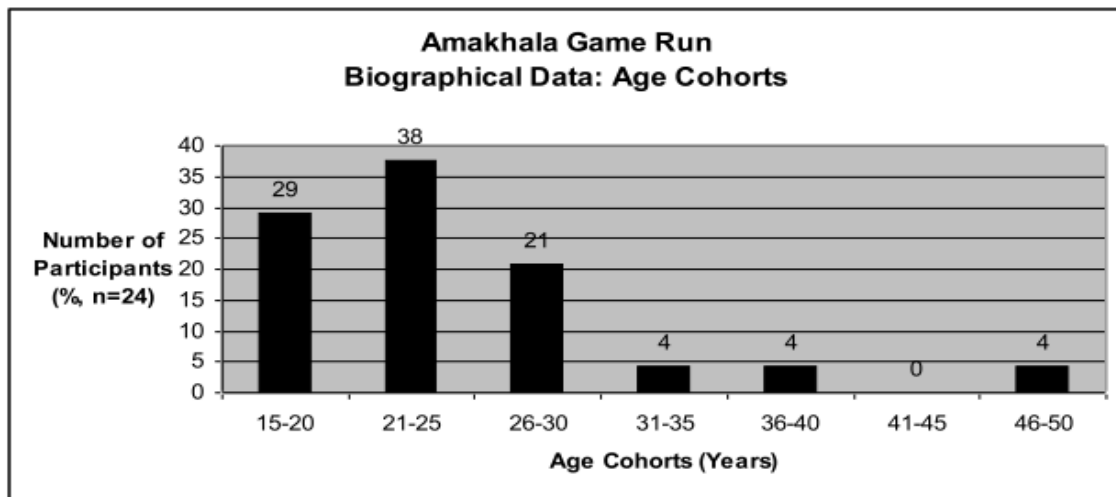


Figure C.5 – Amakhala Game Run: Types of Participants' Occupation



**Figure C.6 – Amakhala Game Run: Present Occupation of Participants**



**Figure C.7 – Amakhala Game Run: Age of Participants**

**Pre- and Post-Questionnaires: Tables C.1 to C.19**

**Table C.1 - Amakhala Pre- Game Questionnaire: How is water used in a southern African context?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Economic</b>		<b>(n=23)</b>
Livestock/farming	12	20
Industrial/business	10	17
Irrigation	4	7
Livelihood	3	5
Game Reserve	1	2
Economical	1	2
<b>SUB-TOTAL: 6</b>	<b>31</b>	<b>53</b>
<b>Social</b>		
Domestic	6	10
Household	5	8
Drinking	5	8
Recreational	2	3
As a commodity	1	2
Inappropriately	1	2
Poor water quality	1	2
Sanitation	1	2
<b>SUB-TOTAL: 8</b>	<b>12</b>	<b>37</b>
<b>Biophysical</b>		
Limited supply	2	3
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>3</b>
<b>Other</b>		
I don't know	2	3
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>3</b>
<b>Political</b>		
Power	1	2
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>2</b>
<b>Totals</b>		
<b>17</b>	<b>47</b>	<b>100</b>

**Table C.2 – Amakhala Post-Game Questionnaire: How is water used in a southern African context?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		
Government makes money	2	3
Power	1	2
<b>SUB-TOTAL: 2</b>	<b>3</b>	<b>5</b>
<b>Economic</b>		
		<b>(n=19)</b>
Livestock/farming	17	26
Industry/business	10	15
Survival	5	8
Livelihood dependant on irrigation	4	6
Irrigation	3	5
Acknowledged link btw water & economy	3	5
Drought = high prices	1	2
Differences btw rural and urban use	1	2
<b>SUB-TOTAL: 8</b>	<b>44</b>	<b>67</b>
<b>Social</b>		
Domestic	9	14
Humans	3	5
Everyone	2	3
Drinking	2	3
Sanitation	1	2
<b>SUB-TOTAL: 5</b>	<b>17</b>	<b>26</b>
<b>Biophysical</b>		
Ecosystems	1	2
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>2</b>
<b>Other</b>		
Water from dams	1	2
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>2</b>
<b>Totals</b>		
<b>17</b>	<b>66</b>	<b>100</b>

