

# Algorithmic Design in Indeterminate Landscapes

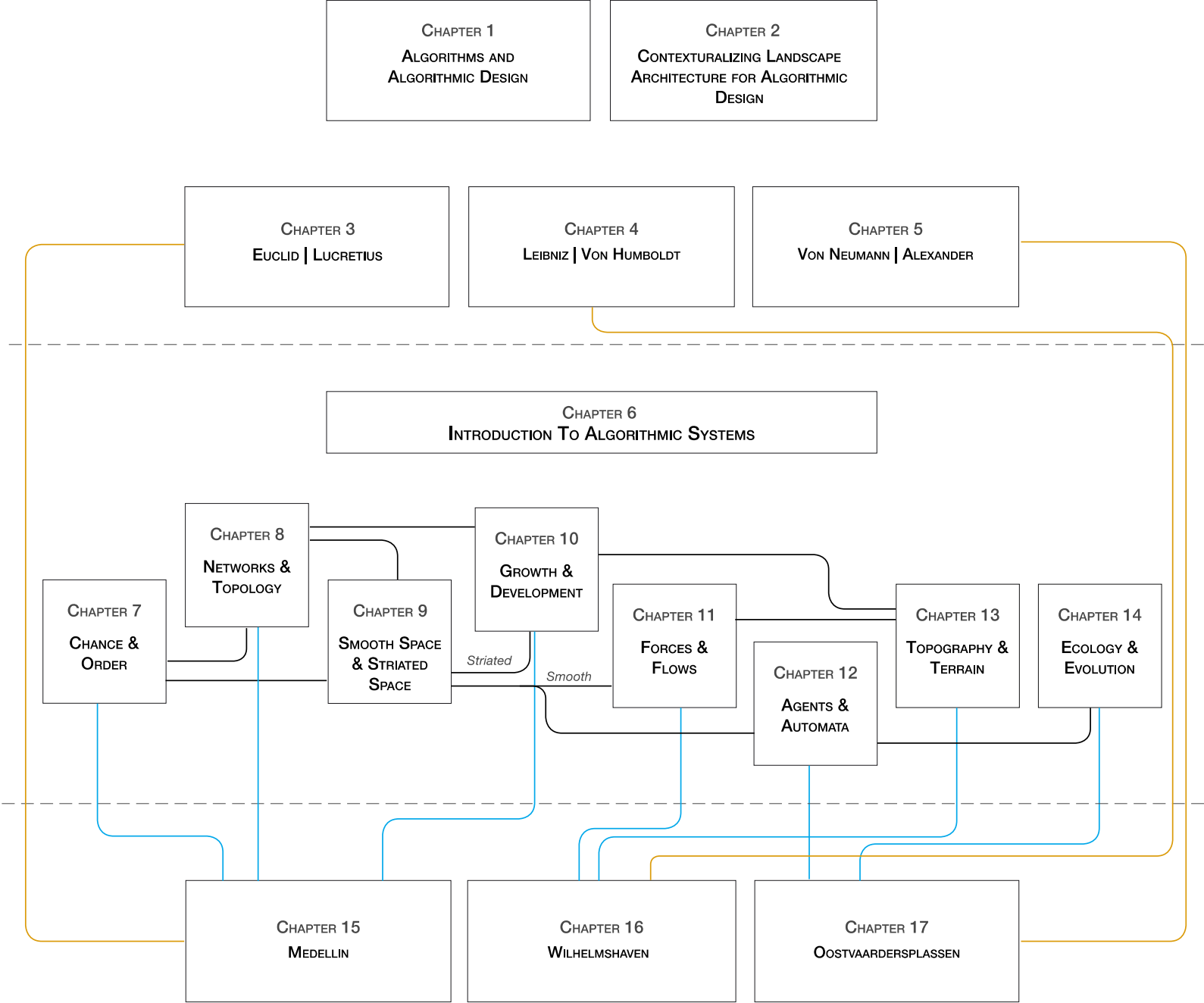
## A Case Study in an Informal Settlement in Medellin, Colombia



Joseph Claghorn  
University of Sheffield, UK  
DLA Conference - May, 2019

Case Study from Doctoral Thesis July 2018:  
Advisors: Christian Werthmann, Leibniz University Hannover Ilija Vukorep, BTU Cottbus  
Additional Reviewers: Katja Benfer, LUH Mirco Becker, LUH

