Appendix A

Supplementary material developed during the literature review that considered the literature promoting the climate change adaptation co-benefits of UA and BIA. The analysis considered the nature and source of these studies.

Table 67: Meta-analysis of literature promoting the CCA and CCM potential of UA.

Meta-analysis of urban agriculture literature.	**First-order references**						
Author; Theme; Research method	Referenced Sources	Theme	Primary Research	Secondary Research	Reference's theme	Field of Research	Research method
Thomaier et al., 2014; Sustainable benefits and building Integration of Zero Acreage Farming.; Specialist Interviews & Literature Reviews	Caplow, 2009	Stormwater reuse	√		Building-integrated agriculture	Urban agriculture	Observational analysis
	Astee et al., 2010	Stormwater reuse & Food Production	√		Green Roofs and rainwater harvesting	Urban Agriculture	Literature Review & Simulation modelling
	Bass & Baskaran, 2001	Stormwater reuse	√		Analysis of the environmental benefits of green roofs	Building environmental science	Analytical simulation
	Castleton et al., 2010	Stormwater reuse		√	Green roofs	Construction Technology	Integrative Literature Review
	Delor, 2011	Energy Savings of green roofs & Food Production	√		Energy savings through use of green roofs	Urban Agriculture	Integrative Literature Review & Thermal Modelling
	Graber et al., 2011	Waste Cycles		√	Auqaponics and circular economies	Urban Agriculture	Literature Review
	Kloas et al., 2011	Waste Cycles					
	Nelkin & Caplow, 2008	Food Production	√		Food production, energy use and water use	Urban Agriculture	Empirical Analysis
	Puri & Caplow, 2009	Food Production					
	Born & Purcell, 2006	Food Production	√		Local food production	Urban Agriculture	Logical Argument & Literature Review
Specht et al (2014); Sustainable benefits and building Integration of Zero Acreage Farming; Literature Review	Astee et al., 2010	Storm water reuse & Food Production	√		Green Roofs and rainwater harvesting	Urban Agriculture	Literature Review & Simulation modelling
	Caplow, 2009	Stormwater reuse	√		Building integrated agriculture	Urban agriculture	Observational analysis
	Bass & Baskaran, 2001	Stormwater reuse	√		Analysis of the environmental benefits of green roofs	Building environmental science	Analytical simulation
	Born & Purcell, 2006	Food Production	√		Local food production	Urban Agriculture	Logical Argument & Literature Review
	Castleton et al., 2010	Stormwater reuse		√	Green roofs	Construction Technology	Integrative Literature Review
	Delor, 2011	Energy Savings of green roofs & Food Production	√		Energy savings through use of green roofs	Urban Agriculture	Integrative Literature Review & Thermal Modelling
	Graber et al., 2011	Waste Cycles		√	Aquaponics and circular economies	Urban Agriculture	Literature Review
	Nelkin & Caplow, 2008	Energy Use	√		Food production, energy use and water use	Urban Agriculture	Empirical Analysis
	Nelkin & Caplow, 2008	Food Production	√		Food production, energy use and water use	Urban Agriculture	Empirical Analysis
	Puri & Caplow, 2009	Food Production					
	Bosschaert, 2008	Food Miles					
	Van der Schans, 2010	Local Production	√		Introduction to urban agriculture	Urban Agriculture	Logical Argument
	De Zeew, 2011	Food Miles	√		Climate mitigation and adaptation potential of urban agriculture	Urban Agriculture	Logical Argument
	Weber & Matthews, 2008	Food Miles	√		Food miles	Food Sciences	Life-cycle assessment
	Engelhard, 2010	Water use		√	Technical considerations to implement roof top urban agriculture.	Landscape Architecture	Literature Review & Case study
	Hill, 2009	Water use					