**Table C.3 – Amakhala Pre- Game Questionnaire: Who controls water?**

<b>Themes</b>	<b>Responses%</b>	
<b>Political</b>	<b>(n=23)</b>	
Government: local & national	17	51
Department of Water Affairs & Forestry (DWAF)	3	9
Minister of Water	1	3
Municipality	1	3
Water associations	1	3
<b>SUB-TOTAL: 5</b>	<b>23</b>	<b>69</b>
<b>Economic</b>		
Landowners with water sources	1	3
Private companies	1	3
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>6</b>
<b>Social</b>		
People	1	3
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>3</b>
<b>Other</b>		
I don't know	7	21
<b>SUB-TOTAL: 1</b>	<b>7</b>	<b>21</b>
<b>Totals</b>		
<b>9</b>	<b>33</b>	<b>100</b>

**Table C.4 – Amakhala Post Game Questionnaire: Who controls Water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=19)</b>
Government: storage/dam regulation	20	59
Water minister	3	9
Department of Water	1	3
<b>SUB-TOTAL: 3</b>	<b>24</b>	<b>71</b>
<b>Economic</b>		
Government: price &/or tax	2	6
Farmers: crops & water tanks	2	6
Industries: technologies	1	3
<b>SUB-TOTAL: 3</b>	<b>5</b>	<b>15</b>
<b>Social</b>		
Communities: practices	1	3
Interests & hobbies	1	3
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>6</b>
<b>Biophysical</b>		
Environment	1	3
Nature	1	3
Rain	1	3
<b>SUB-TOTAL: 3</b>	<b>3</b>	<b>9</b>
<b>Totals</b>		
<b>11</b>	<b>34</b>	<b>100</b>

**Table C.5 – Amakhala Pre- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Poor water management	2	4
Inequitable water use	3	7
Poor dam construction	1	2
History of disenfranchised people	1	2
<b>SUB-TOTAL: 4</b>	<b>7</b>	<b>15</b>
<b>Economic</b>		
Poor communities	2	4
Industry	1	2
Poor payment: salaries & wages	1	2
Growing economies	1	2
<b>SUB-TOTAL: 4</b>	<b>5</b>	<b>11</b>
<b>Social</b>		
Pollution	3	7
Conservation & education	3	7
Population increasing	2	4
Use exceeds supply	2	4
<b>SUB-TOTAL: 4</b>	<b>10</b>	<b>22</b>
<b>Biophysical</b>		
Drought/arid country/water shortages	12	26
Degraded systems	1	2
Animals suffer	1	2
<b>SUB-TOTAL: 3</b>	<b>14</b>	<b>30</b>
<b>Other</b>		
I don't know	6	13
Access	4	9
<b>SUB-TOTAL: 2</b>	<b>10</b>	<b>22</b>
<b>Totals</b>		
<b>17</b>	<b>46</b>	<b>100</b>

**Table C.6 – Amakhala Post- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Lack of infrastructure	4	7
Limited water supply	3	5
Government removed from problems	1	2
Government should supply pumps but due to low education it cannot be used	1	2
Maintenance	1	2
<b>SUB-TOTAL: 5</b>	<b>10</b>	<b>18</b>
<b>Economic</b>		
Price: accessibility & cannot pay	11	20
Dams = higher cost	2	4
Distribution: physically & economically	2	4
Droughts = less crops = less money	2	4
Consumers suffer	1	2
Domestic most important: can collapse economy	1	2
Farmers suffer	1	2
How does one price water	1	2
Rural areas: need rain to produce food & money	1	2
<b>SUB-TOTAL: 9</b>	<b>22</b>	<b>40</b>
<b>Social</b>		
Not thinking long term	2	4
Goal: survival	1	2
Ignorance & lack of knowledge: mostly all sectors, especially government	1	2
No recycling	1	2
Water quality	1	2
Water wastage, shortage, pollution	1	2
<b>SUB-TOTAL: 6</b>	<b>7</b>	<b>13</b>
<b>Biophysical</b>		
Droughts: low supply	10	18
Rains = pests	2	4
High agricultural demand in dry areas	1	2
Rely on rain	1	2
Water = limited resource	1	2
Weather: especially drought	1	2
<b>SUB-TOTAL: 6</b>	<b>16</b>	<b>29</b>
<b>Totals</b>		
<b>26</b>	<b>55</b>	<b>100</b>