# Overall Thesis Structure



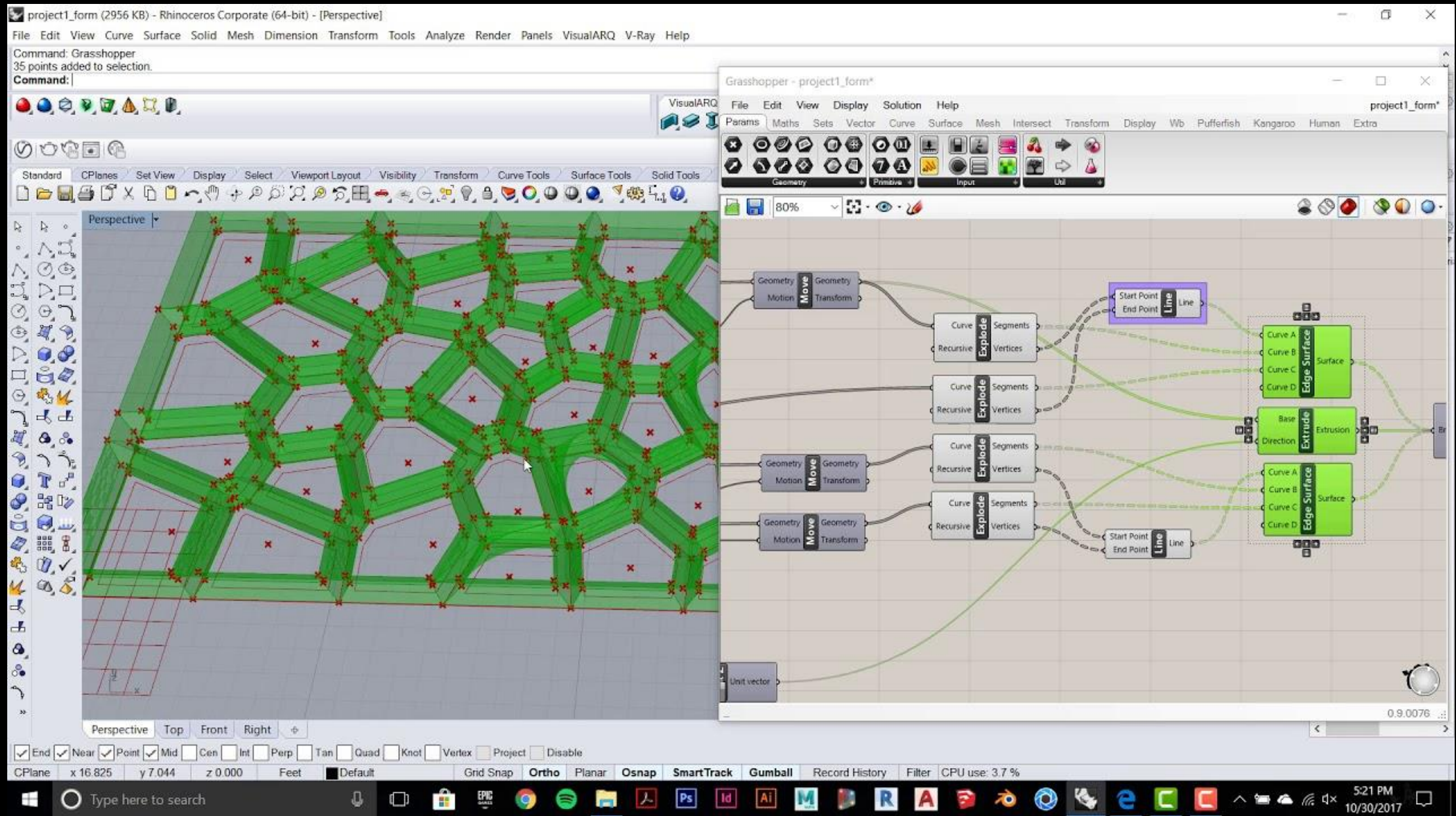
**FORM**

interiority

**INFORMATION**

exteriority











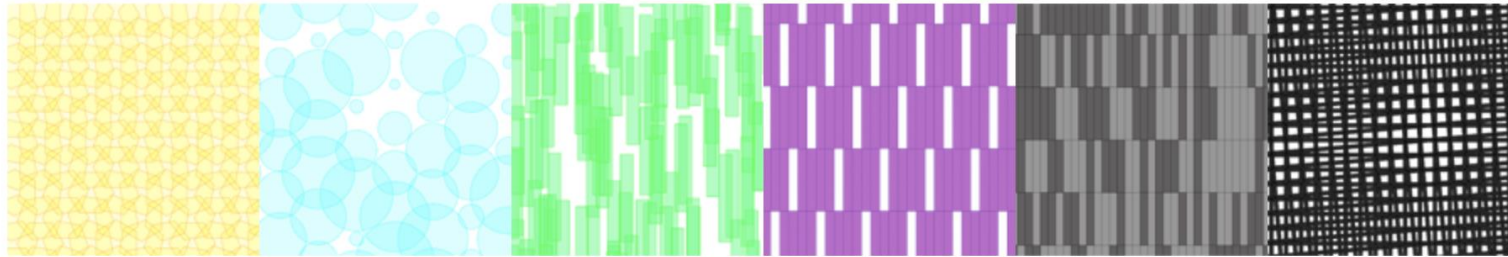
# GENERATIVE LANDSCAPES

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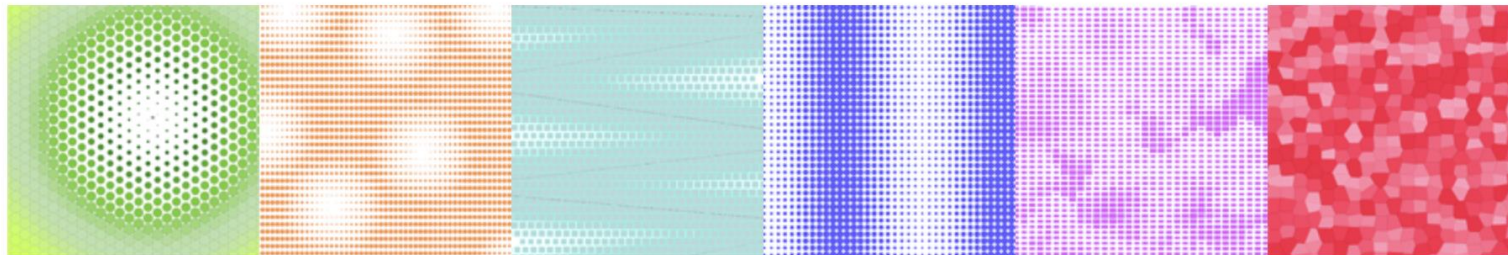
## INDEX OF EXAMPLES

This is an ongoing archive of posts describing specific script examples in Grasshopper. In general, the