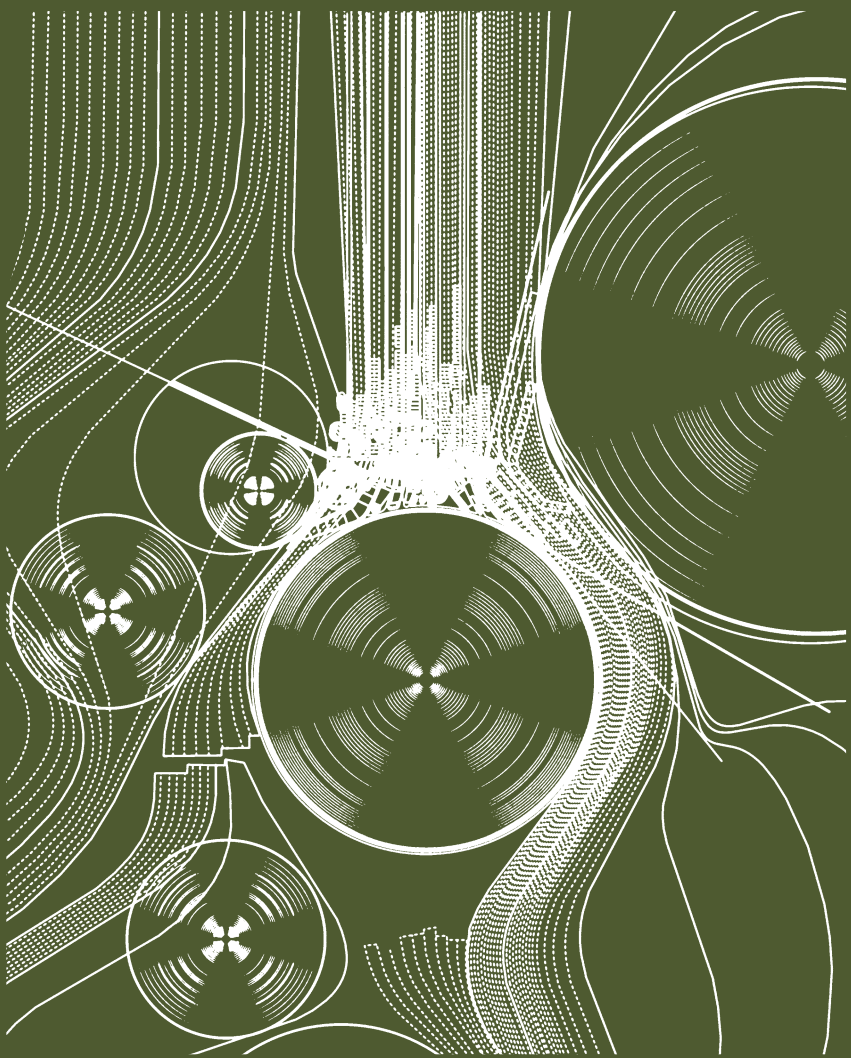
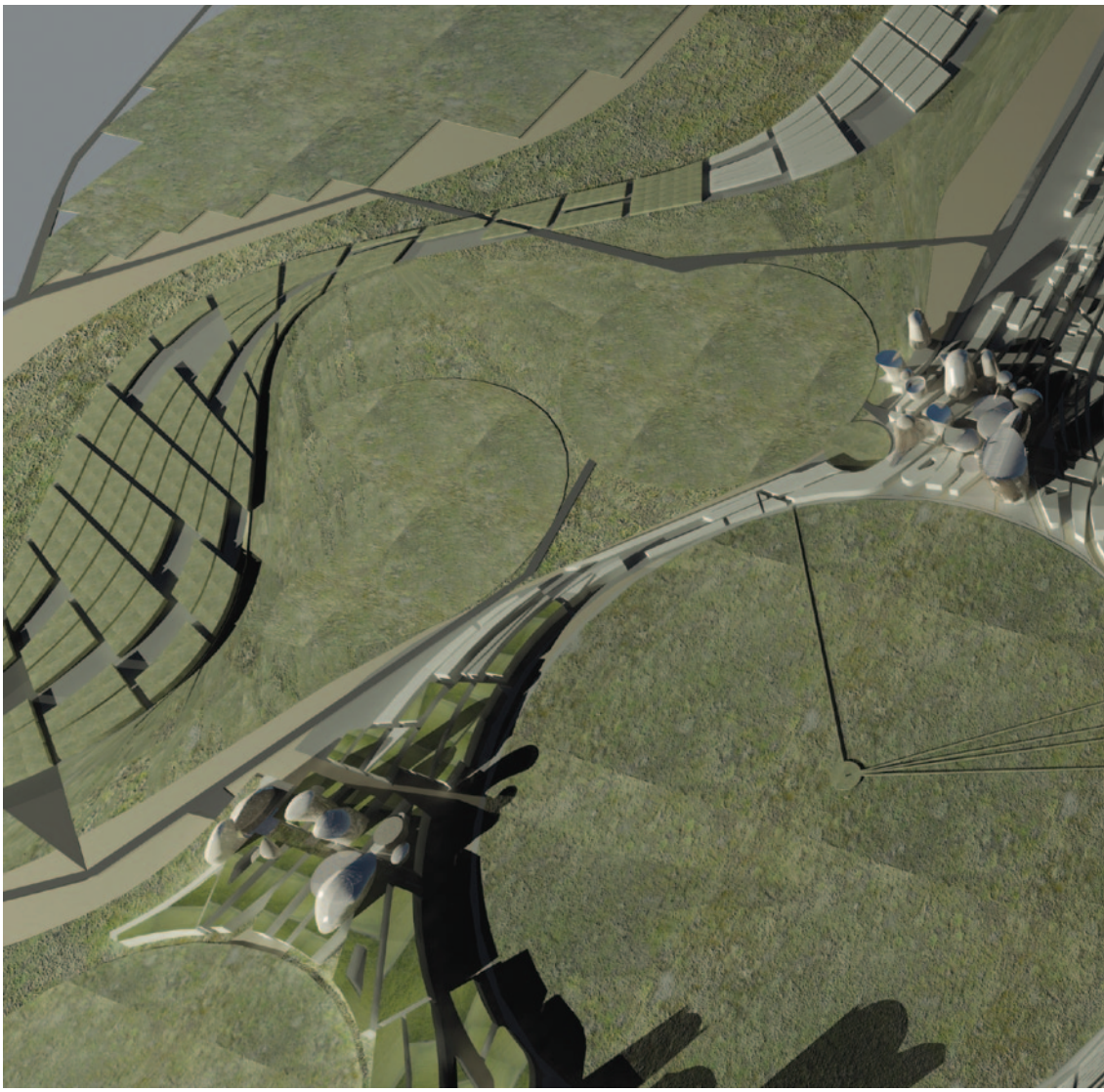
Agropolis

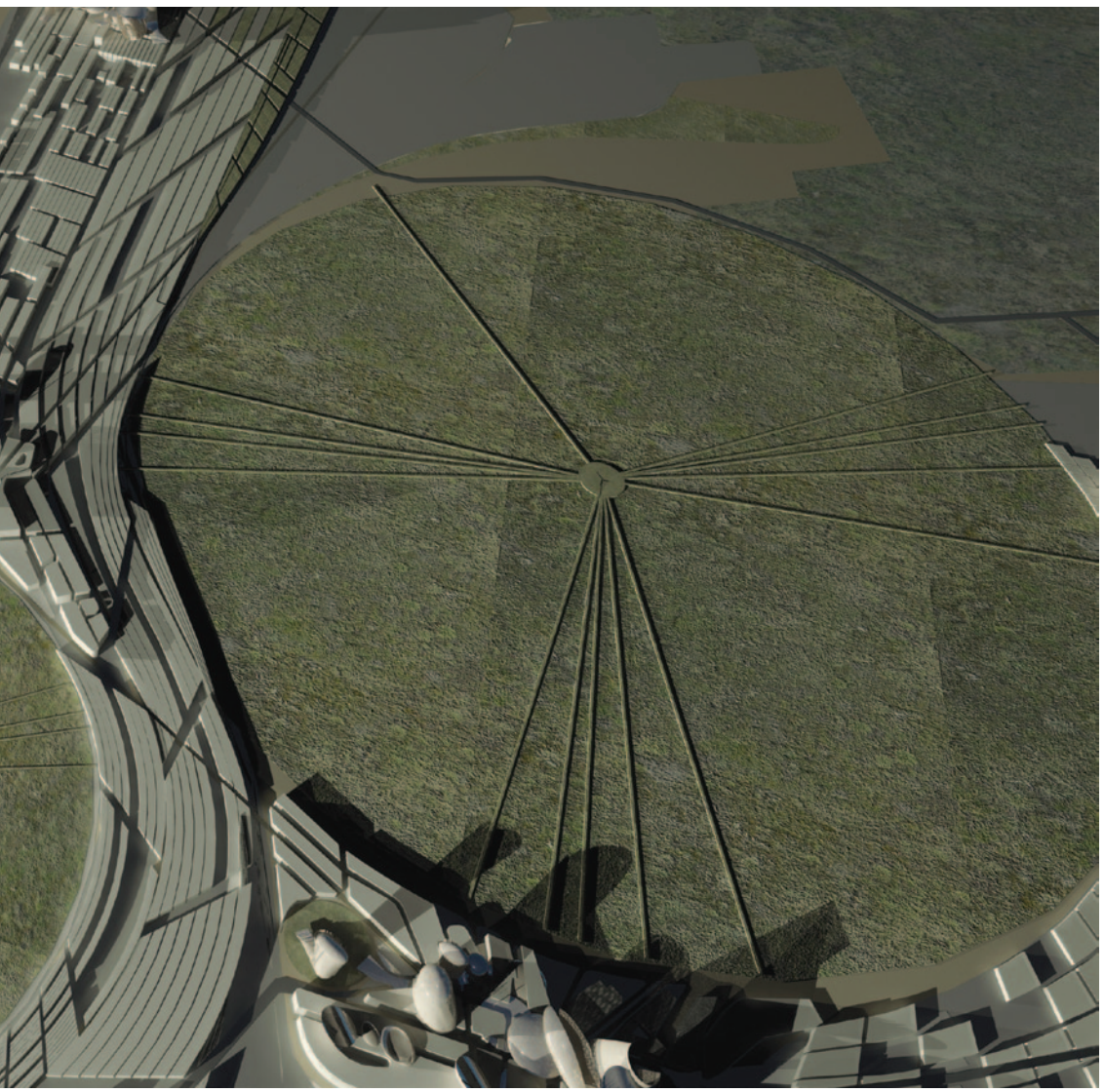


by mam

Project Details

Author:	mam
Designers:	Marjan Colletti and Marcos Cruz
	Colletti and Cruz contributed equally to this project through their collaborative practice, mam architects.
Title:	Agropolis
Output type:	Design
Location:	Khataba (Al Jadida), Egypt
Competition:	The Self-Sufficient City: Envisioning the habitat of the future, Third Advanced Architecture Contest organised by Institut d'Arquitectura Avançada de Catalunya, Barcelona
Competition submission:	2009
Collaborators:	Kapil Amarnani Chawla, Sana Hassan, Heba Layas, Rocky Marchant and Nisha Patel





1
Overall view of Agropolis conurbations following housing typology script

Statement about the Research Content and Process

Description

Agropolis is a design research project for a self-sufficient city in Khataba (Al Jadida), Egypt, that responds to an invited competition by Institut d'Arquitectura Avançada de Catalunya. It examines the rapid increase in peripheral and unsustainable satellite developments of the Nile Delta and aims to redirect the uncontrolled urban sprawl into new agro-urban settlements that grow in accordance with local farming activity.

The Agropolis has self-sufficient transport infrastructures and sustainable use of resources, food and energy production. Its morphology is developed out of pivot irrigation technology, and has a zero carbon footprint. Waste products, including sewage, household garbage and energy are recycled. Liquid waste is processed and used to support local irrigation. Electricity produced by solar panels is integrated into the buildings' skins, lining roofs and walls, and the irrigation system.

Questions

1. **How can an alternative high-tech, large-scale design approach generate sustainable urban development and agriculture in the Nile Delta?**
2. **How can centre pivot irrigation technology change the way future cities are theorised, planned and inhabited, when used as urban morphological blueprints?**
3. **How can an exploratory design respond to population growth forecasts and offer sustainable development in an environmentally vulnerable region?**

Methods

1. **Analysis of Nile Delta urbanism and its historical and geographical contexts to understand its infrastructure, environmental, agricultural and nutritional contexts.**
2. **Comparative studies of agricultural landscape traditions in the Middle East and North America, especially centre pivot and aquifer irrigation techniques.**
3. **Design conceptualization and iterations of research into urban water morphologies, food and energy production, and urban infrastructures.**

Dissemination

The work has been discussed in *AD Exuberance* and *Futuristic;* reviewed in *Designboom;* and presented internationally in lectures in Syracuse, Madrid, Bogotá, Évora, Toledo, Nottingham, Rio de Janeiro, Lisbon, Cork and San José, Costa Rica.

Introduction

Agropolis is a conceptual proposal for a self-sufficient city in Khataba (Al Jadida), Egypt, designed for an invited competition organised by Institut d'Arquitectura Avançada de Catalunya. The rapid increase in the population of the Nile Delta, especially around Cairo and Alexandria, is forcing hundreds of thousands of people into peripheral and unsustainable satellite developments. This is happening both in the desert, in enclosed condominiums for the rich, and in the Delta, in shanty-town-like settlements for the poor. This proposal is for a series of self-sufficient towns intended to redirect the uncontrolled urban sprawl into new agro-urban settlements that grow in accordance with local farming activity.