**Table C.7 – Amakhala Pre- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Government mismanagement	7	13
Apartheid	3	6
Political	2	4
Colonialisation	1	2
Corruption	1	2
Dissociation from resource	1	2
Lack of international aid & skills	1	2
Past development regimes	1	2
Poor dam construction & planning	1	2
Poor water quality	1	2
<b>SUB-TOTAL: 10</b>	<b>19</b>	<b>37</b>
<b>Social</b>		
Growing population	3	6
Low education & ignorance	2	4
Pollution	2	4
Social	2	4
Conservation awareness	1	2
Group conflicts	1	2
Overuse	1	2
Wasteful	1	2
<b>SUB-TOTAL: 8</b>	<b>13</b>	<b>25</b>
<b>Biophysical</b>		
Droughts	5	10
Global warming	2	4
Arid country	1	2
Biophysical	1	2
<b>SUB-TOTAL: 4</b>	<b>9</b>	<b>17</b>
<b>Economic</b>		
Economical	3	6
Capitalism & power	1	2
High irrigation levels	1	2
Inequality	1	2
Poverty	1	2
Reliance on an agricultural economy	1	2
<b>SUB-TOTAL: 6</b>	<b>8</b>	<b>15</b>
<b>Other</b>		
<b>I don't know</b>	<b>3</b>	<b>6</b>
<b>SUB-TOTAL: 1</b>	<b>3</b>	<b>6</b>
<b>Totals</b>		
<b>29</b>	<b>52</b>	<b>100</b>

**Table C.8 – Amakhala Post-Game Questionnaire: Issues and challenges associated with water management**

<b>Political</b>		<b>(n=23)</b>	
<b>Themes</b>	<b>Responses</b>	<b>%</b>	
National control difficult: large population & limited resources	4	9	
Government removed from problem(s)	3	7	
Lack of infrastructure	3	7	
Corruption	2	4	
No well defined plan or control, no disaster management	2	4	
Poor water management	2	4	
Pre & post 94 government: no sufficient planning in black areas	2	4	
Degradation of government services	1	2	
Need for eco dev & revenue	1	2	
Sectors compete: domestic vs. industry & agriculture	1	2	
<b>SUB-TOTAL: 10</b>	<b>21</b>	<b>47*</b>	
<b>Economic</b>			
Debt	3	7	
Lack of irrigation	2	4	
National economy increases prices	2	4	
Prices	2	4	
Distance	1	2	
Lack of funding	1	2	
Poor farming methods	1	2	
<b>SUB-TOTAL: 7</b>	<b>12</b>	<b>27*</b>	
<b>Biophysical</b>			
Weather conditions: droughts, rain equals pests	7	16	
<b>SUB-TOTAL: 1</b>	<b>7</b>	<b>16</b>	
<b>Social</b>			
Increasing pop	2	4	
Lack of communication & understanding	1	2	
Low education, especially in rural areas	1	2	
Protect or conserve	1	2	
<b>SUB-TOTAL: 4</b>	<b>5</b>	<b>10*</b>	
<b>Totals</b>			
<b>22</b>	<b>45</b>	<b>100</b>	

**Table C.9 – Amakhala Post- Game Questionnaire: How has the game helped you to gain a better understanding of water management in a southern African context?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=19)</b>
NB of government's role in dev of SA	2	5
Now questions government's distribution methods	2	5
Understand different parties involved in water management: who suffers	2	5
Gov control difficult	1	3
Gov needs better plan or social, eco, environ problems	1	3
Politics associated with water	1	3
<b>SUB-TOTAL: 6</b>	<b>9</b>	<b>24</b>
<b>Economic</b>		
Prices	3	8
Difficulty obtaining & storing water	3	8
More water = ability to create wealth	2	5
How dependant agriculture is on water	1	3
<b>SUB-TOTAL: 4</b>	<b>9</b>	<b>24</b>
<b>Social</b>		
How desperate & dependent people were on water, especially farmers	6	16
Water as a resource is a necessity & limited	6	16
Issues=same problems in real life: created clearer image/understanding	1	3
Realised water is a privilege	1	3
Reinforced conviction of people's ignorance & lack of knowledge	1	3
<b>SUB-TOTAL: 5</b>	<b>15</b>	<b>41</b>
<b>Biophysical</b>		
Droughts impact economy	2	5
How nature impacts on people's livelihoods & country's economy	1	3
Water shortages impacts entire population	1	3
<b>SUB-TOTAL: 3</b>	<b>4</b>	<b>11</b>
<b>Totals</b>		
<b>18</b>	<b>37</b>	<b>100</b>