examples progress somewhat in difficulty, and later examples often refer to earlier examples. If you are learning Grasshopper, you may want to go through them in order. If you are already an advanced user, you can probably just click on the topic or image you think looks interesting and give it a try!

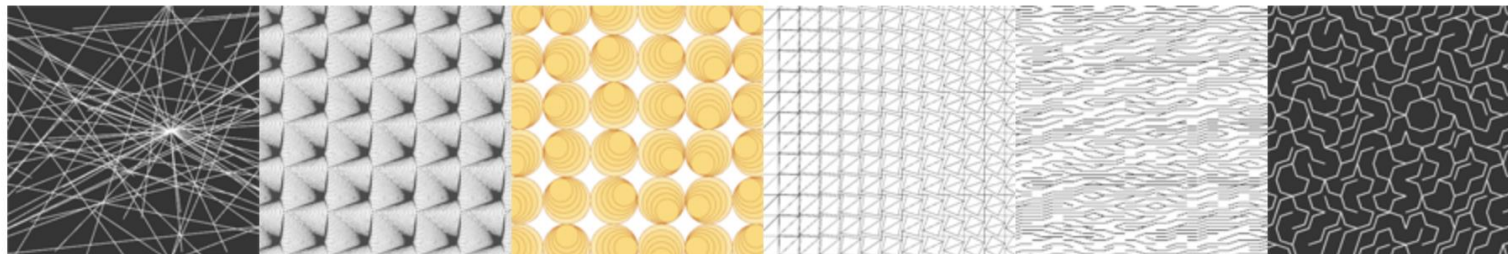
### 1 – 2D Patterns – Part 1: Grids, Transforms, Culls and Dispatches