	Wong et al, 2003a	Energy Use	√		Energy saving potential of roof gardens	Building environmental science	Simulation and modelling
	Ellingsen & Despommier, 2008	Waste cycles	√		Development of a new architectural typology accommodating urban agriculture	Architecture	Logical Argument and modelling
	Gosh, 2004	Waste Cycles		√	Using waste water for aquaculture use	Urban Agriculture	Literature Review
	Alterieri et al. 1999	Waste Cycles	√		Urban food production in Cuba	Urban Agriculture	Descriptive Analysis
	Wilson, 2004	Waste Cycles					
	De Wilt & Dobbelaar, 2005	Waste Cycles					
Samangooie et al., 2016; Comparison of soil-based and Case study analysis soil-less agriculture; Extensive literature review	Mavrogianni, et al., 2009	Temperature amelioration	√		Urban heat island impact and vegetation	Climate Change & GIS	GIS Mapping and Modelling
	Ottelo et al., 2009	Air pollution and filtration	√		Measurement of air pollution filtration benefits of plants	Green Infrastructure & Ecosystem services	Empirical Analysis
	Sheweka & Magdy, 2011	Air pollution and filtration		√	Health benefits of planted walls	Green infrastructure & Building technology	Literature Review
	Garner & Keoleian, 1995	Waste cycles					
	Francis & Lorimer, 2011	Biodiversity		√	Ecological benefits of green roofs and green walls	Green Infrastructure & Ecosystem services	Literature Review
	Newton et al., 2007	Biodiversity					
	Lee, Jordan, & Coleman, 2014	Water consumption					
Orsini et al., 2014; Prototype testing and simulation of new farming technology; Benefits of urban agriculture derived from literature review	Saunders et al, 2006	Food miles	√		Embodied energy and emissions of food produce	Food industry	Life-cycle assessment
	Sanye-Mengual et al., 2013	Embodied energy of urban agriculture	√		Embodied energy of urban agriculture	Food industry	Life-cycle assessment
	Davies et al., 2011	Carbon content of home gardens	√		Carbon content of home gardens	Ecological / green infrastructure	Mapping, simulation and modelling
Lovell, 2010; Sustainable benefits using urban agriculture within the urban environment; Literature Review	Deelstra & Girardet, 2000	Sustainable benefits of urban agriculture		√	Benefits of Urban agriculture	Urban Agriculture	Logical Argument and Literature Review
	Bohn & Viljoen, 2005	Local food production	√		Integrating urban agriculture and open spaces in the urban environment	Urban Agriculture	Logical Argument
	Holmer & Drescher, 2005	Waste cycles	√		Food security impact of urban agriculture	Urban Agriculture	Case study
	Midmore & Jansen, 2003	Long-term energy savings		√	Urban agriculture in Asia and its feasibility to be implemented in terms of resource provision	Urban Agriculture	Logical Argument and Literature Review
	Bernholt et al., 2009	Biodiversity	√		Mapping specie richness in home gardens	Urban agriculture	Mapping and Surveying
De Zeeuw (2011); Climate change mitigation and adaptation potential of urban agriculture; Logical Argument	No specific literature referenced to substantiate statements						

Dubbeling & De Zeeuw (2011); Climate change adaptation potential of urban agriculture; Literature Review & Logical Argument	Santadreu et al., 2002	Increase biodiversity	√		Documenting the impact that urban agriculture has on the local biodiversity	Urban Agriculture	Case study
Lwasa et al (2014); Considers the climate adaptation and mitigation potential of urban agriculture; Literature Review	Zoellick, 2009	Ecosystem service					
	UN Habitat, 2009	Ecosystem service			Strategies to develop sustainable urban forms.	Urban Planning	Literature Review and Report
	Coburn, 2009	Temperature Amelioration	√		Cooling strategies within the urban environment	Urban planning / Arboriculture	Empirical Analysis
	Adelekan, 2010	Flood management	√		Documenting the perception and strategies to adapt to frequent flooding	Urban planning / Geography	Interviews
	Matagi, 2002	Slope stabilisation	√		Environmental damages and degradation within the city of Kampala - the adverse impact of urban agriculture	Civil engineering and urban services	Mapping and documentation
	Nsangu & Redwood, 2009	Stormwater management					
	Alberti & Marzluff, 2004	Stormwater management	√		Ecological resilient of urban ecosystems	Ecological urbanism	Logical Argument
	Mcdonnel et al., 1997	Stormwater management	√		Ecological status and health of soil	Ecology	Empirical analysis
	Steffen-Deventer et al., 2007	Waste cycles	√		Sustainable farming practices	Agriculture	Empirical analysis
	De Zeeuw, 2011	Waste cycles	√		Climate mitigation and adaptation potential of urban agriculture	Urban Agriculture	Logical Argument
	Asomani-Boateng & Haight, 1999	Waste cycles					
	Van Rooijen et al.. 2010	Waste cycles	√		Water management and consumption in the urban environment	Urban Planning	In-situ data collection and semi-structured interviews
	De Bon et al., 2010	Waste cycles		√	Employment, technology and production rates of urban agriculture	Urban Agriculture	Literature Review
	Tallis et al., 2008	Waste cycles & Ecosystem services	√		A framework to using ecosystem services to inform development	Ecology & Developmental Studies	Logical Argument
	Dubbeling, 2009	Transportation		√	Climate adaptation and mitigation potential of urban agriculture	Urban Agriculture	Literature Review and Logical argument
	Drechsel & Kunze, 2001	Waste management					
	Holmer, 2001	Waste management					

	Stoffberg et al., 2010	Carbon dioxide sequestration	√		Considering the sequestration potential of street trees.	Ecology	Empirical Analysis & Mapping
	Roberts et al., 2011	Adaptation strategies	√		Developing an ecosystemic approach to adaptation strategies	Urban Planning	Logical Argument and case studies
	Knuth, 2005	Adaptation strategies		√	Legal framework for the implementation of urban forestry	Urban Planning	Literature Review
	Douglas et al., 2008	Slope, water and flood management	√		Documenting climate change induced flooding adaptation strategies	Urban planning / Geography	Structured interviews and case studies
	Sonou, 2001	Slope, water and flood management		√	Health risks associated with irrigation in urban agriculture projects	Urban Agriculture	Literature review
Padgheham et al. (2015); Considers resilience of urban agriculture; Literature review & Case study analysis	Lwasa et al., 2014	Climate mitigation and adaptation, and Ecosystem services		√	Climate mitigation and adaptation of urban agriculture	Urban Agriculture	Literature Review
	Dubbeling & De Zeeuw (2011)	Climate change adaptation potential of urban agriculture		√	Climate mitigation and adaptation of urban agriculture	Urban Agriculture	Literature Review & Logical Argument
	Moglia, 2014	Climate change adaptation potential of urban agriculture	√		Feasibility of urban agriculture to use stormwater harvesting infrastructure as resource.	Urban Agriculture	Modelling and Simulation
	Orsini et al., 2013	Use of ecosystem		√	The opportunities, benefits and constraints of Urban Agriculture	Urban Agriculture	Literature Review & Logical Argument
	De Bon et al., 2010	Waste cycles		√	Employment, technology and production rates of urban agriculture	Urban Agriculture	Literature Review