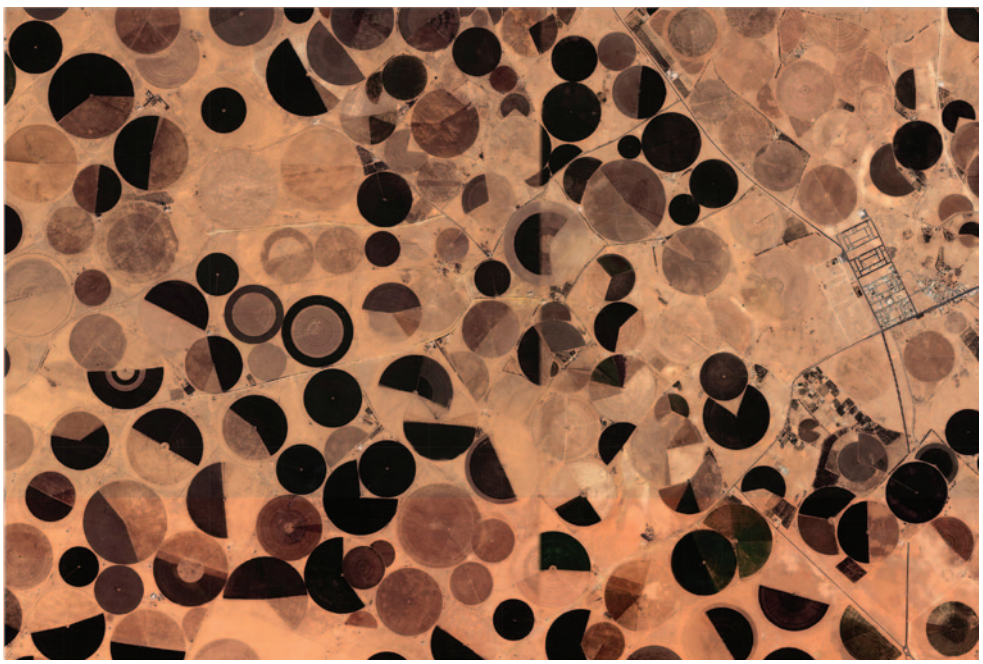
Khataba (Al Jadida) is the first of these settlements, designed as a semi-urban and semi-agricultural self-sufficient environment – an Agropolis. The Agropolis has a self-sufficient local population, new transport infrastructures, a mixed programme and, above all, a sustainable use of resources, food and energy production.

Linear and circular agricultural patterns provide the morphological structure for the Agropolis and other new settlements to grow. A matrix of interconnected and complementary urban nuclei develop in the midst of new agricultural land, in particular in the interstices between gridded fields and large irrigation circles using water extracted from existing aquifers. Instead of mono-cultural zoning strategies, largely used in mid and late 20th-century urbanism, an ecologically balanced and diverse agricultural production would provide food for the community. Khataba (Al Jadida) is designed as a zero carbon footprint agglomeration. Different types of waste products, including sewage, household garbage and energy, are to be recycled. Liquid waste is processed and used to support the necessary irrigation of the surrounding fields. Electricity produced by solar panels is integrated into the buildings' skins, lining roofs and walls, and some of the circular plots of land. [fig. 1]

Aims and Objectives

The central aim is to articulate an alternative, design-led model to current development in the Middle East where cutting-edge technologies offer new ways of expressing sustainability, revolutionising city design beyond carbon neutral buildings to large-scale agricultural and energy production. This gives rise to two objectives:`

1. To integrate sustainable food and energy production into urban planning through technical investigations and morphological studies
2. To propose a pilot scheme through exploratory design that accommodates forecast rates of growth sustainably in areas of extreme environmental vulnerability.



2

2
Centre pivot irrigation circles in Middle Eastern landscapes

Questions

1. How can an alternative high-tech, large-scale design approach generate sustainable urban development and agriculture in the Nile Delta?
2. How can centre pivot irrigation technology change the way future cities are theorised, planned and inhabited, when used as urban morphological blueprints?
3. How can an exploratory design respond to population growth forecasts and offer sustainable development in an environmentally vulnerable region? [fig. 2]

Context

Speculative city design has a rich architectural lineage, envisioning new urban forms to address historical crises, from Howard's Garden City and Le Corbusier's Ville Radieuse, to Archigram's Walking City, Fuller's geodesic domes and Kikutake's Sea Buildings.

Unplanned urban gardening and farming has become an increasingly popular global practice in large metropolises. Ancient Egyptians already used community waste to fertilise urban crops; this approach was also used in the culture of Kleingärten (allotments) in the 19th century, which offered 'green oases' away from the rapidly industrialising and heavily polluted German cities in which children could exercise and cultivate gardens.

This proposal offers an alternative to renowned Middle Eastern eco-city projects, such as Xeritown in Dubai designed by X-Architects and SMAQ, and Masdar City in Abu Dhabi by Foster and Partners and Mott MacDonald, which have been criticised as gated, luxury enclaves for the wealthy. Agropolis accommodates low-income housing and goes beyond an understanding of sustainability that is limited to construction and building performance, to address ecological and nutritional necessity through local food and energy production.

Methods

Analysis

Cairo's rapid expansion in the 20th century was achieved at the expense of the Nile Delta. Predicted demographic and urbanising trends led this project to confront three interrelated crises threatening Cairo's future:

a. Infrastructure

Hundreds of thousands of people are forced into sprouting desert satellite settlements dependent on the capital for jobs and the Nile for resources. Their inflexible planning comprises a typological uniformity of exclusive condominiums that lack vegetation and overstretch energy and transport infrastructure.

b. Environment

This urban sprawl forces over-intensive water use, diminishing the Nile Delta, whose fragile boundaries recede as it extends to Alexandria.

c. Nutrition

Egypt faces an extraordinary crisis in food security and nutrition owing to inadequate national production, particularly in wheat. Cairo is suffering from an acute increase in food imports, making the country increasingly susceptible to price fluctuations of the international markets, with basic goods becoming too expensive for the majority of the population. [fig. 3–7]

3
Location of Khatabi (Al Jadida) on the edge of the Nile Delta, north of Cairo
Image in the public domain via NASA

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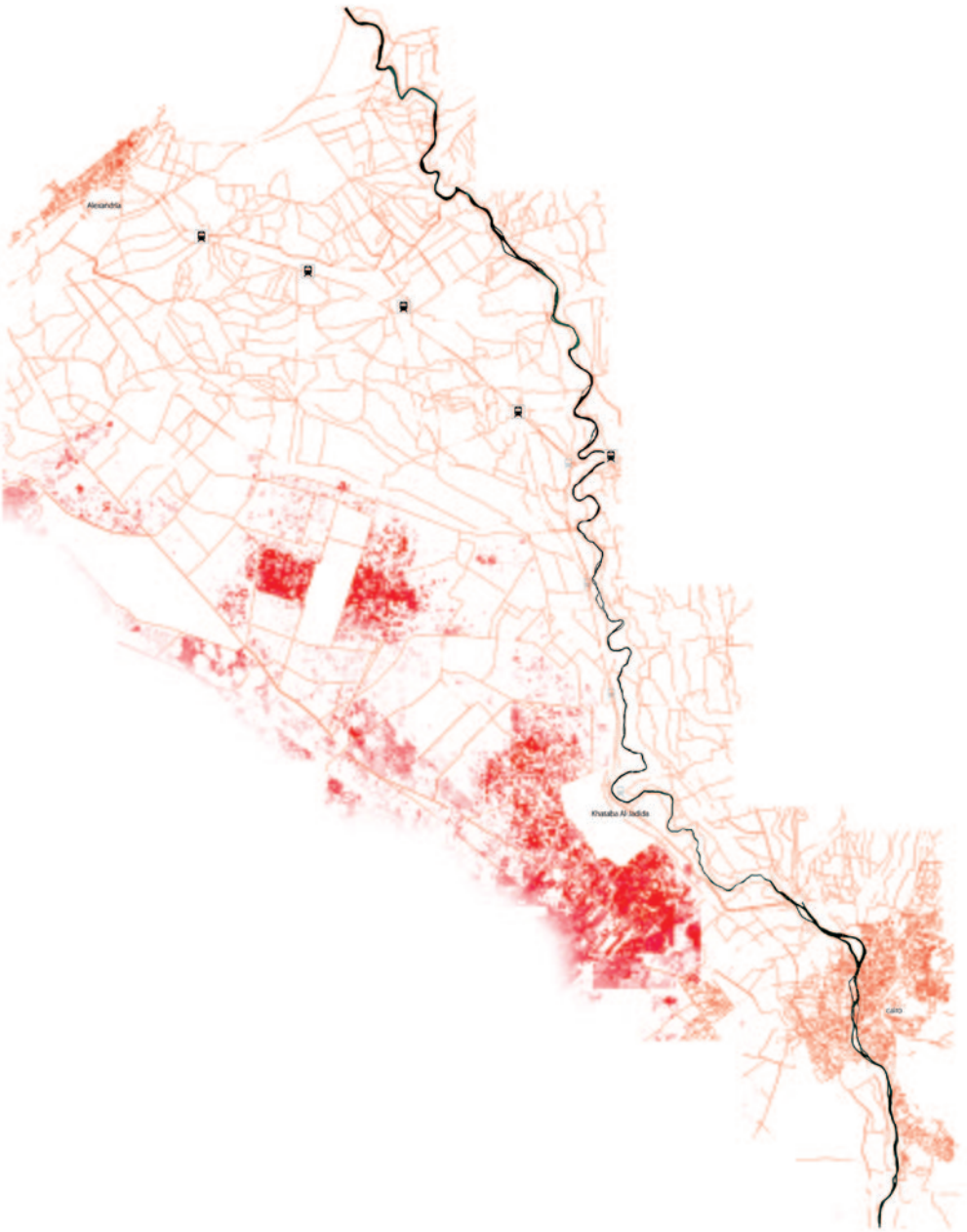
4 & 5
Location of site close to the Nile River



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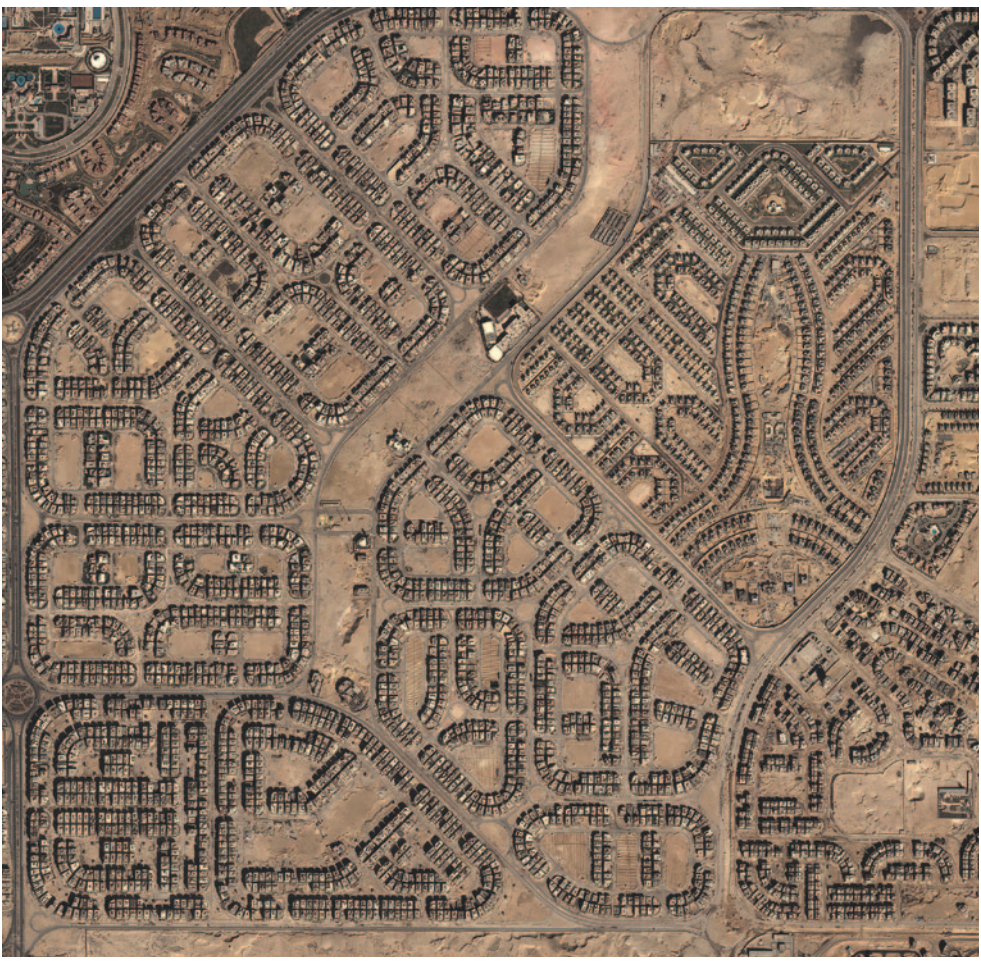

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6 & 7
Unsustainable sprawl of enclosed condominiums on the outskirts of Cairo without environmental preoccupation

7

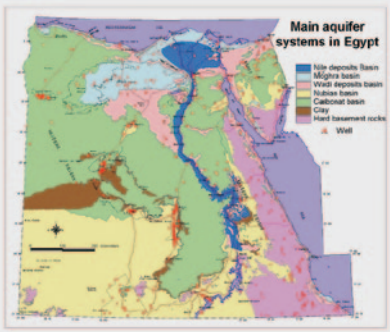
8

9

Comparative study

Cairo is surrounded by expansive virgin territory governed by flat, arid desert landscape. A comparative study of new environments facing similar ecological preoccupations in the Middle East and the Americas shows settlements not determined by pre-existing approaches to natural and urban sustainability are coping with food demand and population increase by embracing experimental technologies.