### 2 – 2D Patterns – Part 2 : Attractors and Utility Tools



### 3 – 2D Patterns – Part 3: Connecting the Dots, Data Structuring, and Tessellation



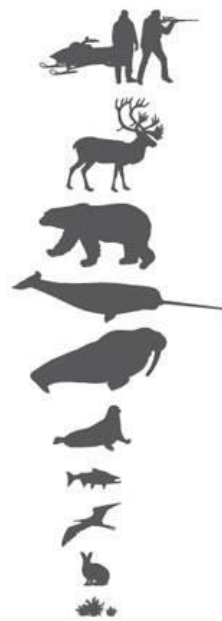
**FORM**

interiority

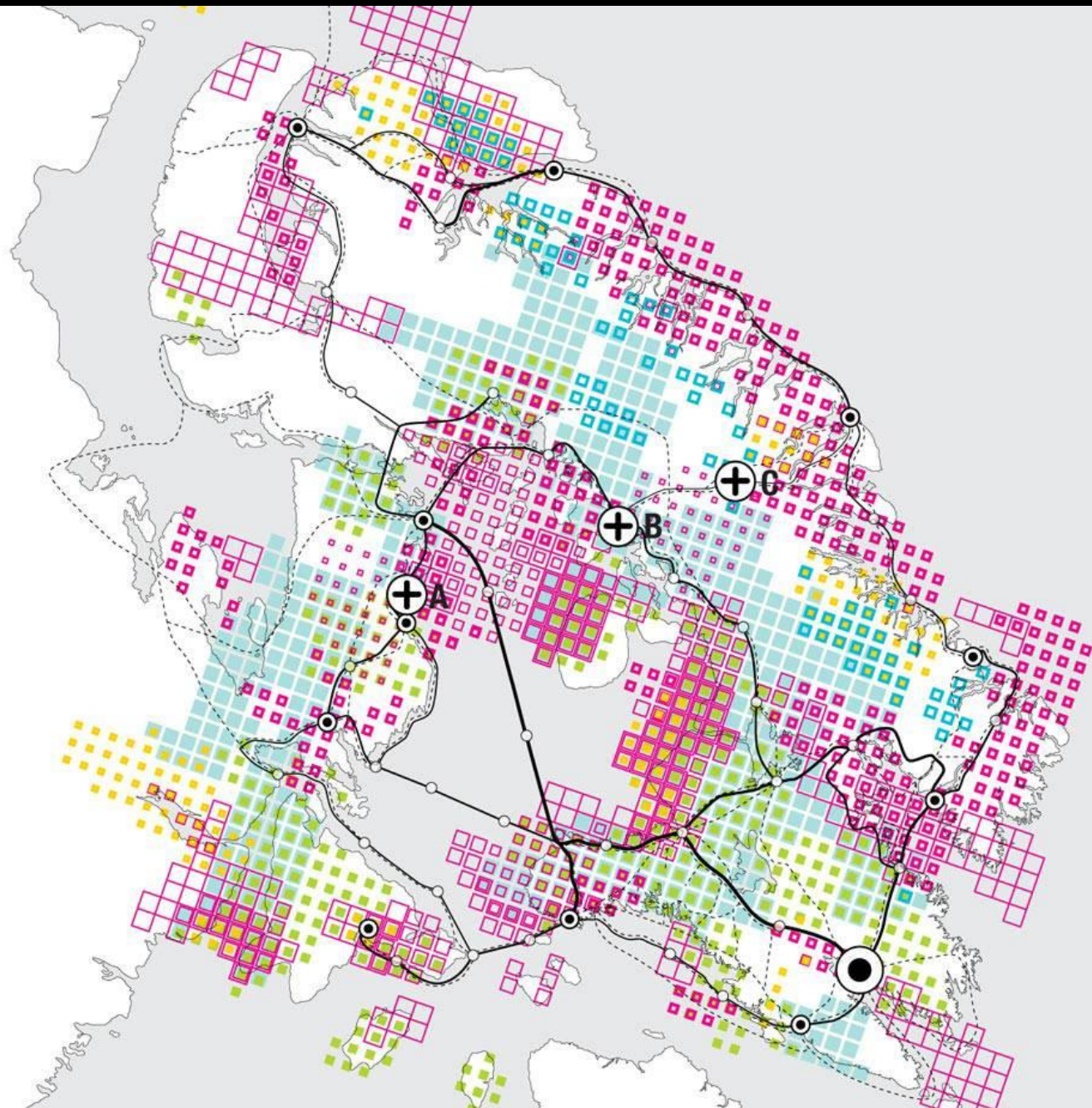
**INFORMATION**

exteriority

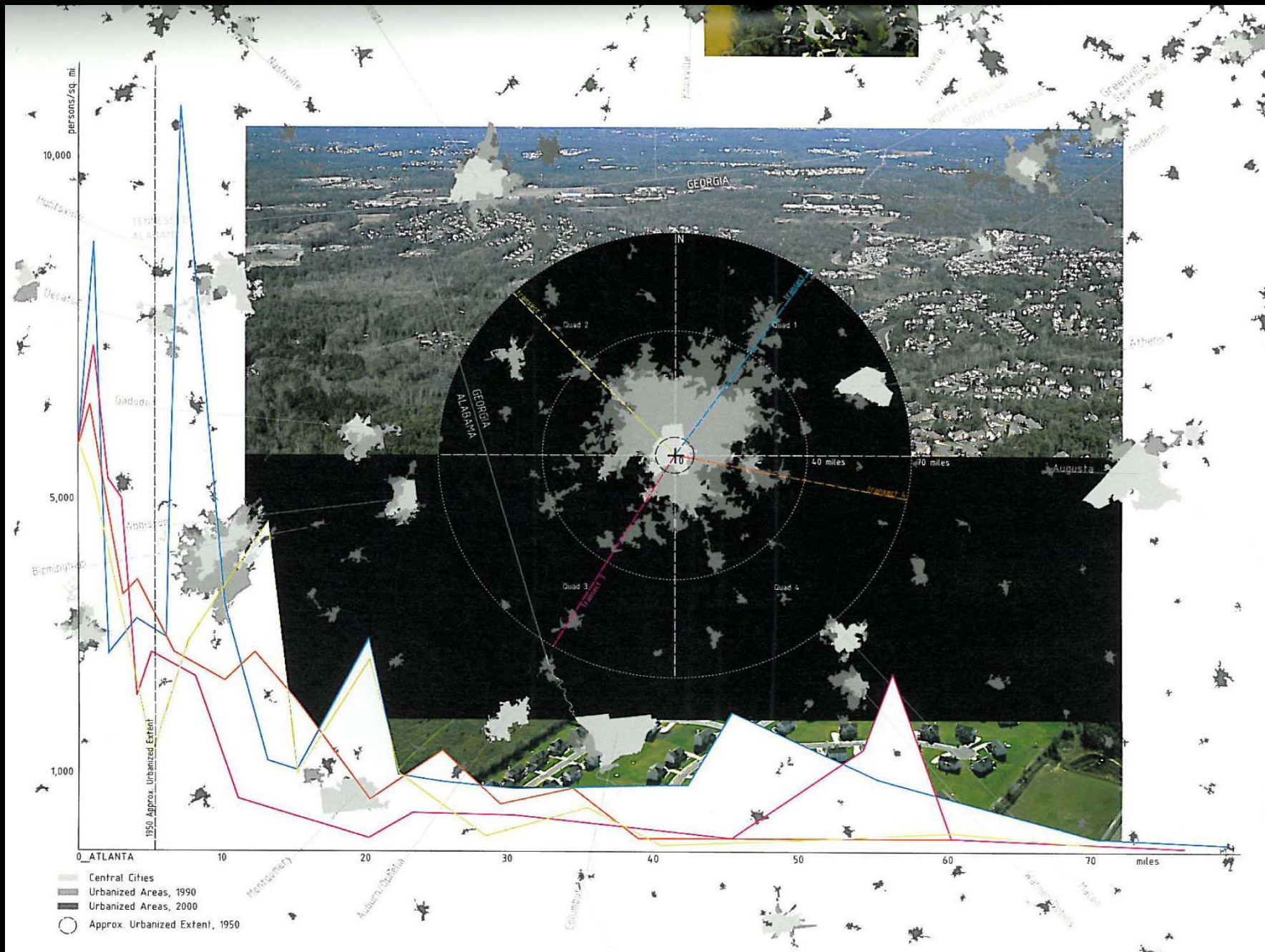




- Caribou Habitat