**Table C.10 – Amakhala Pre- Game Questionnaire: How is water used in your local environment?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Power	2	3
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>3</b>
<b>Economic</b>		
Industry	10	23
Agriculture	9	12
Irrigation	7	9
Geographical location	6	8
Financial class	3	4
Livestock	2	3
<b>SUB-TOTAL: 6</b>	<b>44</b>	<b>57</b>
<b>Social</b>		
Domestic	21	27
Recreation	6	8
Abundance of water	2	3
<b>SUB-TOTAL: 3</b>	<b>29</b>	<b>38</b>
<b>Biophysical</b>		
Source: river, lake, tap, etc.	2	3
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>3</b>
<b>Totals</b>		
<b>11</b>	<b>77</b>	<b>100</b>

**Table C.11 – Amakhala Post-Game Questionnaire: How is water used in your local environment?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Economic</b>		<b>(n=15)</b>
Agriculture	5	12
Industrial	4	9
Water is abundant & affordable	3	7
Business	1	2
Irrigation	1	2
<b>SUB-TOTAL: 5</b>	<b>14</b>	<b>33</b>
<b>Social</b>		
Domestic: sanitation, washing, cleaning, gardening, cooking, household activities	16	37
Drinking	4	9
Recreational: personal	6	14
<b>SUB-TOTAL: 3</b>	<b>26</b>	<b>60</b>
<b>Biophysical</b>		
Water shortages & droughts not common	1	2
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>2</b>
<b>Other</b>		
All sectors of life	1	2
Everything	1	2
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>5</b>
<b>Totals</b>		
<b>18</b>	<b>43</b>	<b>100</b>

**Table C.12 – Amakhala Pre- Game Questionnaire: Who controls water?**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Local Government	17	33
Municipality/City Council	9	17
Department of Water Affairs & Forestry (DWAF)	4	8
State	3	6
Agricultural/Livestock Lobby/Community	1	2
Catchment Agencies	1	2
National Government	1	2
<b>SUB-TOTAL: 7</b>	<b>36</b>	<b>69</b>
<b>Economic</b>		
Employers	1	2
Farmers	1	2
Landlord	1	2
<b>SUB-TOTAL: 3</b>	<b>3</b>	<b>6</b>
<b>Social</b>		
Participant	5	10
Household Members	2	4
Everyone	1	2
<b>SUB-TOTAL: 3</b>	<b>8</b>	<b>15</b>
<b>Other</b>		
I don't know	5	10
<b>SUB-TOTAL: 1</b>	<b>5</b>	<b>10</b>
<b>Totals</b>		
<b>14</b>	<b>52</b>	<b>100</b>

**Table C.13 – Amakhala Post- Game Questionnaire: Who controls Water**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=13)</b>
Government: local	10	42
Municipality	2	8
Water depart	1	4
Water providers	1	4
<b>SUB-TOTAL: 4</b>	<b>14</b>	<b>58</b>
<b>Economic</b>		
Private water & purification companies	3	13
Payee of water bills	1	4
<b>SUB-TOTAL: 2</b>	<b>4</b>	<b>17</b>
<b>Social</b>		
Me (i.e. the participant)	2	8
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>8</b>
<b>Other</b>		
I don't	3	13
Not sure	1	4
<b>SUB-TOTAL: 2</b>	<b>4</b>	<b>17</b>
<b>Totals</b>		
<b>9</b>	<b>24</b>	<b>100</b>