NOTE: *This analysis documents the points in the article where specific benefits or constraints regarding the climate change mitigation or adaptation of urban agriculture is mentioned and which sources or methods are used to substantiate the findings.*

Appendix B

Aggregated mapping data collected in the Hatfield neighbourhood for research objective A. The climate change risk and opportunity assessment data is available at the online repository. See note at the end of Appendix F.

Table 68: Aggregated mapping data collected in the Hatfield neighbourhood.
(Table on following page)

AGGREGATE ANALYSIS OF THE UNUSED AND UNDERUTILISED SPACES IN HATFIELD

Frequency of incidence - FOI Potential Spatial Impact - PSI			FOI	PSI		FOI	PSI		FOI	PSI		FOI	PSI		FOI	PSI
IMMEDIATE CONTEXT	*Enclosed campus*	50%	13%	16%	43%	7%	14%	35%	9%	5%	44%	8%	3%	39%	6%	4%
	Large scale commercial or civic	50%	13%	16%	54%	9%	21%	63%	15%	9%	56%	11%	5%	61%	9%	6%
	Small scale residential	0%	0%	0%	3%	0%	1%	2%	1%	0%	0%	0%	0%	0%	0%	0%
ADJACENT BUILDING PROGRAMMES	*Mono-functional*	44%	12%	14%	63%	11%	24%	46%	11%	6%	62%	12%	5%	54%	8%	5%
	Diverse functions	37%	10%	11%	31%	5%	12%	38%	9%	5%	23%	4%	2%	18%	3%	2%
	Compatible functions	19%	5%	6%	6%	1%	2%	17%	4%	2%	15%	3%	1%	29%	4%	3%
EDGE DEFINITION	*4 Edges - all enclosed*	0%	0%	0%	20%	3%	8%	2%	1%	0%	3%	0%	0%	36%	5%	4%
	3 Edge definition	0%	0%	0%	6%	1%	2%	6%	2%	1%	18%	3%	1%	57%	8%	6%
	2 Edge definition	0%	0%	0%	26%	4%	10%	27%	7%	4%	74%	14%	6%	4%	1%	0%
	1 Edge definition	0%	0%	0%	20%	3%	8%	63%	15%	9%	5%	1%	0%	4%	1%	0%
	No edge definition	100%	26%	31%	29%	5%	11%	2%	1%	0%	0%	0%	0%	0%	0%	0%
SKYVIEW FACTOR	*0.0 - 0.25*	0%	0%	0%	6%	1%	2%	13%	3%	2%	28%	5%	2%	25%	4%	3%
	0.25 - 0.50	0%	0%	0%	3%	0%	1%	8%	2%	1%	13%	2%	1%	11%	2%	1%
	0.50- 0.75	0%	0%	0%	11%	2%	4%	19%	5%	3%	18%	3%	1%	18%	3%	2%
	0.75 - 1.0	100%	26%	31%	80%	14%	30%	60%	15%	8%	41%	8%	3%	46%	7%	5%
ORIENTATION	*Omni*	15%	4%	5%	26%	4%	10%	21%	5%	3%	18%	3%	1%	46%	7%	5%
	East-West	71%	19%	22%	43%	7%	16%	40%	10%	6%	46%	9%	4%	43%	6%	4%
	North-South	13%	4%	4%	26%	4%	10%	38%	9%	5%	36%	7%	3%	11%	2%	1%
SOLAR EXPOSURE	*Fully overshadowed*	0%	0%	0%	0%	0%	0%	0%	0%	0%	15%	3%	1%	11%	2%	1%
	Overshadowed (75%)	0%	0%	0%	0%	0%	0%	2%	1%	0%	8%	1%	1%	4%	1%	0%
	Partly overshadowed (50%)	0%	0%	0%	20%	3%	8%	58%	14%	8%	46%	9%	4%	29%	4%	3%
	Partly overshadowed (25%)	0%	0%	0%	34%	6%	13%	17%	4%	2%	13%	2%	1%	32%	5%	3%
	No overshadowing (0%)	100%	26%	31%	46%	8%	17%	23%	6%	3%	18%	3%	1%	25%	4%	3%
OWNERSHIP	*Public (open)*	0%	0%	0%	34%	6%	13%	44%	11%	6%	8%	1%	1%	0%	0%	0%
	Public (controlled access)	58%	15%	18%	57%	10%	22%	40%	10%	6%	69%	13%	6%	54%	8%	5%
	Private (open)	0%	0%	0%	0%	0%	0%	15%	4%	2%	15%	3%	1%	7%	1%	1%
	Private (controlled access)	40%	11%	13%	9%	1%	3%	2%	1%	0%	8%	1%	1%	39%	6%	4%