- Arctic Char
- Polar Bear
- Aquaculture
- Arctic Tern
- Wetland
- Conservation Area
- Glaciers
- Fresh Water







FORM ← PERFORMANCE → INFORMATION

interiority

*isomorphism*  
*analogue*  
*congruence*

exteriority



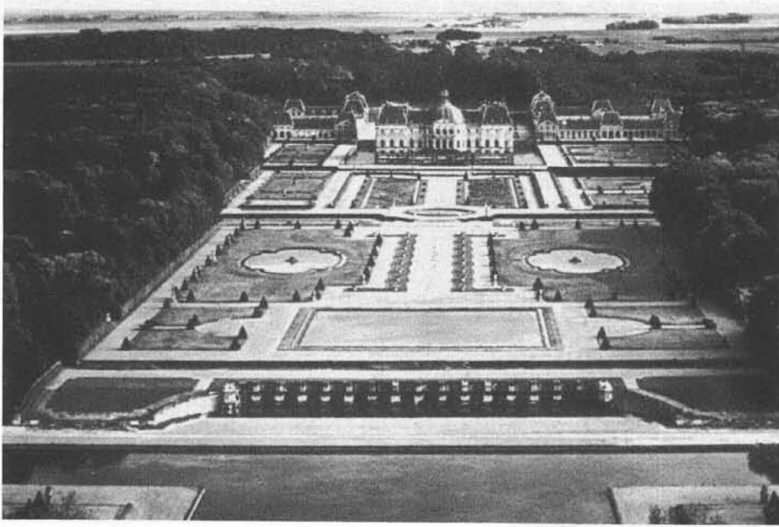


Figure 1. The garden of Vaux-le-Vicomte: deep form and Cartesian order. Photographer unknown.