**Table C.14 – Amakhala Pre- Game Questionnaire: Issues and challenges associated with water management**

<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>		<b>(n=23)</b>
Poor Water Management	1	2
Power Problems	1	2
Infrastructure	3	5
Accessibility	1	2
<b>SUB-TOTAL: 4</b>	<b>6</b>	<b>11</b>
<b>Economic</b>		
Purification	2	4
Poor Payment	1	2
<b>SUB-TOTAL: 2</b>	<b>3</b>	<b>5</b>
<b>Social</b>		
Water Quality	11	19
Not Conserving Water	7	12
Water Pollution	6	11
Unequal Distribution	3	5
<b>SUB-TOTAL: 4</b>	<b>27</b>	<b>47</b>
<b>Biophysical</b>		
Limited Water Supply	7	12
Low Rainfall/Droughts	7	12
Water Shortages	3	5
Flooding	2	4
<b>SUB-TOTAL: 4</b>	<b>19</b>	<b>33</b>
<b>Other</b>		
None	2	4
<b>SUB-TOTAL: 1</b>	<b>2</b>	<b>4</b>
<b>Totals</b>		
<b>15</b>	<b>57</b>	<b>100</b>

**Table C.15 – Amakhala Post-Game Questionnaire: Issues and challenges associated with water management**

	<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Political</b>			<b>(n=15)</b>
	Government advising people to limit use	3	8
	Purification	2	5
	Quality control	2	5
	Availability	1	3
	Ensuring steady, clean, drinkable water supply	1	3
	Larger crop yield if better access to more water	1	3
	Maintenance facilities	1	3
	Pollution in eco poor neighbourhoods	1	3
	Water shortages	1	3
	<b>SUB-TOTAL: 9</b>	<b>13</b>	<b>36</b>
<b>Economic</b>			
	Issues when people cannot afford water	9	24
	Location	1	3
	<b>SUB-TOTAL: 2</b>	<b>10</b>	<b>27</b>
<b>Social</b>			
	Lack of conservation &/or waste of water	3	8
	Me: disregard & don't conserve/recycle enough	2	5
	New York well know for good, available water	1	3
	Overuse	1	3
	<b>SUB-TOTAL: 4</b>	<b>7</b>	<b>19</b>
<b>Biophysical</b>			
	Flooding &/or drought	2	5
	Arid country & little rain	1	3
	<b>SUB-TOTAL: 2</b>	<b>3</b>	<b>8</b>
<b>Other</b>			
	None	3	8
	Same as SA content	1	3
	<b>SUB-TOTAL: 2</b>	<b>4</b>	<b>11</b>
<b>Totals</b>			
	<b>19</b>	<b>37</b>	<b>100</b>

**Table C.16 – Amakhala Pre- Game Questionnaire: Issues and challenges associated with water management**

	<b>Themes</b>	<b>Responses</b>	<b>%</b>
<b>Economic</b>			<b>(n=23)</b>
	Poverty	3	7
	Capitalism	2	5
	High unemployment rates	2	5
	Privatisation	1	2
	<b>SUB-TOTAL: 4</b>	<b>8</b>	<b>18*</b>
<b>Political</b>			
	Incompetent municipality	9	20
	Disenfranchised individuals	2	5
	Corruption	1	2
	<b>SUB-TOTAL: 3</b>	<b>12</b>	<b>27</b>
<b>Social</b>			
	Ignorance	6	14
	Materialism	3	7
	Water quality	3	7
	Pollution	2	5
	<b>SUB-TOTAL: 4</b>	<b>14</b>	<b>32*</b>
<b>Biophysical</b>			
	Low rainfall	6	14
	Global warming	3	7
	<b>SUB-TOTAL: 2</b>	<b>9</b>	<b>20*</b>
<b>Other</b>			
	Accessibility	1	2
	<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>2</b>
<b>Totals</b>			
	<b>14</b>	<b>44</b>	<b>100*</b>