VEGETATION BIOMATTER	*100% Completely covered*	**0%**	0%	0%	**34%**	6%	13%	**17%**	4%	2%	**15%**	3%	1%	**14%**	2%	1%
	75% Coverage	**0%**	0%	0%	**6%**	1%	2%	**10%**	3%	1%	**15%**	3%	1%	**4%**	1%	0%
	50% Coverage	**0%**	0%	0%	**9%**	1%	3%	**4%**	1%	1%	**10%**	2%	1%	**14%**	2%	1%
	25% Coverage	**6%**	2%	2%	**14%**	2%	5%	**21%**	5%	3%	**36%**	7%	3%	**11%**	2%	1%
	0% No vegetation	**94%**	25%	29%	**37%**	6%	14%	**48%**	12%	7%	**23%**	4%	2%	**57%**	8%	6%
TREE COVER	*100% Completely covered*	**0%**	0%	0%	**6%**	1%	2%	**13%**	3%	2%	**10%**	2%	1%	**0%**	0%	0%
	75% Coverage	**0%**	0%	0%	**9%**	1%	3%	**6%**	2%	1%	**3%**	0%	0%	**7%**	1%	1%
	50% Coverage	**0%**	0%	0%	**20%**	3%	8%	**21%**	5%	3%	**26%**	5%	2%	**21%**	3%	2%
	25% Coverage	**0%**	0%	0%	**46%**	8%	17%	**38%**	9%	5%	**31%**	6%	2%	**36%**	5%	4%
	0% No vegetation	**100%**	26%	31%	**20%**	3%	8%	**23%**	6%	3%	**31%**	6%	2%	**36%**	5%	4%
INFRASTRUCTURE AND RESOURCES	*None available*	**75%**	20%	23%	**80%**	14%	30%	**48%**	12%	7%	**62%**	12%	5%	**64%**	9%	6%
	1 Type Available	**0%**	0%	0%	**20%**	3%	8%	**42%**	10%	6%	**38%**	7%	3%	**21%**	3%	2%
	2-3 Types available	**25%**	7%	8%	**0%**	0%	0%	**10%**	3%	1%	**0%**	0%	0%	**14%**	2%	1%
	More than 3 types available	**0%**	0%	0%	**0%**	0%	0%	**0%**	0%	0%	**0%**	0%	0%	**0%**	0%	0%
MATERIAL USE	*N/A*	**0%**	0%	0%	**66%**	11%	25%	**27%**	7%	4%	**23%**	4%	2%	**14%**	2%	1%
	Mass	**100%**	26%	31%	**31%**	5%	12%	**15%**	4%	2%	**13%**	2%	1%	**18%**	3%	2%
	Framed high mass	**0%**	0%	0%	**3%**	0%	1%	**56%**	14%	8%	**46%**	9%	4%	**61%**	9%	6%
	Framed light weight	**0%**	0%	0%	**0%**	0%	0%	**0%**	0%	0%	**3%**	0%	0%	**0%**	0%	0%
	Framed glazed	**0%**	0%	0%	**0%**	0%	0%	**2%**	1%	0%	**15%**	3%	1%	**7%**	1%	1%
EXISTING STRUCTURE	*N/A*	**0%**	0%	0%	**97%**	17%	37%	**25%**	6%	4%	**26%**	5%	2%	**7%**	1%	1%
	Vertical	**0%**	0%	0%	**3%**	0%	1%	**75%**	18%	11%	**69%**	13%	6%	**93%**	13%	9%
	Horisontal	**100%**	26%	31%	**0%**	0%	0%	**0%**	0%	0%	**5%**	1%	0%	**0%**	0%	0%
AREA & SCALE	*0-50 sqm*	**0%**	0%	0%	**0%**	0%	0%	**2%**	1%	0%	**0%**	0%	0%	**0%**	0%	0%
	50-500sqm	**23%**	6%	7%	**26%**	4%	10%	**63%**	15%	9%	**69%**	13%	6%	**54%**	8%	5%
	500-2000 sqm	**54%**	14%	17%	**20%**	3%	8%	**25%**	6%	4%	**28%**	5%	2%	**32%**	5%	3%
	> 2000 sqm	**21%**	6%	7%	**54%**	9%	21%	**10%**	3%	1%	**3%**	0%	0%	**14%**	2%	1%
		Open Roof level			**Open ground level**			**Attached ground level**			**Inbetween ground level**			**Enclosed ground level**		

	Number of Spaces in the city	**26%**	**17%**	**24%**	**19%**	**14%**
	Total area covered of these spaces	**31%**	**38%**	**14%**	**8%**	**10%**

Table 68: Aggregated mapping data collected in the Hatfield neighbourhood.

Additional mapping analysis spread sheets are available online at https://drive.google.com/drive/u/0/folders/0APPEDpxkMebwUk9PVA

Appendix C

Additional information regarding the respondents interviewed during research objective B. The analysis data is available online. See note at end of Appendix F.