Centre pivot irrigation techniques in the United States, pioneered in Arizona and Arkansas and emerging in the Middle East, provide an efficient system where irrigation circles are employed as a means to irrigate large surfaces with very little water which, in turn, is extracted from existing aquifers or rivers. This technology offers the potential to go beyond schemes that mitigate resource consumption by reconfiguring production through integrated environmental and built elements. In this part of Egypt the aquifers are regularly refilled with water from the Nile Delta, turning this system into an ecologically balanced and economic practice. [fig. 8–11]



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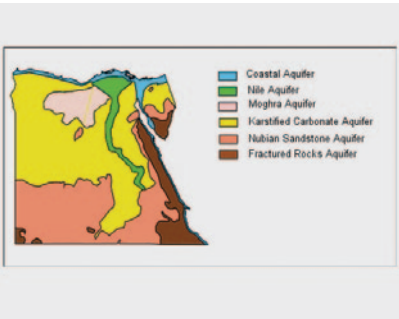

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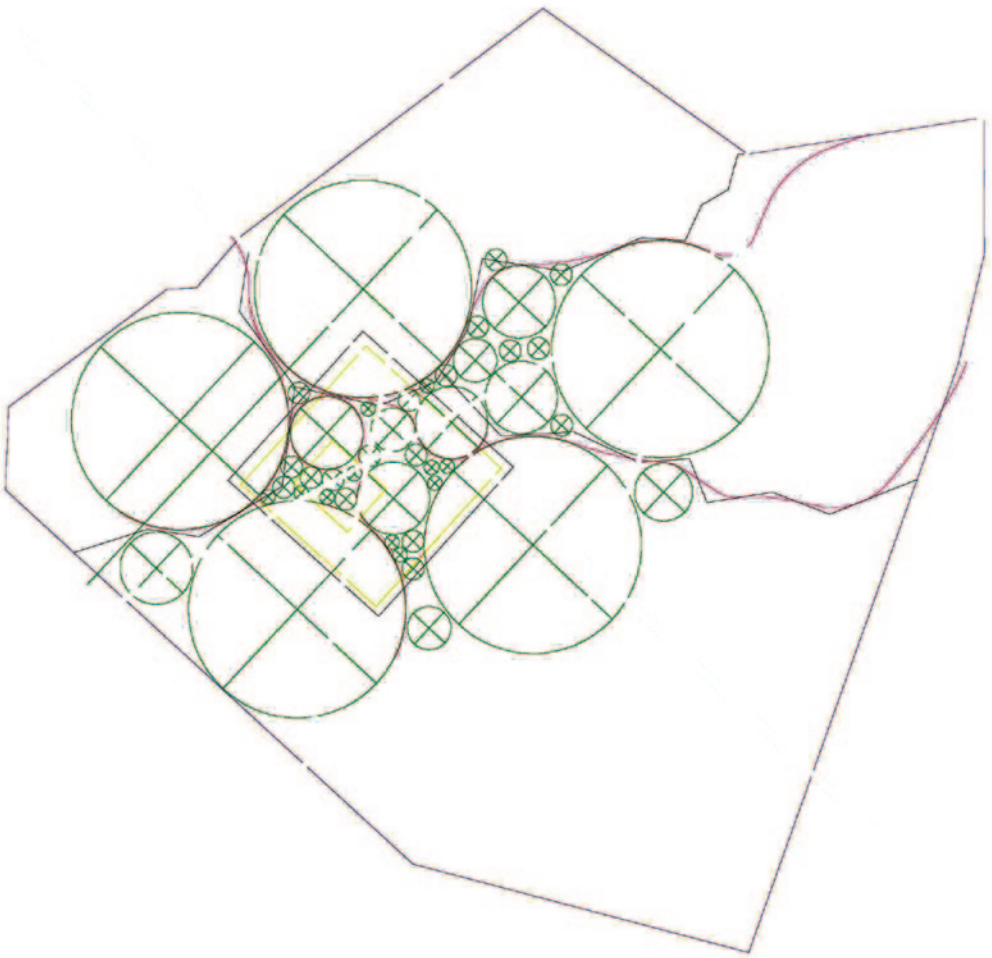
8
Detail view of irrigation circles in desert areas of Middle East and outskirts of Cairo by site

9
Centre pivot irrigation systems on the ground
Image in the public domain via US Federal Government

10 & 11
Main aquifer systems and wells in Egypt



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12
Irrigation circle concepts (Kapil Amarnani Chawla)

13
Views of sprawling linear housing areas in between urban nuclei along the proposed new railway line linking Cairo with Alexandria with possible expansions of other Agropolises along the Nile Delta

14 & 15
Preliminary computer study plan using Rhino

Design concept

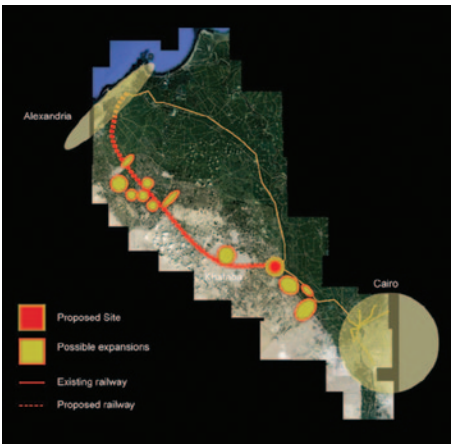
a. Morphological pattern

Water has a functional and symbolic importance in Islamic societies in which wells are organising elements at the heart of the city or settlement. Irrigation patterns traditionally shaped the urban landscape as cities had developed around subdivided strips of agricultural land in thin orthogonal plots.

Agropolis reintroduces water as the centre of activity through sprinkler systems that organise the environmental habitats. The circles provide the basic agricultural infrastructure laying down a framework within which, and between which, there is the potential to grow cities.

The proposal rejects the idea of traditional peripheral urban growth around dominant central hubs, depicted in sociological models such as Ernest Burgess's concentric zones, Homer Hoyt's sectors, and Chauncy Harris and Edward Ullman's multiple nuclei. Agropolis inverts the radial city model, built around agricultural centres to offer a new identity where crops and cities grow symbiotically in a sequence of autonomous linear and circular agricultural morphological patterns.

The circle morphology grows in scale from wastewater purification silos to small public squares, road networks around plots, large agricultural centres and forests. The segmented circles of centre pivot irrigation demarcate multi-cultivated crops, and the cylindrical built form echoes this pattern in an arrangement that gives rise to a variety of interlocking programmes within a controlled spatial framework. [fig.12–29]



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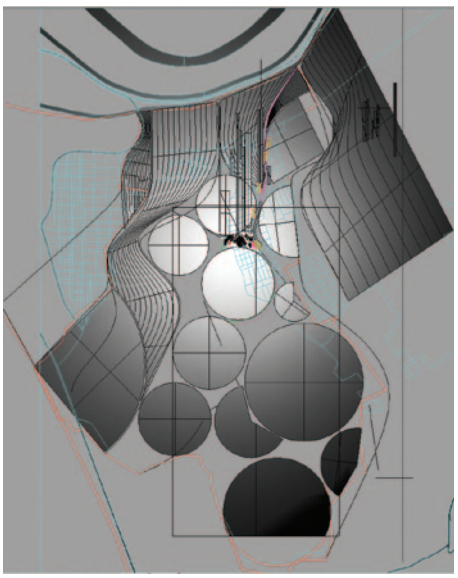

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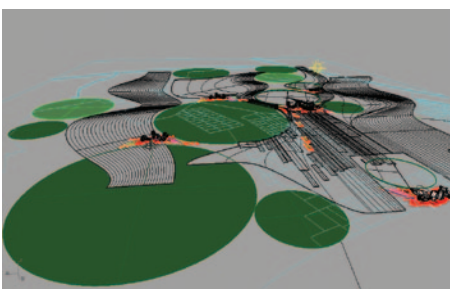

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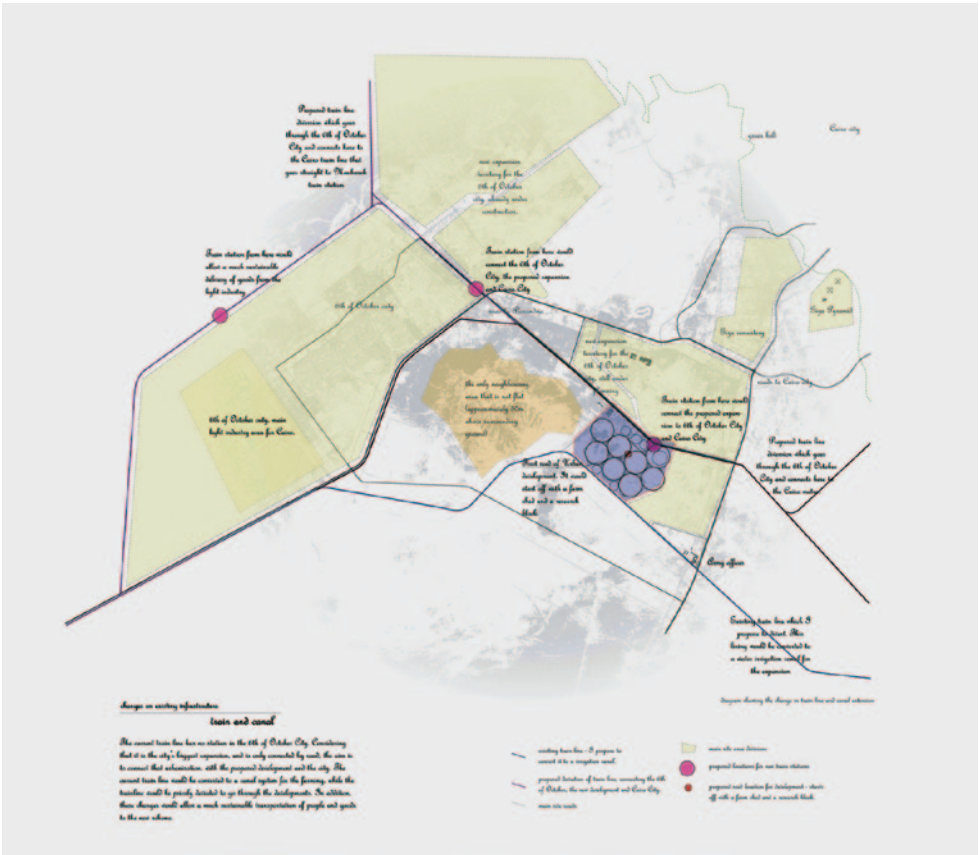
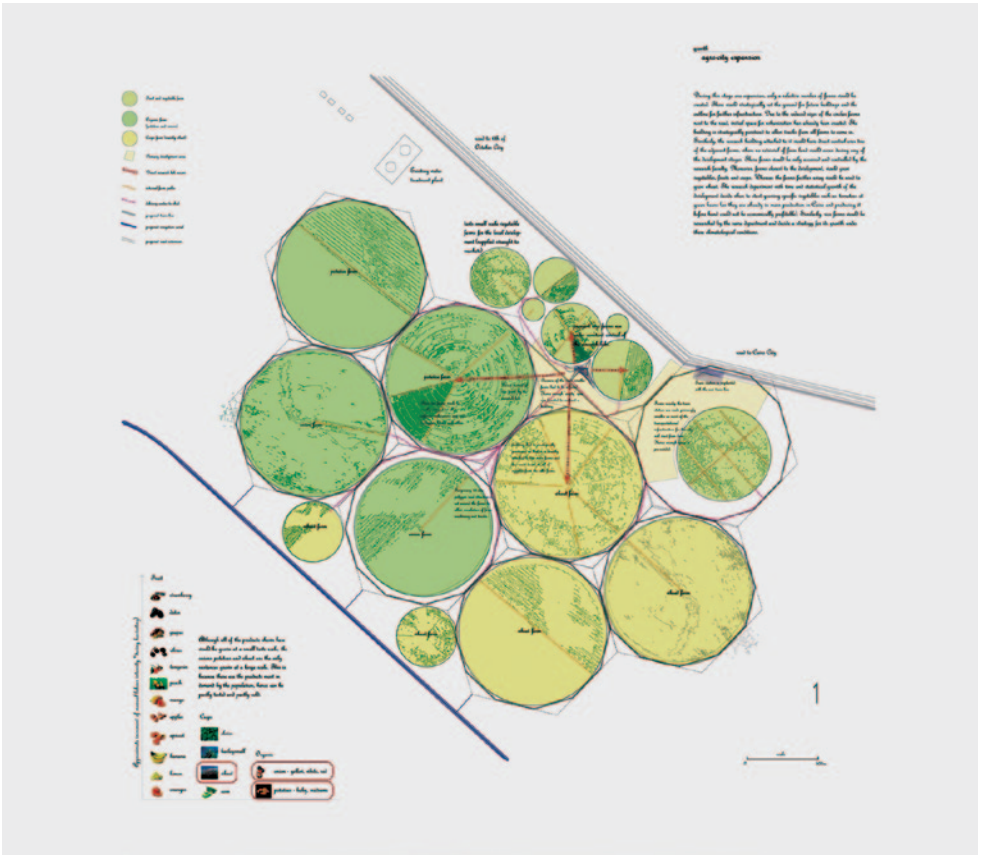
16 & 17
Morphological circle studies (Kapil Amarnani Chawla)