**Table C.17 – Amakhala Post- Game Questionnaire: Issues and challenges associated with water management**

Themes	Responses	%
<b>Political</b>		<b>(n=15)</b>
Corruption	1	3
Drought serious when lack of planning	1	3
Impure water spreads disease quickly	1	3
Location	1	3
No infrastructure to store water	1	3
Regulations	1	3
Scarcity of resources in growing demand	1	3
Transportation	1	3
Uneducated people	1	3
Wrong instructions from government	1	3
<b>SUB-TOTAL: 10</b>	<b>10</b>	<b>34</b>
<b>Economic</b>		
People cant pay &/or lack of jobs	1	3
RDP housing & emerging middle class	1	3
<b>SUB-TOTAL: 2</b>	<b>2</b>	<b>7</b>
<b>Social</b>		
Attitude: entitled to water thus its infinite	4	14
Limited knowledge & experience	1	3
Pollution	1	3
People don't pay attention when resource is cheap & plentiful	1	3
<b>SUB-TOTAL: 4</b>	<b>7</b>	<b>24</b>
<b>Biophysical</b>		
Environ problems	3	10
Droughts	2	7
Global & local water shortages	1	3
Low water supply	1	3
<b>SUB-TOTAL: 4</b>	<b>7</b>	<b>24</b>
<b>Other</b>		
Always issues	1	3
Not Applicable (NA)	1	3
Same as SA context	1	3
<b>SUB-TOTAL: 3</b>	<b>3</b>	<b>10</b>
<b>Totals</b>		
<b>23</b>	<b>29</b>	<b>100*</b>

**Table C.18 – Amakhala Post- Game Questionnaire: How has the game helped you to gain a better understanding of water management?**

<b>Themes</b>	<b>Responses %</b>	
<b>Political</b>	<b>(n=17)</b>	
Importance of government in managing water supply	3	12
Lack of forward planning	1	4
Sympathetic to government's supplying predicament	1	4
Water management more efficient & effective in USA	1	4
White collar workers selfish & reckless with water consumption	1	4
Yes: not easy to allocate needs of people	1	4
<b>SUB-TOTAL: 6</b>	<b>8</b>	<b>32</b>
<b>Economic</b>		
Considered survival & impact of price increases without subsidies & droughts	2	8
Realised how valuable water is: finite resource	2	8
Demand effects cost drastically	1	4
<b>SUB-TOTAL: 3</b>	<b>5</b>	<b>20</b>
<b>Social</b>		
Water crucial for personal functions	1	4
<b>SUB-TOTAL: 1</b>	<b>1</b>	<b>4</b>
<b>Other</b>		
Gained appreciation: problems in ACG are not an issue in my environment, so it did not really change my understanding of my own environment since its so different	5	20
Realise how fortunate I am & appreciate it more	2	8
Implications of drought	1	4
Inability to counter natural disasters	1	4
NB of availability & reserves	1	4
Varied due to different way US controls water	1	4
<b>SUB-TOTAL: 6</b>	<b>11</b>	<b>44</b>
<b>Totals</b>		
<b>16</b>	<b>25</b>	<b>100</b>

**Table C.19 – Amakhala Post- Game Questionnaire: Do you think that you would be able to use insights from your game experience?**

<b>Themes</b>	<b>Responses%</b>	
<b>Political</b>		<b>(n=17)</b>
Ways & need to conserve water: sustainability	4	14
Attitude towards government: impossible task	1	4
Help with politics, global understanding of world & issues of SA	1	4
Insights arising from poor water management: government & consumer's perspective	1	4
<b>SUB-TOTALS: 4</b>	<b>7</b>	<b>25</b>
<b>Economic</b>		
Shows complexities of running country & business in real world	2	7
Hope to apply on engineers, water projects without borders & later in career	1	4
How NB 1 person's job is	1	4
Not all issues result from commercial sector of economy	1	4
Peasant farmers: battle to survive	1	4
Understand how beneficial debt relief & communication are to economic dev	1	4
Use insights in work & everyday life	1	4
Water scare = price increase	1	4
<b>SUB-TOTALS: 8</b>	<b>9</b>	<b>35</b>
<b>Social</b>		
Advise own family on water use	2	7
Read people quickly if reliable	1	4
Sympathise with others	1	4
Use insights in teaching African lit & environment issues & culture in Africa	1	4
Yes: in a developing country where there is a lack of knowledge	1	4
<b>SUB-TOTALS: 5</b>	<b>6</b>	<b>21</b>
<b>Other</b>		
All learning NB	1	4
Attitude change about forward planning	1	4
Don't know yet interesting	1	4
Good idea of how systems work	1	4
Grateful	1	4
Wider implications of water waste	1	4
<b>SUB-TOTALS: 6</b>	<b>6</b>	<b>21</b>
<b>Totals</b>		
<b>23</b>	<b>27</b>	<b>100</b>

## Appendix D: Chapter 8

### D.1 Sum of three game run response rates

Participants' responses were re-analysed and values were modified accordingly. The values in brackets are therefore the original values. The italicised and underlined values were not included in the Chi-Square calculations due to their low value, below 5, and due to being unable to re-organise responses into different environmental dimensions.