Table 69: Descriptions of interview respondents.

Respondent Number	Place	Date	Role/Occupation	Description
Respondent 1	Singapore	15.01.2018	**Farmer**	**Rooftop farmer**
Respondent 2	Singapore	16.01.2018	**Farmer**	**Rooftop farmer**
Respondent 3	Sydney, Australia	21.03.2018	**Specialist**	**Researcher**
Respondent 4	Cape Town, South Africa	04.04.2018	**Product Developer**	**Vertical farming technology**
Respondent 5	Pretoria, South Africa	05.04.2018	**Specialist**	**Project developer**
Respondent 6	Pretoria, South Africa	11.04.2018	**Specialist**	**Researcher**
Respondent 7	Pretoria, South Africa	11.04.2018	**Farmer**	**Aquaponics / vertical farmer**
Respondent 8	Johannesburg, South Africa	12.04.2018	**Specialist**	**Researcher**
Respondent 9	Johannesburg, South Africa	12.04.2018	**Farmer**	**Rooftop farmer**
Respondent 10	Amsterdam, Netherlands	18.04.2018	**Specialist**	**Researcher**
Respondent 11	Wageningen, Netherlands	19.04.2018	**Specialist**	**Researcher**
Respondent 12	Den Haag, Netherlands	23.04.2018	**Farmer**	**Rooftop farmer**
Respondent 13	Amsterdam, Netherlands	24.04.2018	**Farmer / Developer**	**Rooftop & Indoor Farmer**
Respondent 14	Amsterdam, Netherlands	24.04.2018	**Farmer**	**Rooftop & Indoor Farmer**
Respondent 15	Venlo, Netherlands	25.04.2018	**Farmer**	**Researcher**
Respondent 16	Brussels, Belgium	26.04.2018	**Farmer**	**Rooftop farmer**
Respondent 17	Brussels, Belgium	26.04.2018	**Farmer**	**Indoor Farmer**
Respondent 18	Ghent, Belgium	27.04.2018	**Farmer**	**Researcher / Indoor Farmer**
Respondent 19	Waregem, Belgium	27.04.2018	**Product Developer**	**Indoor farming technology**
Respondent 20	Johannesburg, South Africa	08.05.2018	**Farmer**	**Ground-based farmer**
Respondent 21	Pretoria, South Africa	11.05.2018	**Farmer**	**Ground-based farmer**
Respondent 22	Johannesburg, South Africa	14.05.2018	**Specialist**	**Researcher**
Respondent 23	Pretoria, South Africa	15.05.2018	**Specialist**	**Researcher**
Respondent 24	England	17.05.2018	**Specialist**	**Researcher**
Respondent 25	Netherlands & Germany	26.05.2018	**Specialist**	**Project developer / Professional**
Respondent 26	Netherlands	12.06.2018	**Specialist**	**Project developer / Professional**

Table 70: Description of farms visited during the observational study.

Farm	Country	Date	Farm type
Farm 1	Singapore	12.01.2018	BIA, ground-based UA
Farm 2	Singapore	13.01.2018	BIA
Farm 3	South Africa	11.04.2018	BIA
Farm 4	South Africa	12.04.2018	BIA
Farm 5	Netherlands	18.04.2018	Ground-based UA
Farm 6	Netherlands	19.04.2018	Ground-based UA
Farm 7	Netherlands	20.04.2018	Ground-based UA
Farm 8	Netherlands	23.04.2018	BIA
Farm 9	Netherlands	24.04.2018	BIA
Farm 10	Netherlands	25.04.2018	BIA
Farm 11	Netherlands	25.04.2018	BIA
Farm 12	Belgium	26.04.2018	BIA
Farm 13	Belgium	26.04.2018	BIA,
Farm 14	Belgium	27.04.2018	BIA
Farm 15	Belgium	27.04.2018	BIA
Farm 16	Netherlands	29.04.2018	Ground-based UA
Farm 17	South Africa	08.05.2018	Ground-based UA
Farm 18	South Africa	11.05.2018	Ground-based UA
Farm 19	South Africa	20.08.2018	BIA
Farm 20	South Africa	20.08.2018	Ground-based UA
Farm 21	South Africa	18.04.2019	BIA
Farm 22	South Africa	21.05.2019	BIA
Farm 23	South Africa	05.06.2019	BIA
Farm 24	South Africa	03.06.2019	BIA
Farm 25	South Africa	10.06.2019	BIA
Farm 26	South Africa	16.07.2019	BIA
Farm 27	South Africa	16.07.2019	BIA

Excel spread sheets with the data analysis are available online at

https://drive.google.com/drive/u/0/folders/0APPEDpxkMebwUk9PVA

Appendix D

Example of interview questions considered and asked during the semi-structured interviews.

Urban agriculture specialists.

Background:

1. Background – training where, when and why.
2. How did you get involved in urban agriculture?
3. For clarification, what is your experience in the urban agriculture industry?
4. What was your role and focus in these projects?
5. Discuss one of the projects to initiate discussion.