Proposed train line
Intersection which goes
through the 6th of October
City and connects here to
the Cairo train line that
goes straight to Maadi and
train station
From station from here could
start a much sustainable
delivery of goods from the
light industry
6th of October city, main
light industry area for Cairo.
From station from here could
connect the 6th of October
City, the proposed expansion
and Cairo City
the only neighbouring
area that is not flat
(approximately 30m
above surrounding
ground)
Train station from here could
connect the proposed expan-
sion to 6th of October City
and Cairo City
Proposed train line
Intersection which goes
through the 6th of October
City and connects here to
the Cairo railway
Ferry offices
Existing train line which I
propose to divert. The
living would be connected to
a water navigation canal for
the expansion
Diagram showing the changes in train line and canal extension
Changes on existing infrastructure
train and canal
The current train line has no station in the 6th of October City. Considering
that it is the city's biggest expansion, and is only connected by road, the aim is
to connect that urbanization, with the proposed development and the city. The
current train line would be connected to a canal system for the farming, while the
travellers would be priorly directed to go through the development. In addition,
these changes would allow a much sustainable transportation of people and goods
to the new scheme.
existing train line - I propose to
connect it to a navigation canal
proposed location of train line, connecting the 6th
of October, the new development and Cairo City
main city roads
main city area intersect
proposed locations for new trains stations
proposed road location for development - starts
off with a farm land and a research block

17



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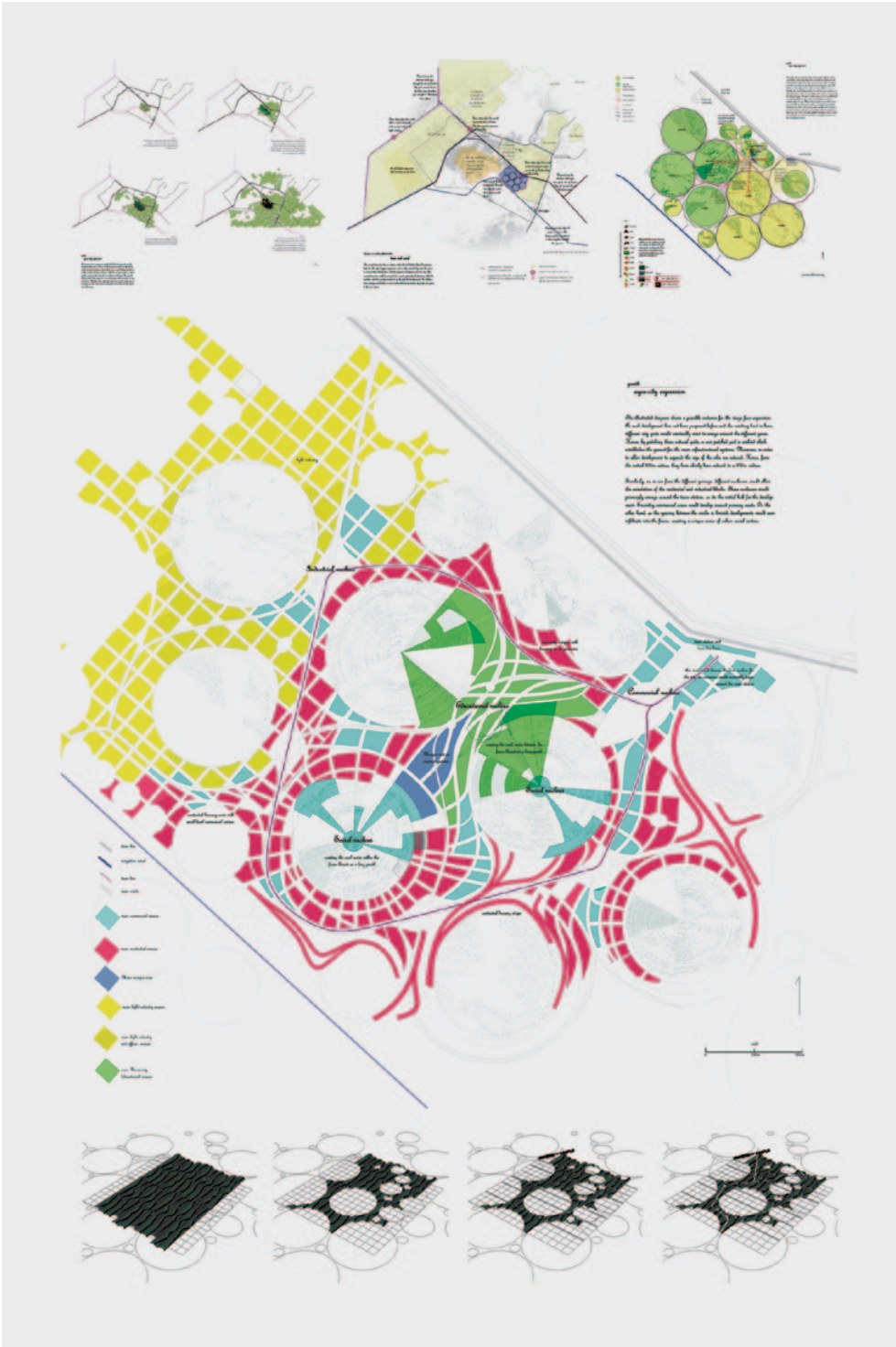
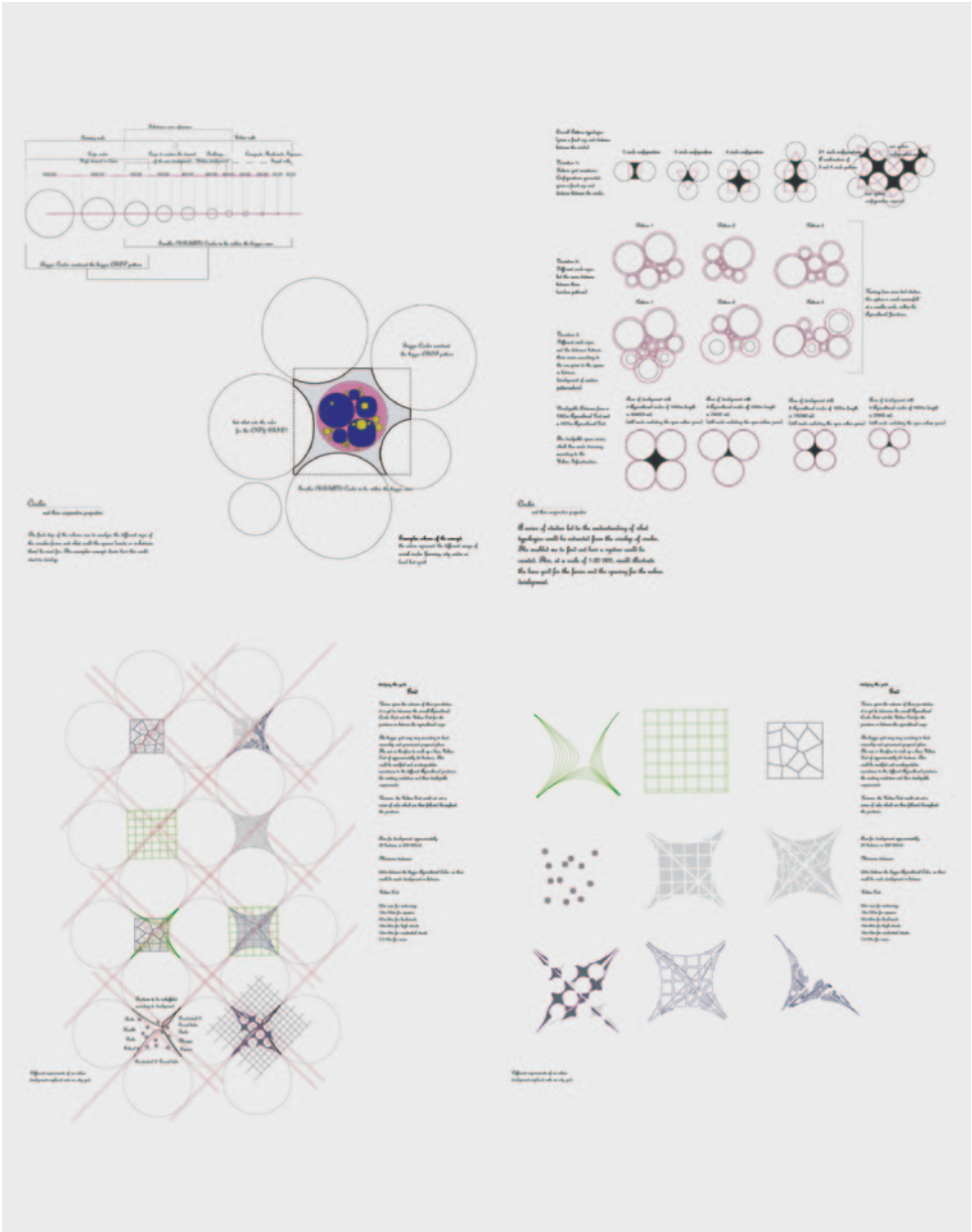
18
Morphological circle studies (Kapil Amarnani Chawla)

19
Morphological study with different urban grids inserted between irrigation circles (Kapil Amarnani Chawla)





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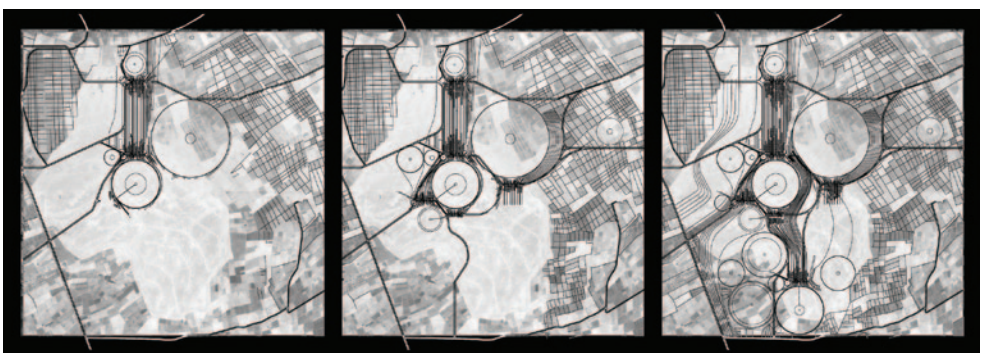
20
Detail of in between areas (Kapil Amarnani Chawla)