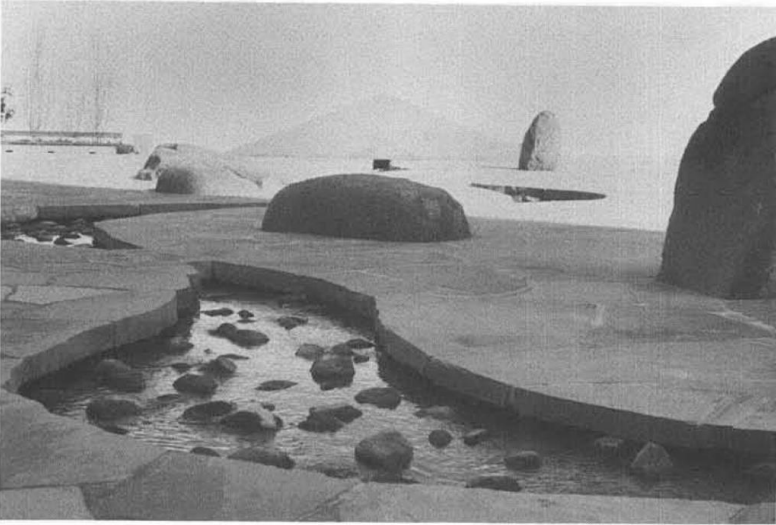
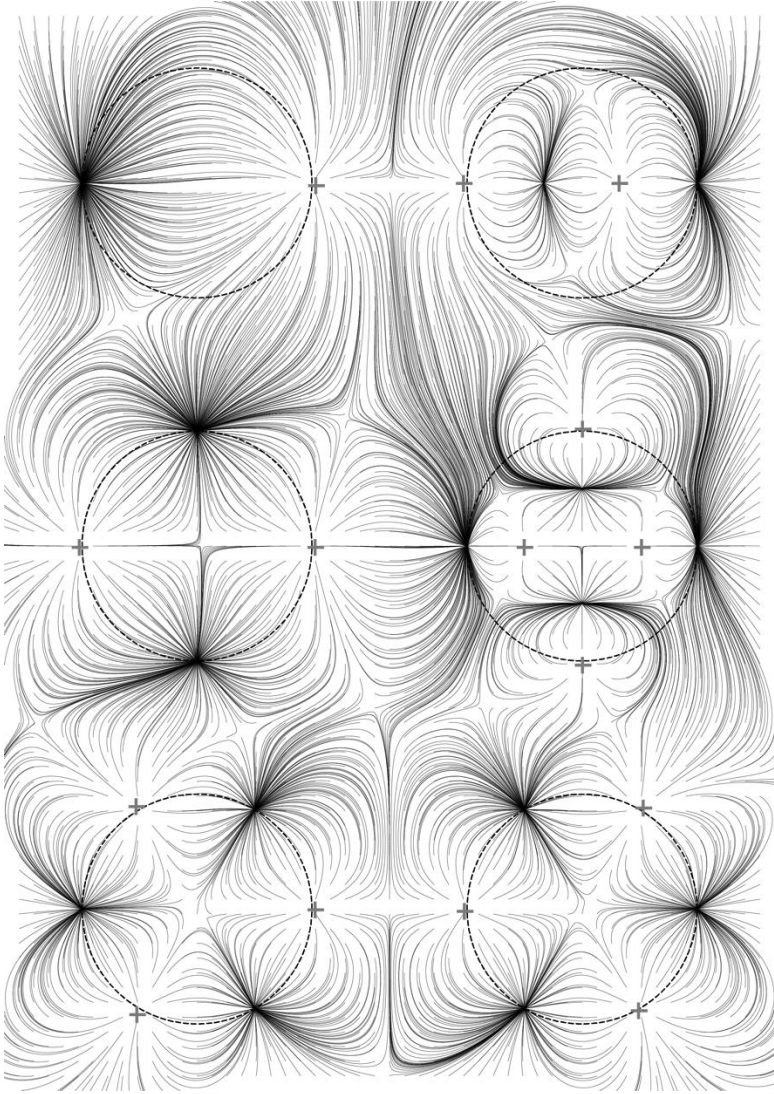


Figure 2. Isamu Noguchi's *California Scenario*, a summation of the California landscape.

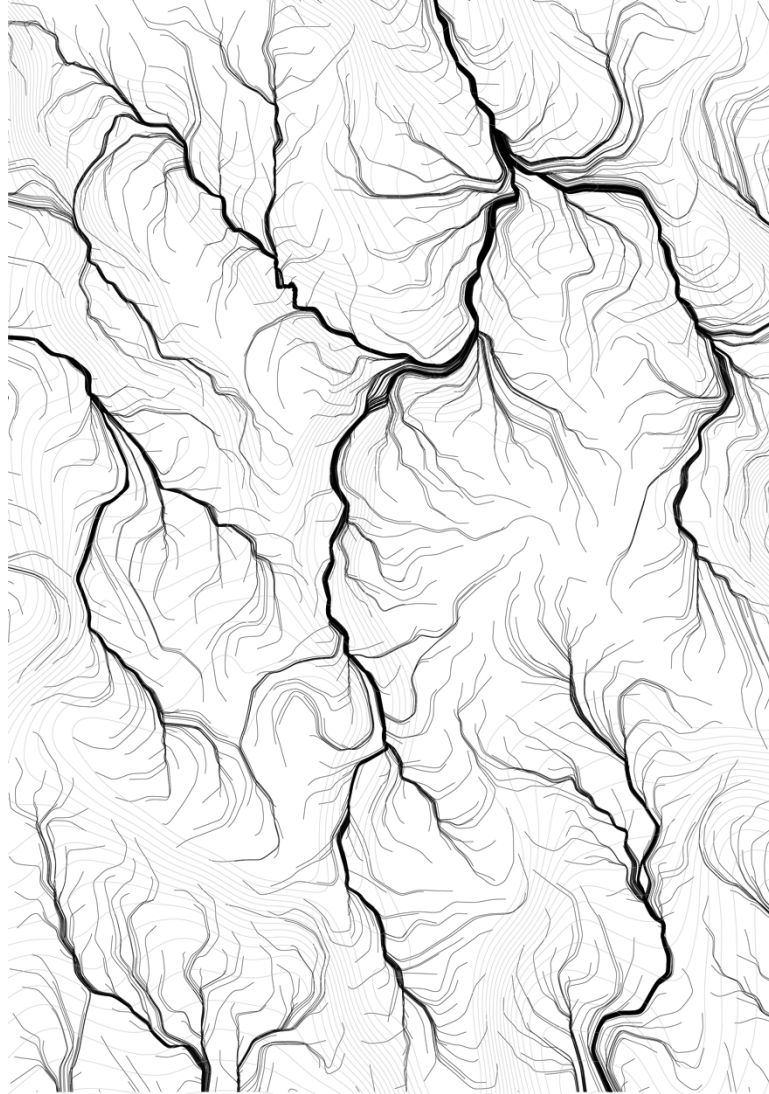
“Form and process are inseparable. For landscape design to be truly meaningful, it should also give visible expression to the processes that shape the earth, thus making a connection between nature and human culture. Landscapes that accomplish this can be described as having deep forms.