Management:

1. There are various management approaches to running an urban agriculture project, please explain which approach you deem the most successful.
2. What do you deem vital to ensure that an urban agriculture project is successful?
3. What are the typical maintenance cycles in urban agriculture projects?
4. How does one ensure financial stability in an urban agriculture project?
5. What role does the greater context (neighbourhood) play and how does its success affect a typical urban agriculture project?
6. Do you make use of volunteers to manage the project?

Planting system:

1. What type of planting system was used in the project?
2. Why was this systems used?
3. Was the choice of the system informed by the structural requirements?
4. What type of produce are grown and why?
5. What would you deem appropriate types of produce to grow? How do one decide on that?

Spatial system:

1. How was the position of the planting system decided upon?
2. Why was the site chosen? What informed the choice?
3. What difficulties regarding the spatial character of the site did you experience?
4. How was access to the site managed?

5. What are important spatial requirements to consider in typical urban agriculture project?
6. How much auxiliary space is used for services, tools etc?

Structural:

1. What are the critical structural aspects that must be considered?
2. What were the various structural issues to consider?
3. Why was the specific system used in the project?
4. What problems did the existing structure present during the implementation of the project?

Implementation:

1. How was the implementation of the project approached?
2. How do we consider implementing these projects – do you have specific criteria that must be in place before choosing the site?
3. What role did the owner of the building play?
4. Was a specialist installer needed to construct the system/structure?
5. What role did the immediate community play in the implementation of the project?

Problems:

1. Were there any specific problems encountered during the implementation of his project?
2. What would you do differently in future?

More Contacts:

1. Who would you suggest I contact to further my research into the Spatial and construction requirements of urban agriculture?

Urban agriculture product supplier specialists.

Background:

1. Background – discuss product type, focus and use?
2. For clarification what is your experience in the urban agriculture industry?
3. How long have your products been used in the urban agriculture industry?
4. What role do you as supplier play in urban agriculture projects?
5. Discuss one or more types of spaces or projects.

Spatial system:

1. How much space is needed to install the systems?
2. What are important spatial requirements to consider in typical urban agriculture project?
3. How much auxiliary space is used for services, tools etc?
4. How is the position of the planting system decided upon?
5. How was access to the site to install system managed?
6. How can the planting space be optimised?

Structural:

1. What are the critical structural aspects that must be considered during installation?
2. Why was the specific system used in the project? Do various systems for a variety of applications exist?
3. Can your system function as a structural system by itself or does it need additional sub-structure?

Planting system:

1. In what type of applications can this planting system work?
2. What type of plants can these systems grow?
3. How flexible or adaptable is this system?
4. What material is this system made of?
5. How is the system maintained?
6. Can different parts be easily exchanged?

Fixing methods:

1. Were the systems fixed to the structure, if so how?
2. Explain the choice of fixing method – what influenced the choice?
3. What impact did the existing structure or façade have on the structural choice and implementation?

Services:

1. What services must be available before installing the system?
2. Can this system run with renewable energy and water systems?
3. How does this system limit energy and water consumption?
4. Can harvested rainwater be used in this system? Must it be filtered beforehand?

Implementation:

1. How are these systems implemented? Should a specialist be involved?
2. How long does it take to train a farmer to use the system?
3. How easy is it to adapt the system?

Microclimate:

1. Can these systems be installed outdoors?
2. How much of an impact does the weather have on the system?
3. Are these systems adapted to withstand extreme weather events?
4. How can these systems be protected from these extreme weather events?

Problems:

1. Were there any specific problems encountered during the implementation of his project?
2. Are there any specific problems or concerns regarding the spaces or other specialists involved that need to be addressed?

More Contacts:

1. Who would you suggest I contact to further my research into the spatial and construction requirements of urban agriculture?

Dietitian

Background:

1. Background – training where, when and why.
2. How did you get involved in urban agriculture?
3. For clarification what is your experience in the urban agriculture field?
4. What was your role and focus on these projects?
5. Discuss one of the projects to initiate discussion.

Food types:

1. What are the critical food types that provide a balanced diet in South Africa?
2. What type of food is typically missing the average South African diet?
3. What food varieties can be grown by individuals that will make a significant difference to food insecurity?
4. Are there any specific preparation or handling methods identified that are the most efficient to improve food quality?

Façade or Structural Engineer

Background:

1. Background – training where, when and why.
2. For clarification what is your experience in the urban agriculture industry?
3. What was your role and focus on these projects?
4. Discuss one of the projects to initiate discussion.

Structural

1. What are the critical structural aspects that must be considered?
2. What was the various structural issues to consider?
3. Why was the specific system used in the project?
4. What problems did the existing structure present during the implementation of the project?
5. Are there types of structures which you will deem problematic for this type of retrofitting projects?

Spatial system:

1. How was the position of the planting system established?
2. Why was the site chosen? What informed the choice?
3. What difficulties regarding the spatial character of the site were experienced?
4. How was access to the site managed?

Fixing methods:

1. Were the systems fixed to the structure, if so how?
2. Explain the choice of fixing method – what influenced the choice?
3. What impact did the existing structure or façade have on the structure choice and implementation?
4. Was the waterproofing/facade affected in any way? How did you go about limiting the impact?