Question 1: Southern African Context				
Political	Economic	Social	Biophysical	Other
21 (23)	56	20	6 (4)	11
8	109 (114)	48 (49)	7	9 (3)

Question 1: Your Context				
Political	Economic	Social	Biophysical	Other
63 (66)	121	56	10	5 (2)
5 (7)	59	56	5 (3)	5

Question 2: Southern African Context				
Political	Economic	Social	Biophysical	Other
47	15	5 (4)	<u>0</u>	17
67	19	5 (4)	<u>7</u>	5 (2)

Question 2: Your Context				
Political	Economic	Social	Biophysical	Other
80	21	16	<u>1</u>	8
52	15	7	<u>2</u>	6

Question 3: Southern African Context				
Political	Economic	Social	Biophysical	Other
39	11	10	27	<u>18</u>
44	36	12	28	<u>3</u>

Question 3: Your Context				
Political	Economic	Social	Biophysical	Other
58	5	35	26	<u>3</u>
47	13	15	7	<u>13</u>

Question 4: Southern African Context				
Political	Economic	Social	Biophysical	Other
57	10	18	15	<u>11</u>
59	11	7	23	<u>2</u>

Question 4: Your Context				
Political	Economic	Social	Biophysical	Other
37	17	27	15	<u>2</u>
33	4	11	16	<u>4</u>

## D.2 Chi-Square Calculations

<b>Sum of three game responses: Southern African Context</b>							
Question 1: How is water used?		Political	Economic	Social	Biophysical	Other	Sum
Observed	Pre	21	56	20	6	11	<b>114</b>
	Post	8	109	48	7	9	<b>181</b>
	Sum	<b>29</b>	<b>165</b>	<b>68</b>	<b>13</b>	<b>20</b>	<b>295</b>
Expected (4x6/75)	Pre	11.20678	63.76271	26.27797	5.023729	7.728814	
	Post	17.79322	101.2373	41.72203	7.976271	12.27119	
(Observed - Expected) squared / Expected	Pre	8.557959	0.945062	1.499844	0.189721	1.384515	12.5771
	Post	5.390096	0.595232	0.944653	0.119493	0.872015	7.921489
							<b><u>20.50</u></b>

<b>Sum of three game responses: Southern African Context</b>							
Question 2: Who controls water?		Political	Economic	Social	Biophysical	Other	Sum
Observed	Pre	47	15	5	0	17	<b>84</b>
	Post	67	19	5	7	5	<b>96</b>
	Sum	<b>114</b>	<b>34</b>	<b>10</b>	<b>7</b>	<b>22</b>	<b>180</b>
Expected (4x6/75)	Pre	53.2	15.86667	4.666667	3.266667	10.26667	
	Post	60.8	18.13333	5.333333	3.733333	11.73333	
(Observed - Expected) squared / Expected	Pre	0.722556	0.047339	0.02381	3.266667	4.416017	8.476389
	Post	0.632237	0.041422	0.020833	2.858333	3.864015	7.41684
							<b><u>15.89</u></b>

<b>Sum of three game responses: Southern African Context</b>							
Question 3: Please identify and explain what issues and challenges, if any, are associated with water management.		Political	Economic	Social	Biophysical	Other	Sum
Observed	Pre	39	11	10	27	18	<b>87</b>
	Post	44	36	12	28	3	<b>120</b>
	Sum	<b>83</b>	<b>47</b>	<b>22</b>	<b>55</b>	<b>21</b>	<b>207</b>
Expected (4x6/75)	Pre	34.88406	19.75362	9.246377	23.11594	8.826087	
	Post	48.11594	27.24638	12.75362	31.88406	12.17391	
(Observed - Expected) squared / Expected	Pre	0.485637	3.879082	0.061424	0.652619	9.535447	14.61421
	Post	0.352087	2.812334	0.044532	0.473149	6.913199	10.5953
							<b><u>25.21</u></b>