-John Tillman Lyle  
“Can Floating Seeds Make Deep Forms?”

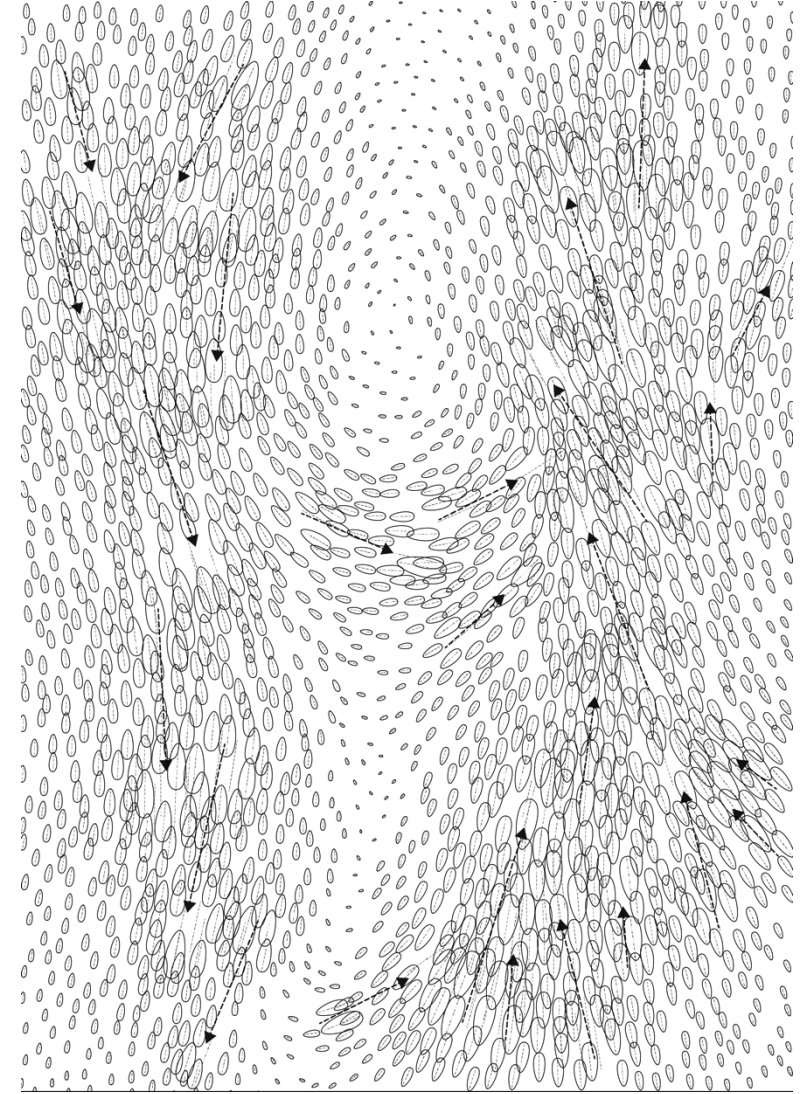
# Fields + Flows



Maxwell Equation Field