21
Detailed expansion drawing with dashed proposed train line

21



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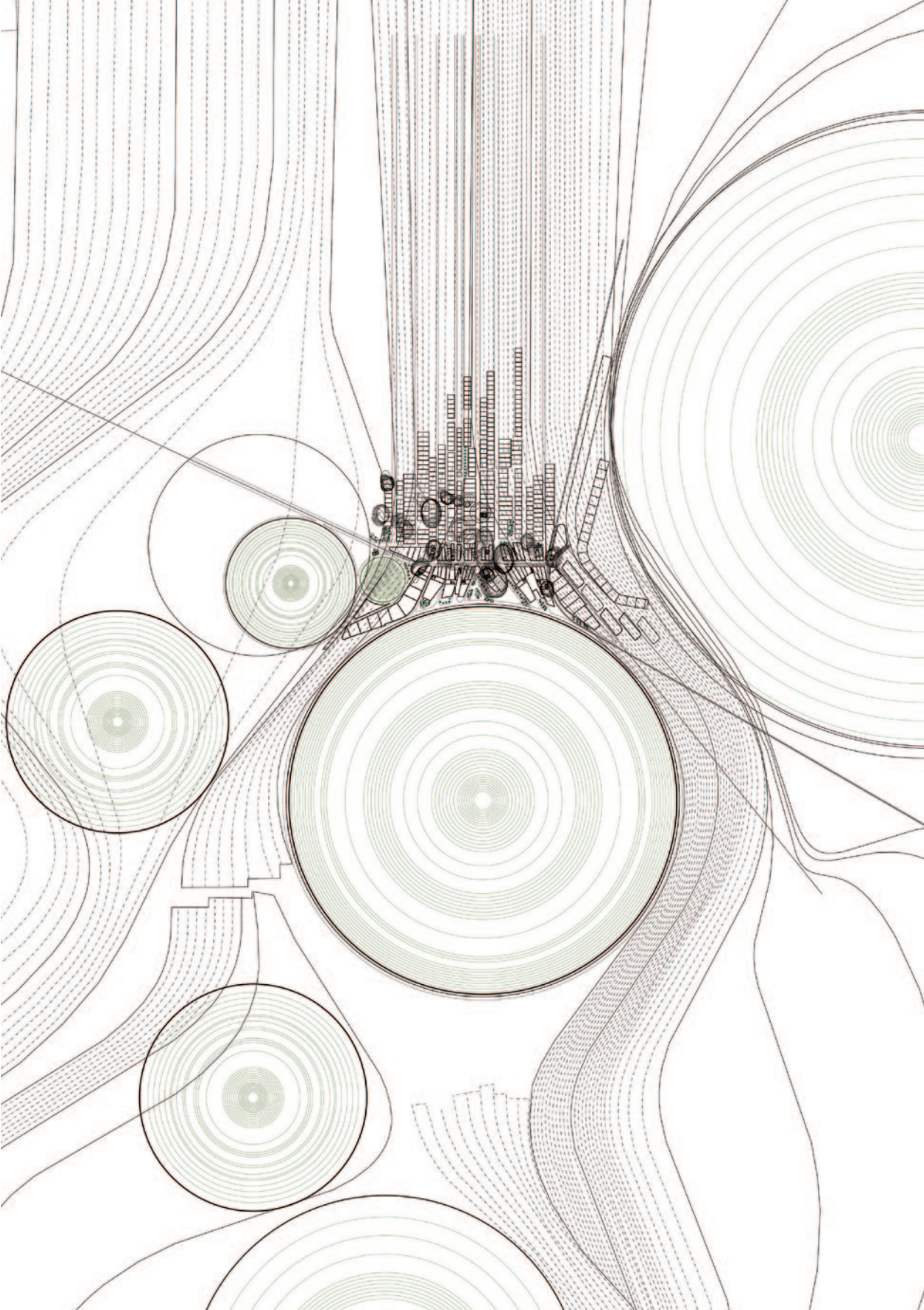
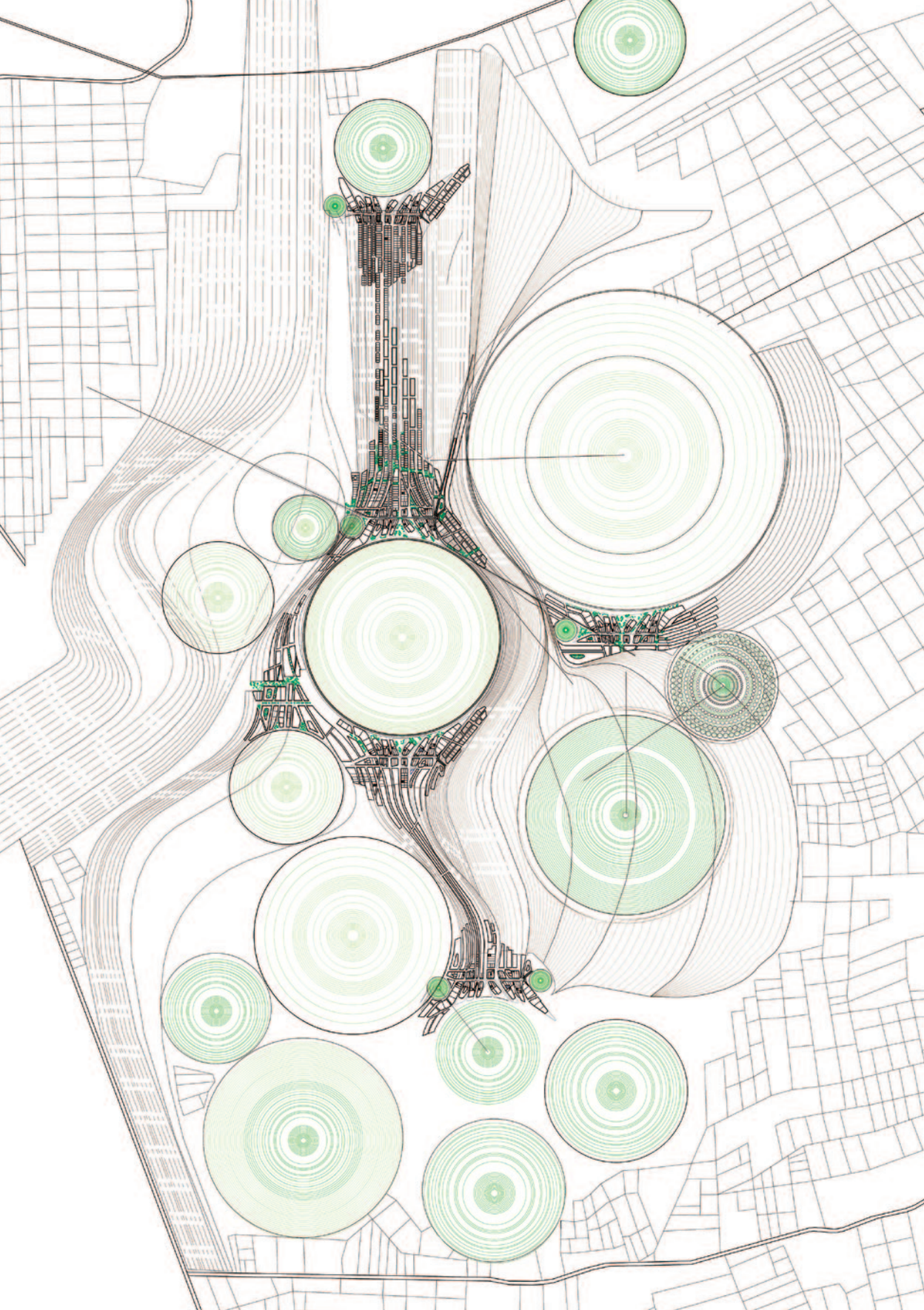
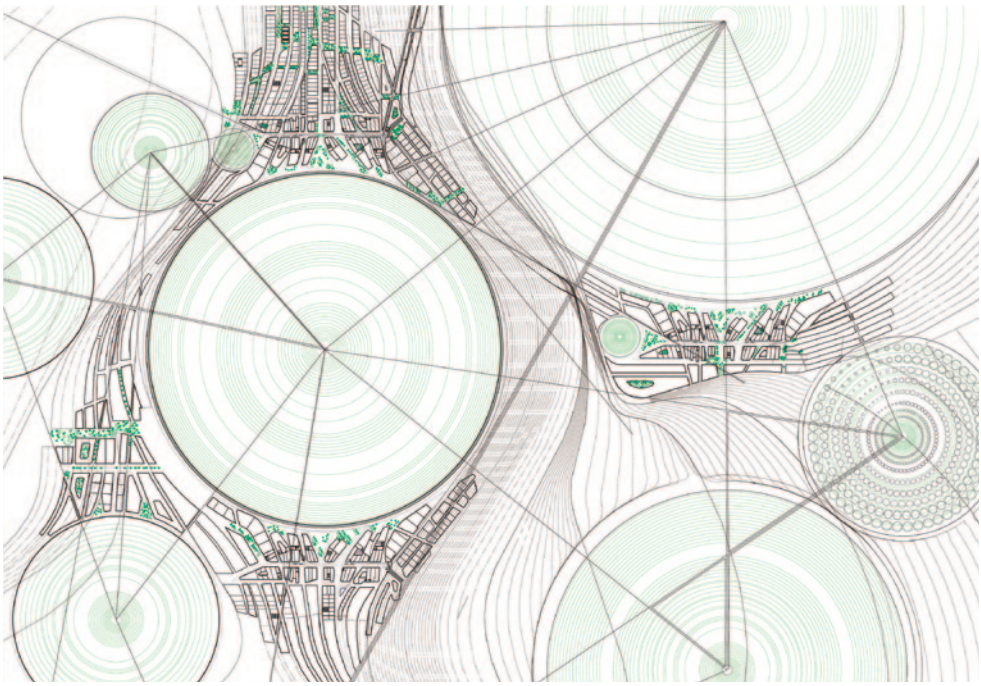
22
Expansion development diagram of Agropolis in three different stages over a period of ten years

23
Master site plan with overview of different nuclei







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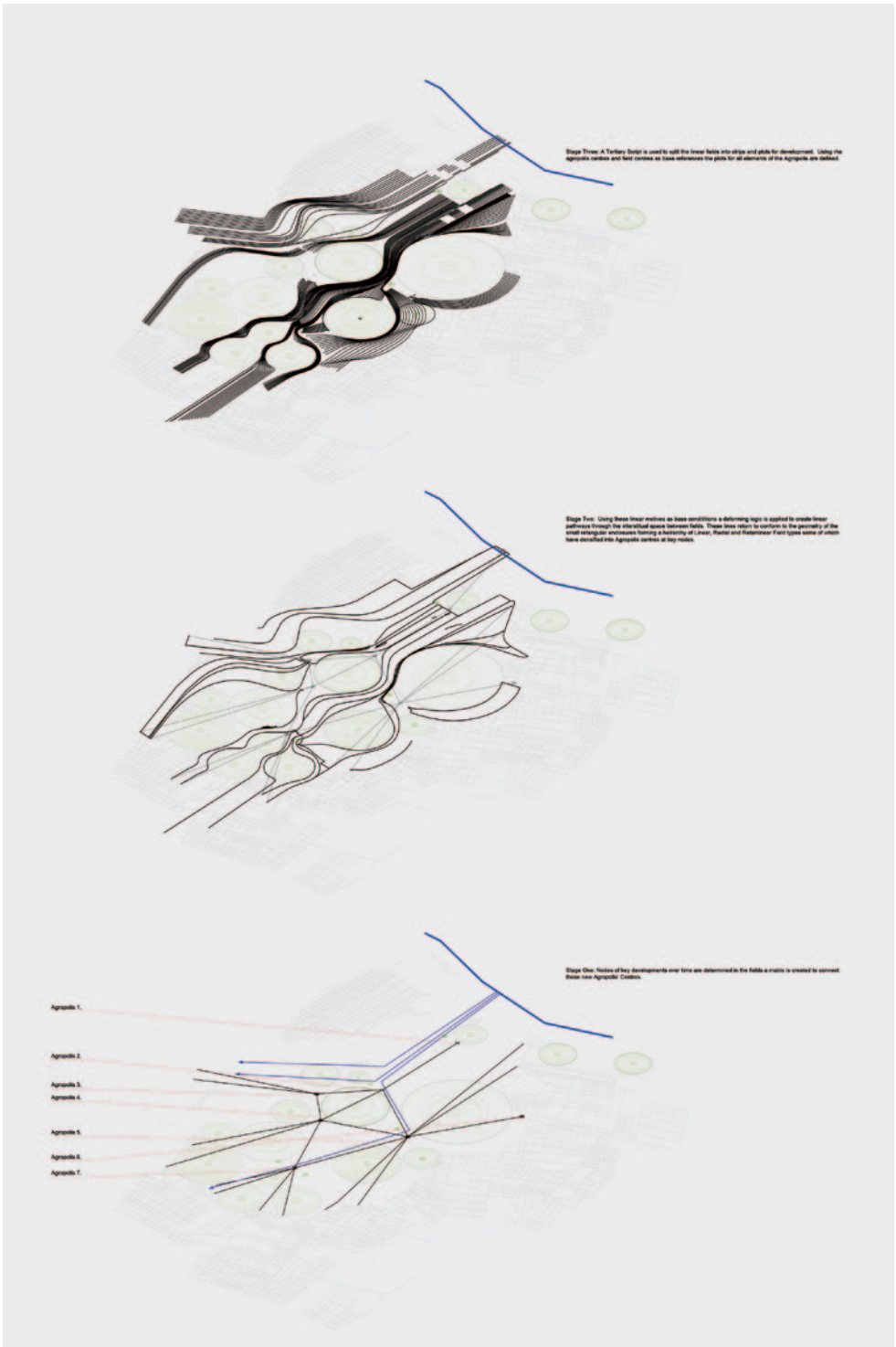
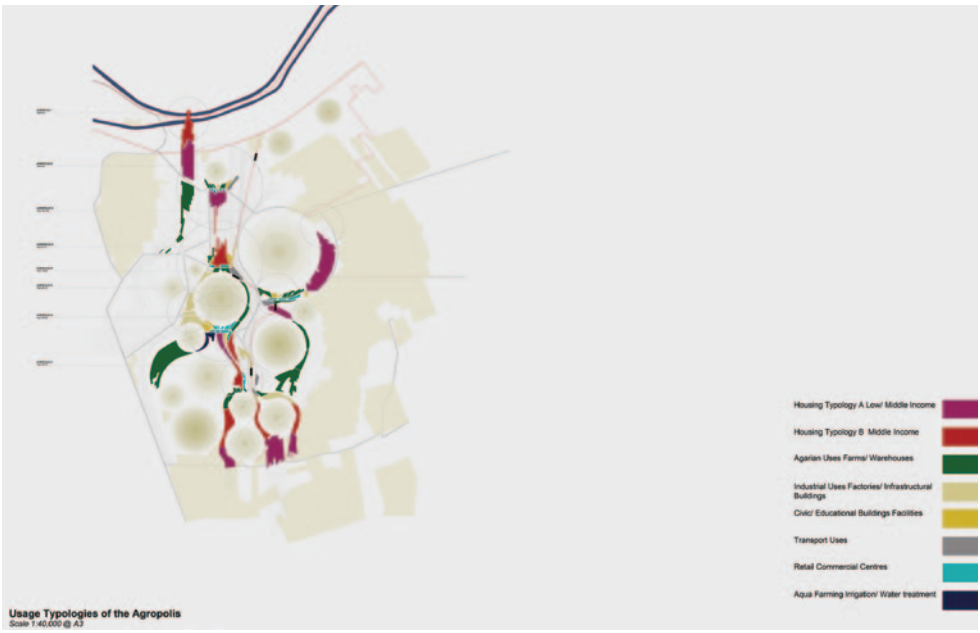
24
Different irrigation circle uses, on right with photovoltaic panels

25
Overview of different nuclei


Stage Three: A Tertiary Script is used to split the linear fields into strips and plots for development. Using the agropolis centres and field centres as base references the plots for all elements of the Agropolis are defined.
Stage Two: Using these linear motives as base conditions a deforming logic is applied to create linear pathways through the interstitial space between fields. These lines return to conform to the geometry of the small rectangular enclosures forming a hierarchy of Linear, Radial and Reticulinear Field types some of which have densified into Agropolis centres at key nodes.
Stage One: Nodes of key developments over time are determined in the fields a matrix is created to connect these new Agropolis' Centres.
Agropolis 1.
Agropolis 2.
Agropolis 3.
Agropolis 4.
Agropolis 5.
Agropolis 6.
Agropolis 7.