System – Planting system:

1. What type of planting system was used in the project?
2. Why was this system employed?
3. Was the choice of the system informed by the structural requirements?

Implementation:

1. How was the implementation of the project approached?
2. How did you approach implementing these projects – do you have a certain criteria that must be in place before choosing the site?
3. What role did the owner of the building play?
4. Was a specialist installer needed to construct the system/structure?

Problems:

1. Were there any specific problems encountered during the implementation of his project?
2. What would you do differently in future?

More Contacts:

1. Who would you suggest I contact to further my research into the spatial and construction requirements of urban agriculture?

Urban Agriculture Researcher

Background:

1. Background – training where, when and why.
2. How did you get involved in the urban agriculture field?
3. For clarification what is your experience in the urban agriculture discourse?
4. What was your role and focus on these projects?
5. Discuss one of the projects to initiate discussion.

Premise for urban agriculture

1. What is your opinion of the current food production and consumption network?
2. If one consider the global food network and the existence of food scarcity and wastage at the same time – what would you deem important to focus on if global food security is to be achieved?
3. Why would you promote the implementation of urban agriculture?
4. What are the benefits of urban agriculture that you believe is worth pursuing?
5. What are the critical concerns around urban agriculture that need to be addressed?
6. What is needed to leverage urban agriculture into a large scale urban intervention?
7. What is the future of urban agriculture/urban food networks?

More Contacts.

1. Who would you suggest I contact to further my research into the spatial and construction requirements of urban agriculture?

Appendix E

FAO-PM Equation and data set used during research objective C, see Allen et al. (1998) for more information.

Excerpt from Allen et al. (1998):

Original Penman-Monteith equation (1965):

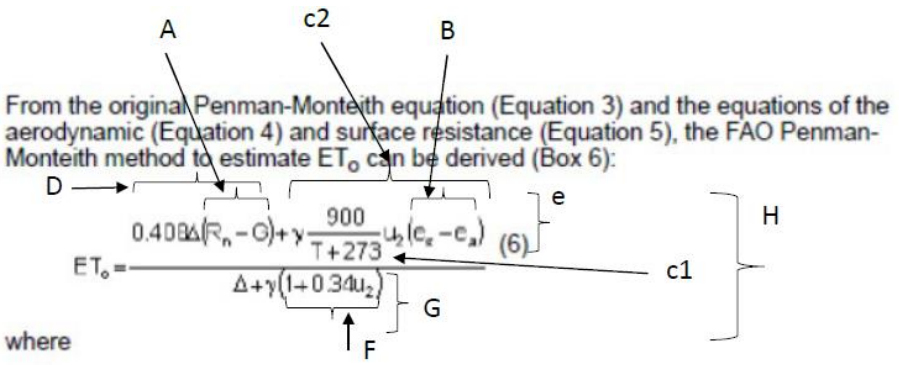
$$\lambda ET = \frac{\Delta(R_n - G) + \rho_a c_p \frac{(e_s - e_a)}{r_a}}{\Delta + \gamma\left(1 + \frac{r_s}{r_a}\right)}$$

Adjusted FAO-PM equation (1998):

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \quad (6)$$

Figure 106: Penmann-Monteith equation and adjusted FAO-PM equation.

The equation was broken into segments to allow for the development of an Excel model of the equation:



1 ET_o reference evapotranspiration [mm day^{-1}],
2 R_n net radiation at the crop surface [MJ m^{-2} day^{-1}],
3 G soil heat flux density [MJ m^{-2} day^{-1}],
4 T mean daily air temperature at 2 m height [°C],
5 u_2 wind speed at 2 m height [m s^{-1}],
6 e_s saturation vapour pressure [kPa],
7 e_a actual vapour pressure [kPa],
8 e_s - e_a saturation vapour pressure deficit [kPa],
9 Δ slope vapour pressure curve [kPa $°C^{-1}$],
10 γ psychrometric constant [kPa $°C^{-1}$].

The reference evapotranspiration, ET_o, provides a standard to which:

- evapotranspiration at different periods of the year or in other regions can be compared;
- evapotranspiration of other crops can be related.

Figure 107: Segmentation of FAO-PM equation to apply in the excel model.

Table 71:FAO-PM model inputs - Johannesburg context.

Month	INPUTS								
	2- Rn	3 - G	4 - T	5 - u2	6 - es	7 - ea	8 - es-ea	9 -Δ	10 - γ
1	26.58944	0.013517	8.65	0.01	2.772027	1.17761	1.594417	0.151531	0.054699
2	26.71642	-0.01183	9.5	0.01	2.77789	1.123094	1.654795	0.148703	0.054699
3	23.14735	-0.01626	11.05	0.01	2.833146	0.935489	1.897658	0.145132	0.054699
4	18.73525	-0.06083	9.8	0.01	1.970445	0.685803	1.284642	0.107941	0.054699
5	14.7642	-0.04435	11.2	0.01	1.834806	0.518454	1.316352	0.096851	0.054699
6	12.74524	-0.07392	10.75	0.01	1.442767	0.39054	1.052227	0.078714	0.054699
7	14.02305	-0.00275	12.55	0.01	1.773758	0.401156	1.372602	0.089574	0.054699
8	16.89764	0.057024	12.4	0.01	1.989306	0.544278	1.445028	0.100243	0.054699
9	20.68864	0.069696	10.35	0.01	2.219089	0.712769	1.506319	0.11843	0.054699
10	23.7234	0.024668	10.5	0.01	2.632043	0.790742	1.841301	0.137833	0.054699
11	25.15841	0.013981	10.8	0.01	2.517694	0.83531	1.682385	0.131206	0.054699
12	26.29624	0.031046	8.6	0.01	2.694926	1.192797	1.502129	0.147903	0.054699

Table 72: FAO-PM model calculations and outputs - Johannesburg context.