<b>Sum of three game responses: Southern African Context</b>							
Question 4: Why do you think these issues & challenges have emerged?		Political	Economic	Social	Biophysical	Other	Sum
Observed	Pre	57	10	18	15	11	<b>100</b>
	Post	59	11	7	23	2	<b>100</b>
	Sum	<b>116</b>	<b>21</b>	<b>25</b>	<b>38</b>	<b>13</b>	<b>200</b>
Expected (4x6/75)	Pre	58	10.5	12.5	19	6.5	
	Post	58	10.5	12.5	19	6.5	
(Observed - Expected) squared / Expected	Pre	0.017241	0.02381	2.42	0.842105	3.115385	6.418541
	Post	0.017241	0.02381	2.42	0.842105	3.115385	6.418541
							<b><u>12.84</u></b>

<b>Sum of three game responses: Your Context</b>							
Question 1 : How is water used?		Political	Economic	Social	Biophysical	Other	Sum
Observed	Pre	63	121	56	10	5	<b>255</b>
	Post	5	59	56	5	5	<b>130</b>
	Sum	<b>68</b>	<b>180</b>	<b>112</b>	<b>15</b>	<b>10</b>	<b>385</b>
Expected (4x6/75)	Pre	45.03896	119.2208	74.18182	9.935065	6.623377	
	Post	22.96104	60.77922	37.81818	5.064935	3.376623	
(Observed - Expected) squared / Expected	Pre	7.162663	0.026553	4.456328	0.000424	0.397886	12.04385
	Post	14.04984	0.052084	8.741259	0.000833	0.78047	23.62448
							<b><u>35.67</u></b>
<b>Sum of three game responses: Your Context</b>							
Question 2: Who controls water?		Political	Economic	Social	Biophysical	Other	Sum
Observed	Pre	80	21	16	1	8	<b>125</b>
	Post	52	15	7	2	6	<b>80</b>
	Sum	<b>132</b>	<b>36</b>	<b>23</b>	<b>3</b>	<b>14</b>	<b>205</b>
Expected (4x6/75)	Pre	80.4878	21.95122	14.02439	1.829268	8.536585	
	Post	51.5122	14.04878	8.97561	1.170732	5.463415	
(Observed - Expected) squared / Expected	Pre	0.002956	0.04122	0.278303	0	0.033728	0.356207
	Post	0.004619	0.064405	0.434849	0	0.0527	0.556574
							<b><u>0.91</u></b>

<b>Sum of three game responses: Your Context</b>							
Question 3: Please identify and explain what issues and challenges, if any, are associated with water management.		Political	Economic	Social	Biophysical	Other	Sum
Observed	Pre	57	10	18	15	11	<b>100</b>
	Post	59	11	7	23	2	<b>100</b>
	Sum	<b>116</b>	<b>21</b>	<b>25</b>	<b>38</b>	<b>13</b>	<b>200</b>
Expected (4x6/75)	Pre	58	10.5	12.5	19	6.5	
	Post	58	10.5	12.5	19	6.5	
(Observed - Expected) squared / Expected	Pre	0.017241	0.02381	2.42	0.842105	3.115385	6.418541
	Post	0.017241	0.02381	2.42	0.842105	3.115385	6.418541
							<b>12.84</b>
<b>Sum of three game responses: Your Context</b>							
Question 4: Why do you think these issues & challenges have emerged?		Political	Economic	Social	Biophysical	Other	Sum
Observed	Pre	37	17	27	15	2	<b>96</b>
	Post	33	5	11	16	4	<b>65</b>
	Sum	<b>70</b>	<b>22</b>	<b>38</b>	<b>31</b>	<b>6</b>	<b>167</b>
Expected (4x6/75)	Pre	40.23952	12.64671	21.84431	17.82036	3.449102	
	Post	27.24551	8.562874	14.79042	12.06587	2.335329	
(Observed - Expected) squared / Expected	Pre	0.260801	1.498506	1.216844	0.446367	0.608824	4.031342
	Post	1.215399	1.482455	0.971391	1.282742	1.186611	6.138598
							<b>10.17</b>