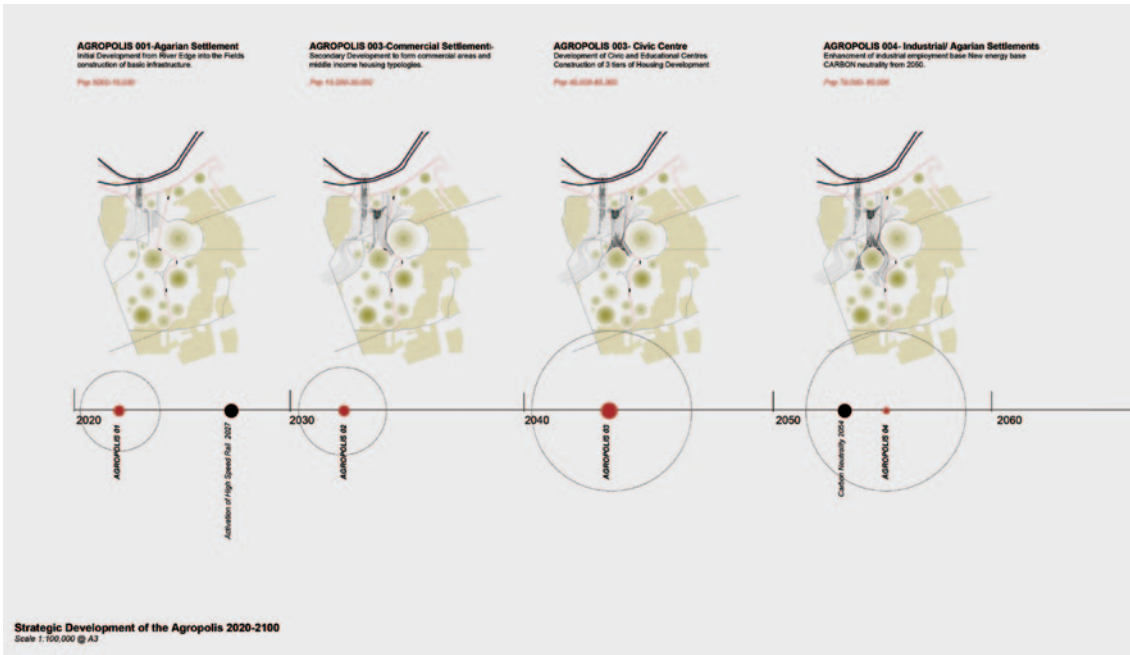


28

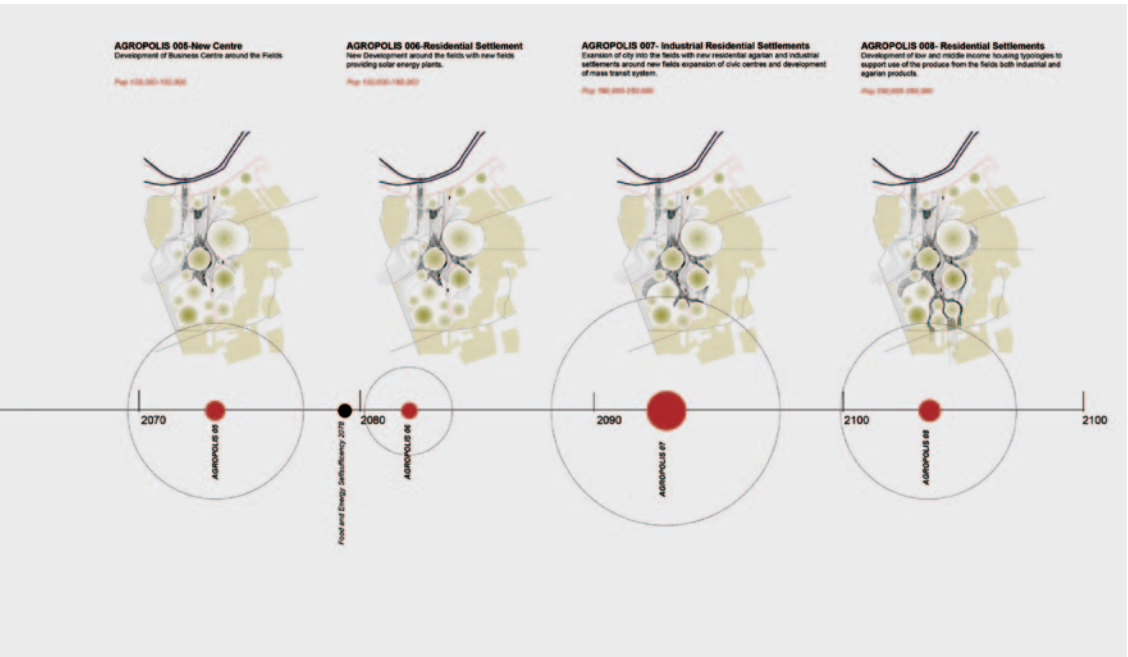
26 ***(previous page)***
One of the urban nuclei with typological subdivision of housing allotments

27
Studies of linear path for housing typologies and connection nodes

28
Various housing typologies and other programmatic distribution on-site



Strategic Development of the Agropolis 2020-2100
Scale 1:100,000 @ A3



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29
Strategic development between 2020 and 2100

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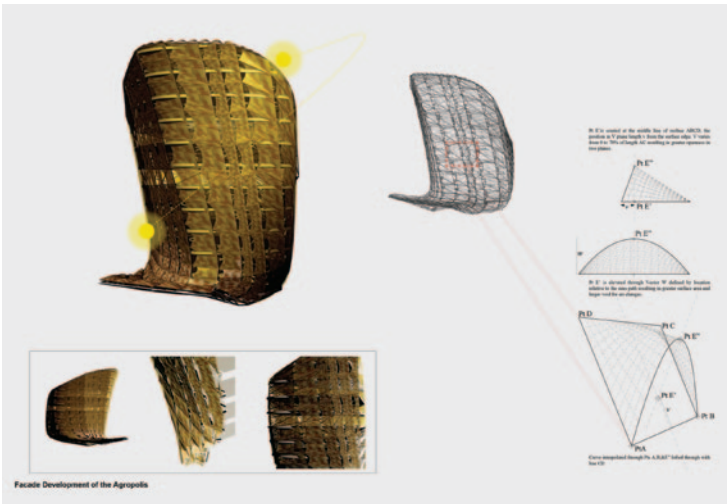

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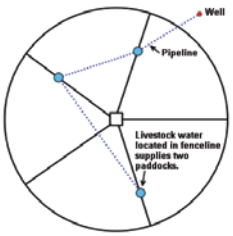
b. Food and energy production

The Agropolis pioneers productive planning, yielding crops in landscaped circles and solar energy in the built form. With food and energy production at the heart of the scheme, it embodies efficient sustainable planning, minimising waste and maximising renewable resource consumption. The proximity to food production and consumption benefits the population, eliminating reliance on external purchases and independently satisfying its demand for food.

The buildings echo landscape forms, but encompass cutting-edge energy production in highly absorbent material using multi-layered skin with solar-pixels. This references MIT research which develops a way to double the performance of traditional solar panels by using dyed glass and fibre optics as a layer placed on top of existing solar arrays. The sheen of these panels on the built form echoes the reflective qualities of water. Circular silos are used for water purification and recycling waste products, which are used to irrigate the surrounding farmland. [fig. 30–38]



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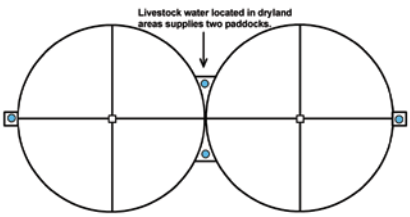

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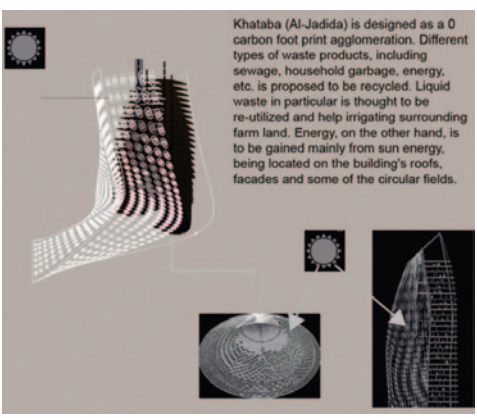

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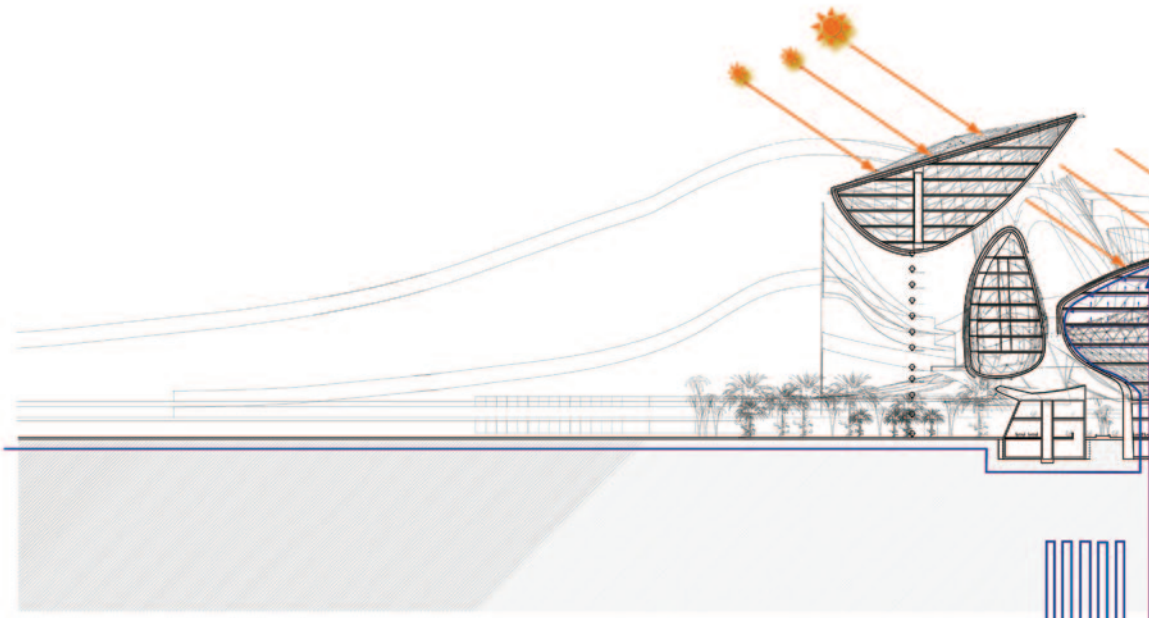
30
Strategic irrigation infrastructure

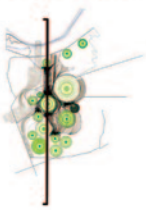
31 & 32
Studies of photovoltaic panels inserted on curved building skins and throughout urban circles

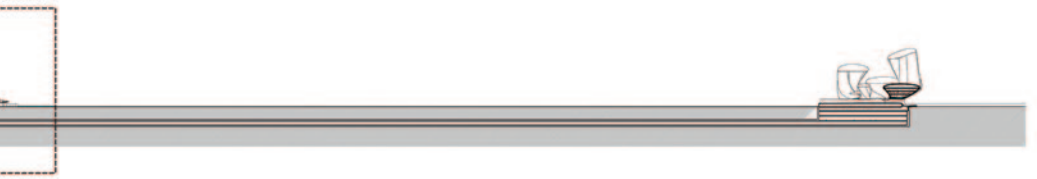
33 & 34
Study of existing irrigation circles with water location for livestock

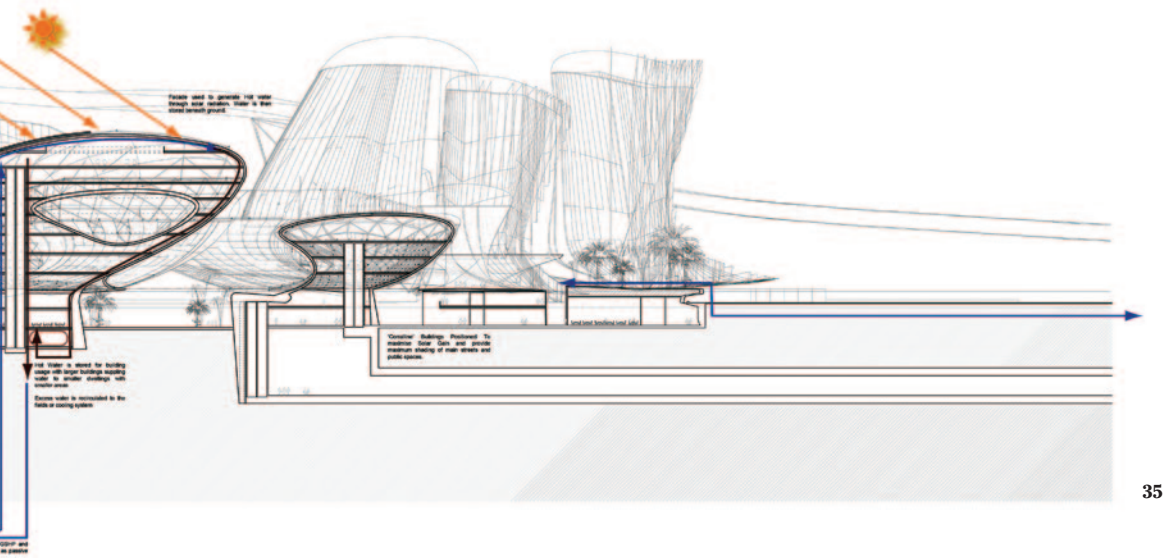
Section Across City 1/2500 @ A0



Section Through AGROPOLIS 1. 1/500 @ A0







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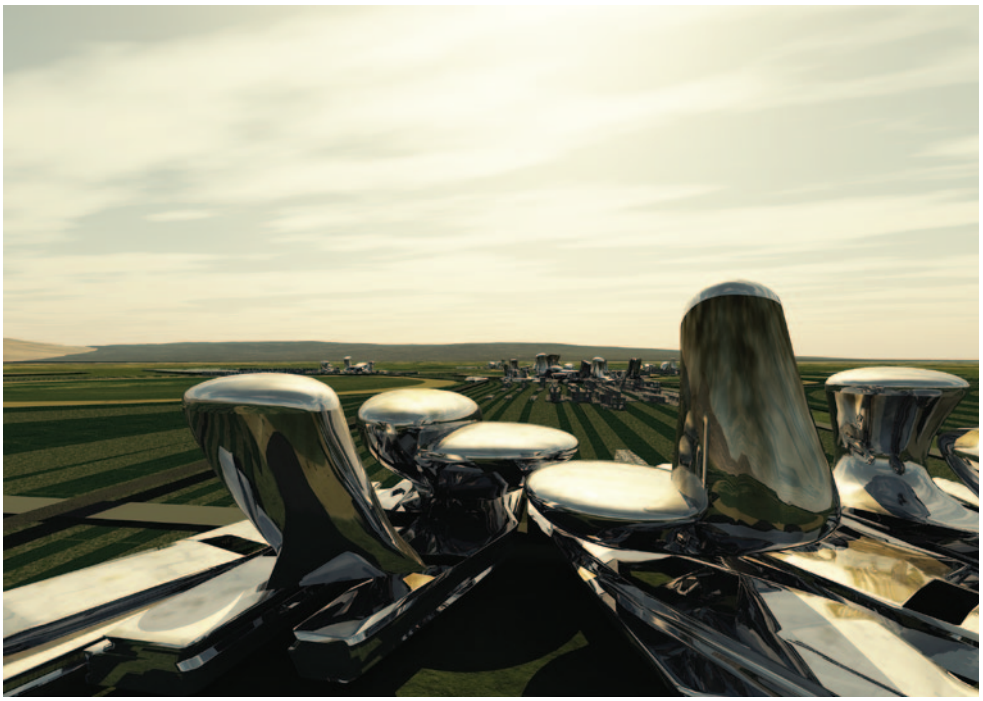
35
Diagrammatic section with sun exposure