Month	Calculations - See equation breakdown									OUTPUT	
	EQ -A	EQ -B	EQ - C1	EQ - C2	EQ - D	EQ - E	EQ - F	EQ - G	EQ - H	1- Eto	Conversion - latent energy- W/M^2
1	26.57592	1.594417	281.65	0.002787	1.643044	1.645831	0.054885	0.206416	7.973387	7.973387	19.54261485
2	26.72825	1.654795	282.5	0.002884	1.621622	1.624505	0.054885	0.203587	7.979396	7.979396	19.55734336
3	23.16361	1.897658	284.05	0.003289	1.37161	1.374899	0.054885	0.200017	6.873906	6.873906	16.84780827
4	18.79607	1.284642	282.8	0.002236	0.827776	0.830012	0.054885	0.162826	5.097554	5.097554	12.49400525
5	14.80855	1.316352	284.2	0.00228	0.585162	0.587443	0.054885	0.151736	3.871486	3.871486	9.488935211
6	12.81916	1.052227	283.75	0.001826	0.411693	0.413519	0.054885	0.133599	3.09522	3.09522	7.586324274
7	14.0258	1.372602	285.55	0.002366	0.512591	0.514957	0.054885	0.144459	3.564728	3.564728	8.737078344
8	16.84061	1.445028	285.4	0.002493	0.688767	0.691259	0.054885	0.155128	4.456063	4.456063	10.92172346
9	20.61894	1.506319	283.35	0.002617	0.996292	0.998909	0.054885	0.173314	5.763568	5.763568	14.12639201
10	23.69873	1.841301	283.5	0.003197	1.332715	1.335913	0.054885	0.192717	6.931976	6.931976	16.99013664
11	25.14443	1.682385	283.8	0.002918	1.346036	1.348954	0.054885	0.186091	7.248893	7.248893	17.76689401
12	26.2652	1.502129	281.6	0.002626	1.584958	1.587584	0.054885	0.202788	7.828795	7.828795	19.18822292

The FOA-PM model for Johannesburg is available online depository at https://drive.google.com/drive/u/0/folders/0APPEDpxkMebwUk9PVA

Appendix F

Confirmation of ethics approval to undertake the research.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

Reference number: EBIT/10/2018 5 March 2018

Mr JM Hugo
Department of Architecture
University of Pretoria
Pretoria
0028

Dear Mr Hugo

FACULTY COMMITTEE FOR RESEARCH ETHICS AND INTEGRITY

Your recent application to the EBIT Research Ethics Committee refers.

Conditional approval is granted.

This means that the research project entitled "Retrofitting Tshwane with building integrated agriculture to enable climate adaptation and mitigation – A study of the implementation constraints and potentials" is approved under the strict conditions indicated below. If these conditions are not met, approval is withdrawn automatically. The applicant is not required to submit an updated application.

Conditions for approval

- The applicant has indicated that employees of a firm, organisation or institution are to be interviewed. Letters of permission from the respective organisations should be obtained prior to data collection and should be kept on record by the applicant.

This approval does not imply that the researcher, student or lecturer is relieved of any accountability in terms of the Code of Ethics for Scholarly Activities of the University of Pretoria, or the Policy and Procedures for Responsible Research of the University of Pretoria. These documents are available on the website of the EBIT Ethics Committee.

If action is taken beyond the approved application, approval is withdrawn automatically.

According to the regulations, any relevant problem arising from the study or research methodology as well as any amendments or changes, must be brought to the attention of the EBIT Research Ethics Office.

The Committee must be notified on completion of the project.

The Committee wishes you every success with the research project.

Prof JJ Hanekom
Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Engineering, Built Environment and Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en Inligtingtegnologie / Lefapha la Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

EBIT/10-A1/2018 26 May 2019

Mr JM Hugo
Department of Architecture
University of Pretoria
Pretoria
0083

Dear Mr Hugo

This is to notify you that your amendment to your application entitled "*Retrofitting Tshwane with building integrated agriculture to enable climate adaptation and mitigation – A study of the implementation constraints and potentials*" has been approved by the EBIT Ethics Committee.

Kind regards

Prof JJ Hanekom
Chair: Faculty Committee for Research Ethics and Integrity
FACULTY OF ENGINEERING, BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

Additional data have been made available at:

https://drive.google.com/drive/u/0/folders/0APPEDpxkMebwUk9PVA

Please contact jan.hugo@up.ac.za to gain access to the information.