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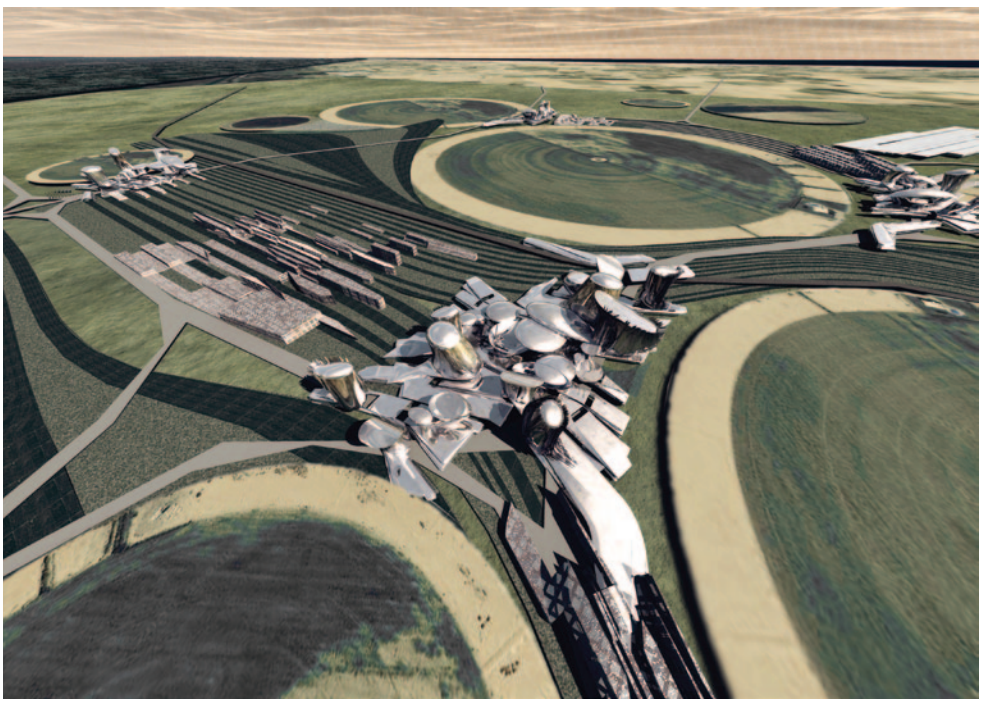
36
View of urban nuclei in Agropolis with expanding linear housing areas in between



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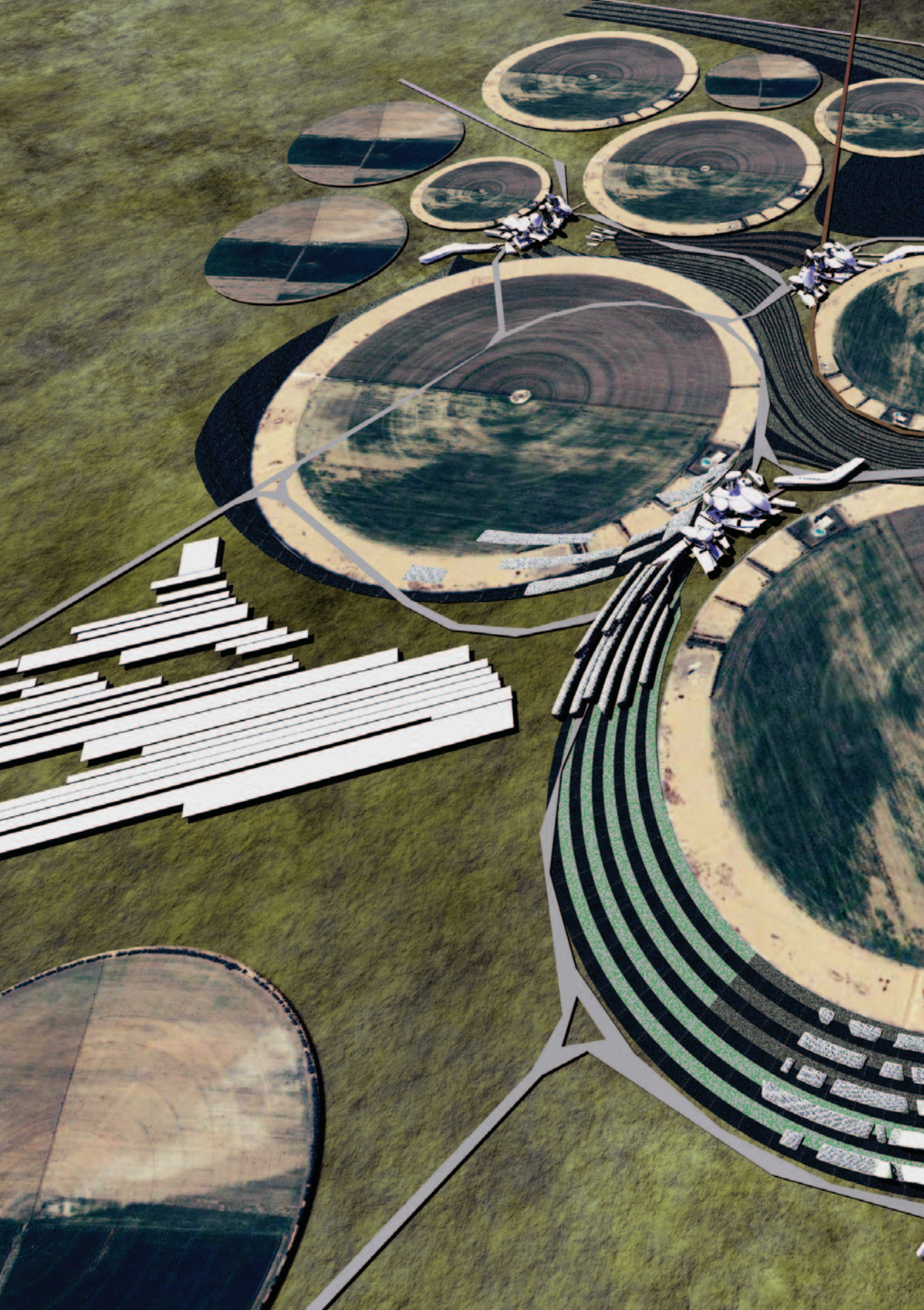
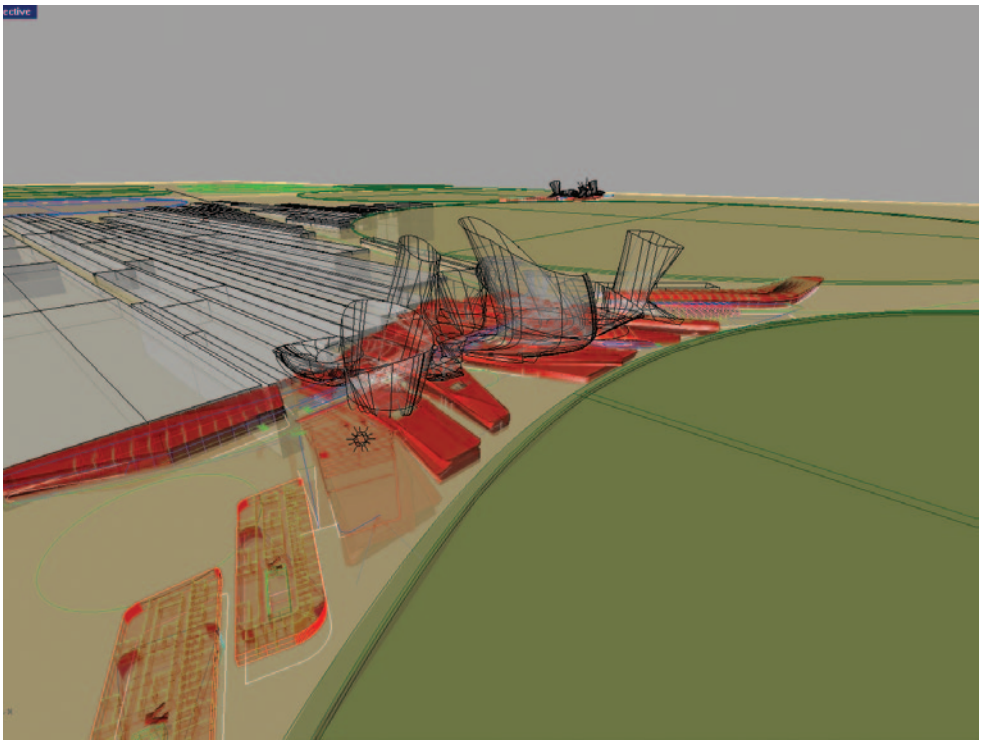
Overall view of Agropolis





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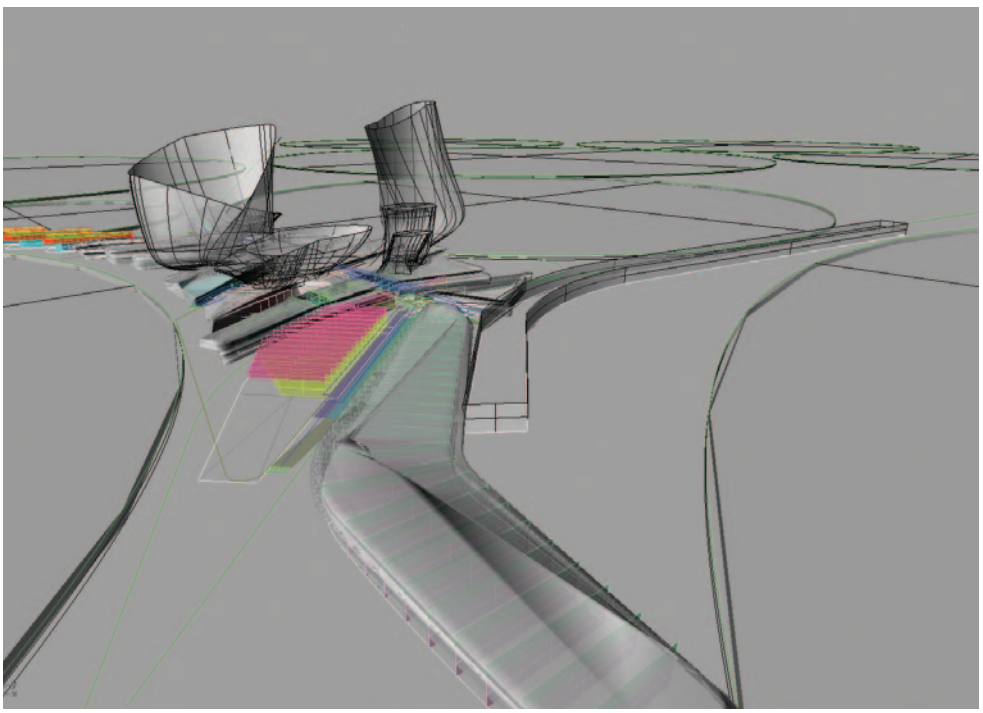

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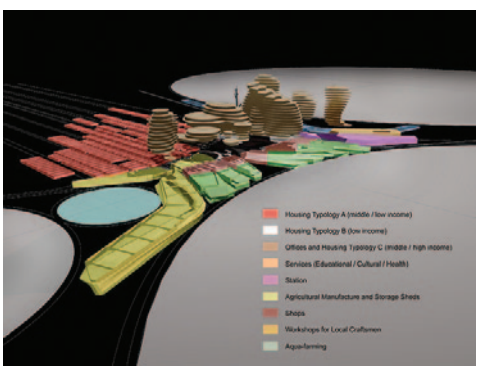
c. Built infrastructure

By using the left-over spaces that are usually considered to be wasteland, new town centres develop in the interstices between irrigation circles and gridded fields, creating a matrix of interconnected and complementary urban nuclei in the midst of agricultural land. Housing in parallel rows around circles can form streets, with linked networks between settlements directing growth into conurbations. Some houses surround the circumference of circles with wedge-shaped gardens and communal points in centres, while smaller sets of circles become public squares of the city.

A series of tests develop programmatic solutions and their application to the site. The ground levels host facilities for agricultural manufacturing, along with small- and mid-scale commerce, workshops for local craftsmen, and cultural/educational/health services on a main street. The upper levels host offices and other ancillary services. [fig. 39–44]



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Perspective of Agropolis

39
Preliminary study of nuclei using Rhino

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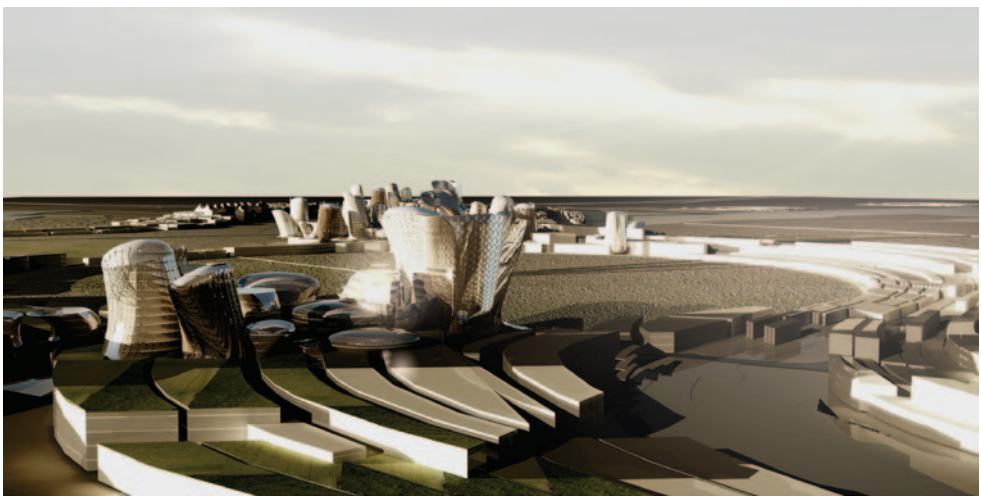
View of six nuclei and linear housing massing between

41
Programmatic distribution of Agropolis and final views with expanding housing typologies on curved linear path



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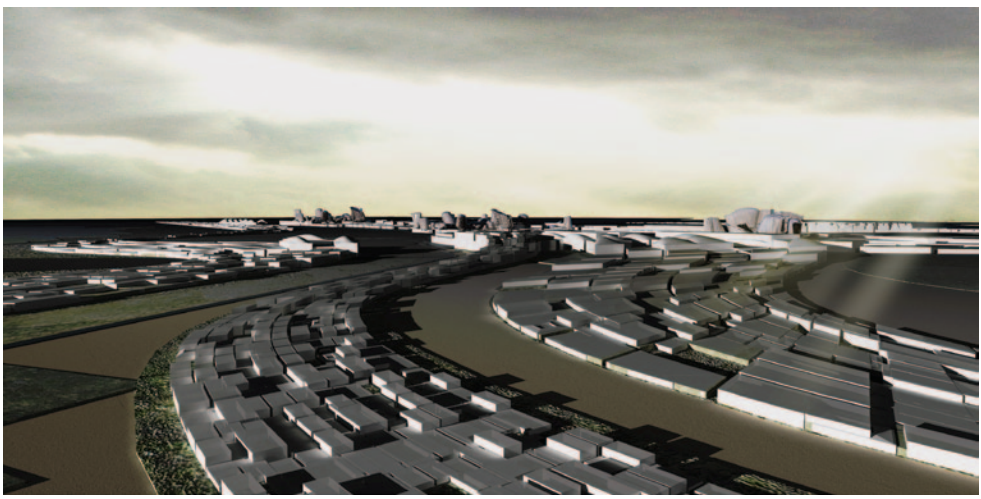
42
View of six nuclei and linear housing massing between



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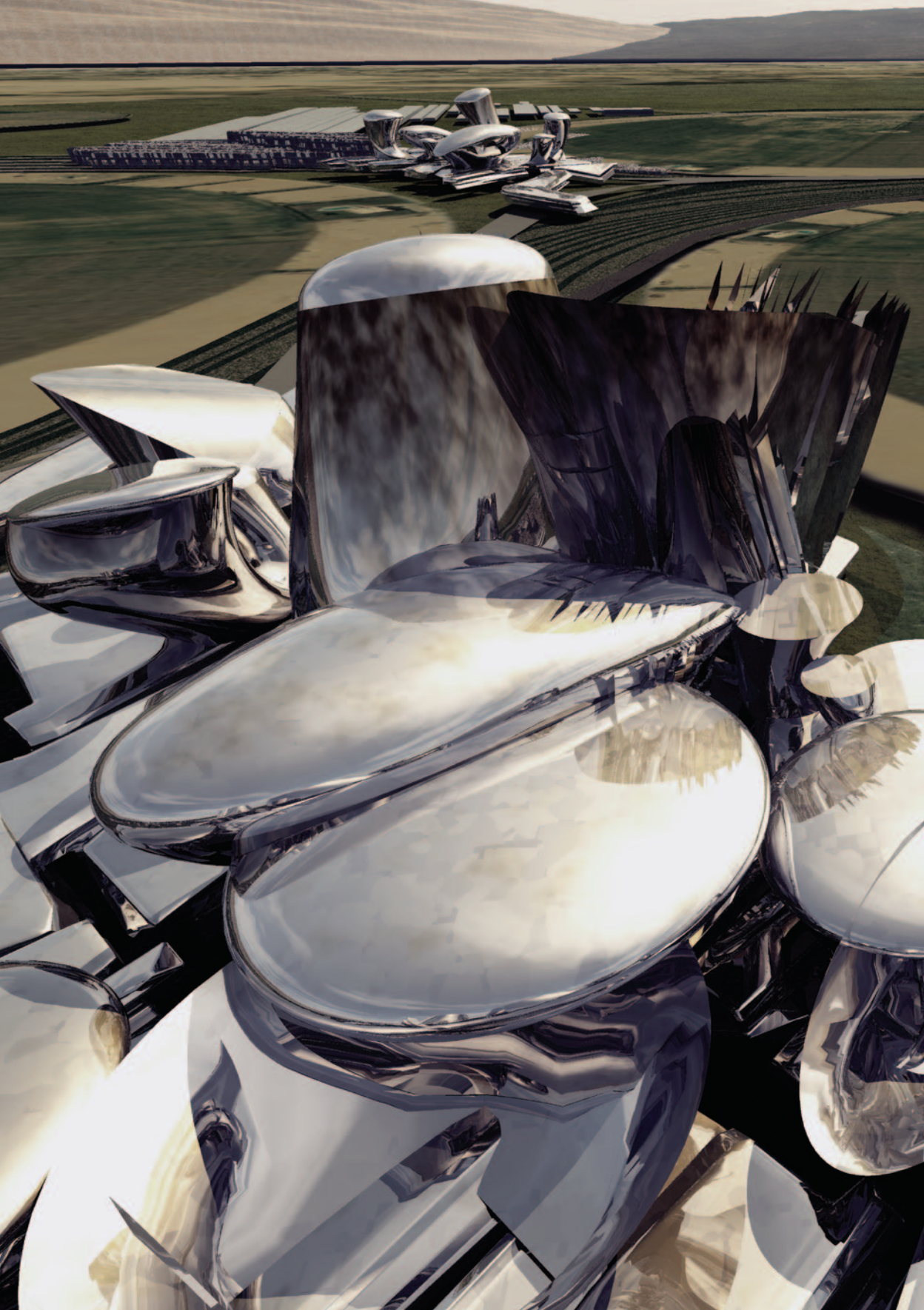
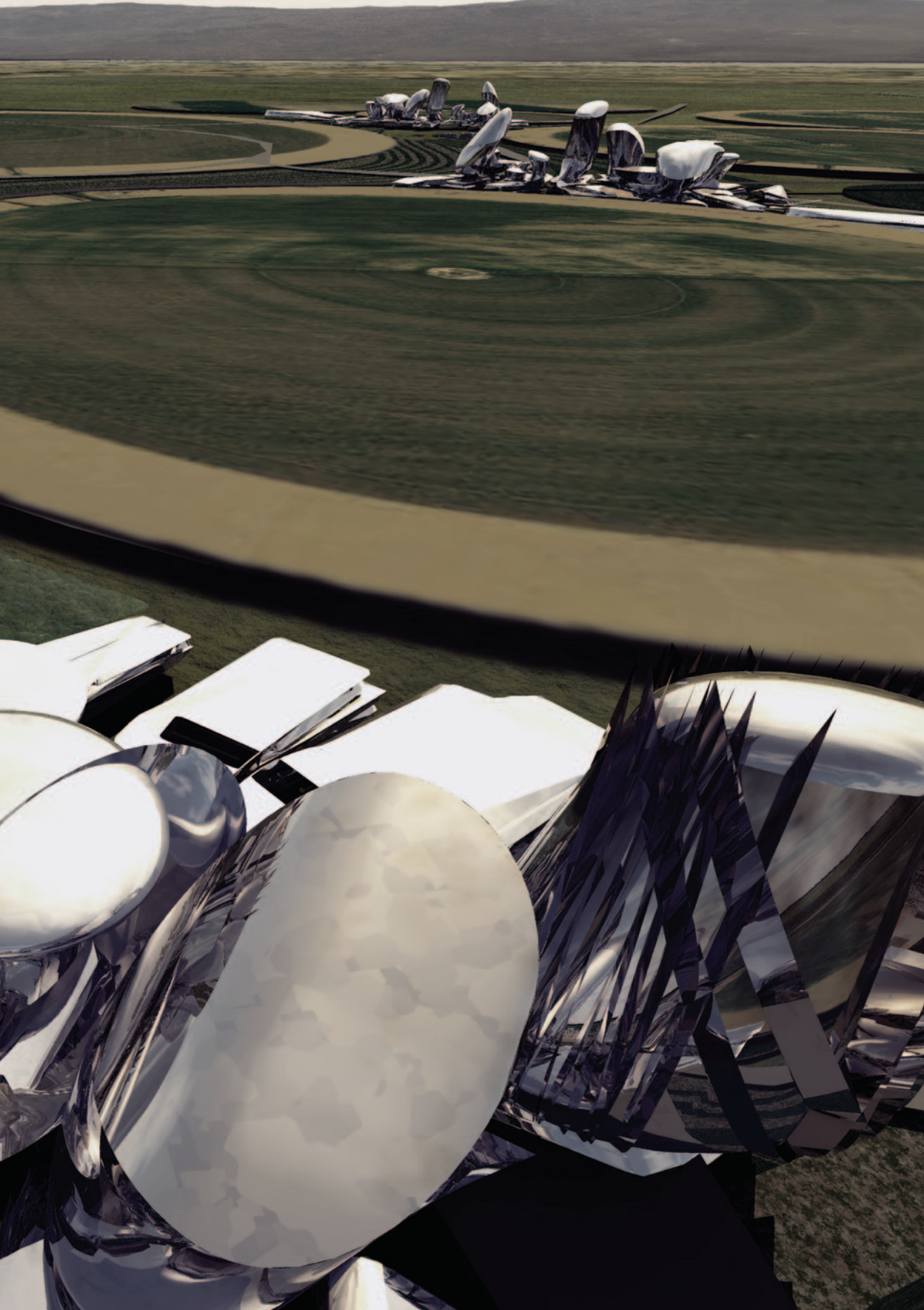
43
Programmatic distribution of Agropolis and final views with expanding housing typologies on curved linear path





Dissemination

The authors have discussed the work in the following publications:

Marjan Colleti, 'Exuberance and digital virtuosity', in AD: *Exuberance* (ed. Marjan Colletti), 2010.
Marcos Cruz and Marjan Colletti, 'marcosandmarjan', in *Futuristic: Visions of Future Living* (ed. Caroline Klein), 2011.

The work has been reviewed on various architectural and design websites, including in *Designboom* (2010).

It has also been presented in national and international keynote presentations and invited lectures:

Keynotes

Privado e Publico symposium, Faculdade de Letras da Universidade Tecnica de Lisboa, Lisbon, Portugal (2011)
Biomimicry Challenge conference, Syracuse University, New York, USA (2012)

Invited lectures

Syracuse University, New York, USA (2010)
ESAyT School of Architecture and Technology, Universidad Camilo José Cela, Madrid, Spain (2010)
Universidad Pontíficia Javeriana, Bogotá, Colombia (2010)
Universidade de Évora, Portugal (2011)
Veritas Architecture Festival, Universidad Veritas, San José, Costa Rica (2011)
Universidad de Castilla-la-Mancha, Toledo, Spain (2011)
Nottingham Trent University, UK (2011)
Faculdade de Arquitetura e Urbanismo, Universidade Federal do Rio de Janeiro, Brazil (2011)
Fundação Berardo, CCB, Lisbon, Portugal (2012)
University of Cork, Ireland (2012)

Presentations

LUSO conference of UK-based Portuguese researchers, University of Nottingham, UK (2011)

Related publications by the researcher(s)

Book chapter

pp. 52–57
Marcos Cruz and Marjan Colletti, 'marcosandmarjan', in *Futuristic: Visions of Future Living* (ed. Caroline Klein). Cologne: DAAB Media GmbH, 2011: 142–147.

Journal article

pp. 58–65
Marjan Colleti, 'Exuberance and digital virtuosity', in *Exuberance* (ed. Marjan Colletti), *Architectural Design* 80.2 (Mar 2010): 8–15.

Related writings by others

Online review

pp. 67–75
'marcosandmarjan: al jadida agropolis self sufficient city', *Designboom* (23 Jun 2010): www.designboom.com/architecture/marcosandmarjan-al-jadida-agropolis-self-sufficient-city

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Overall rendering view

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