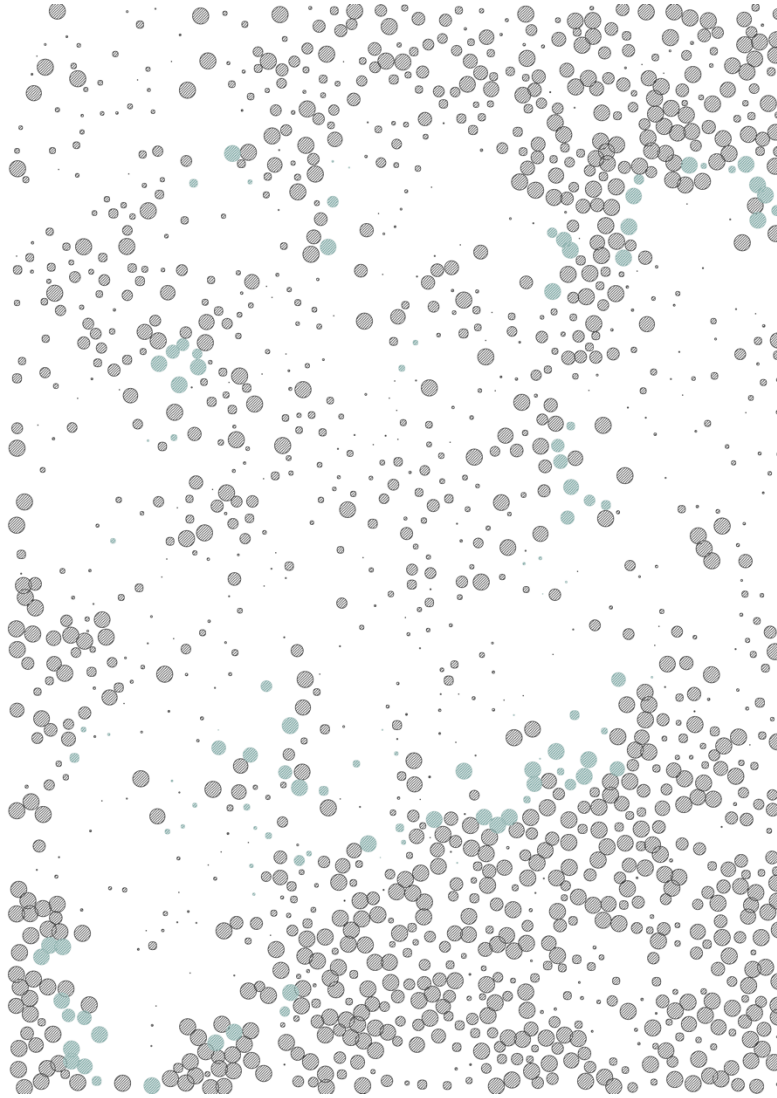
Incremental Random Vector Rotation



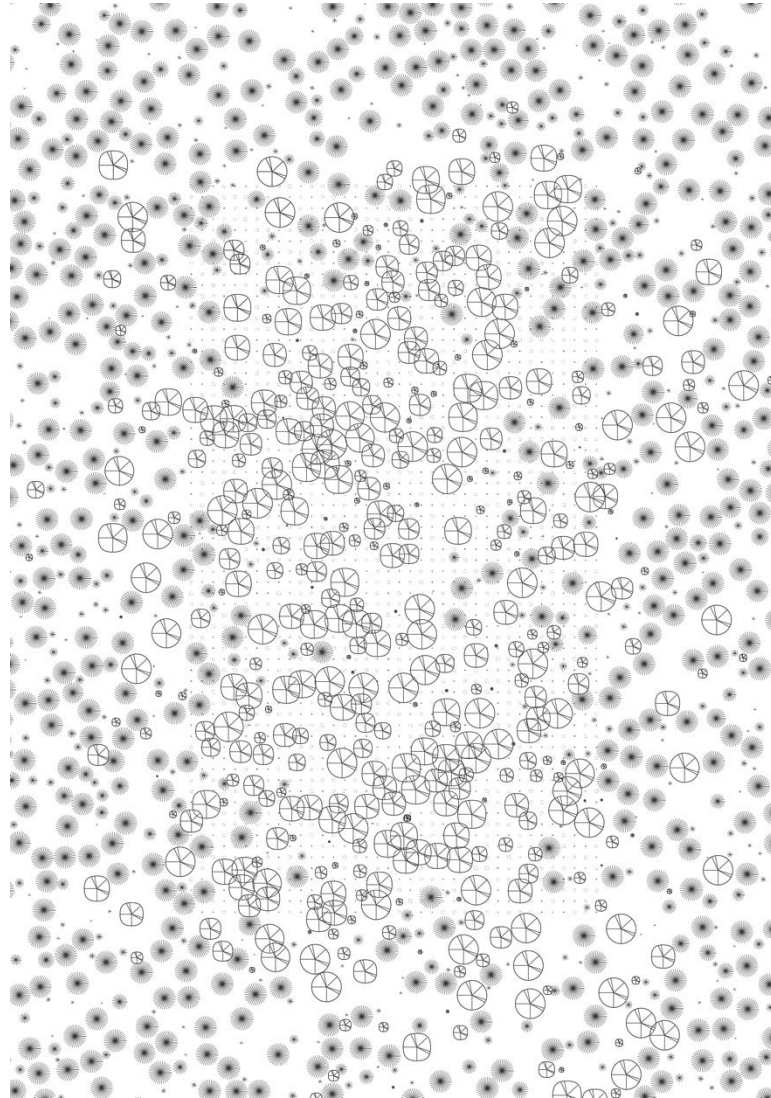
Field With Custom Vectors



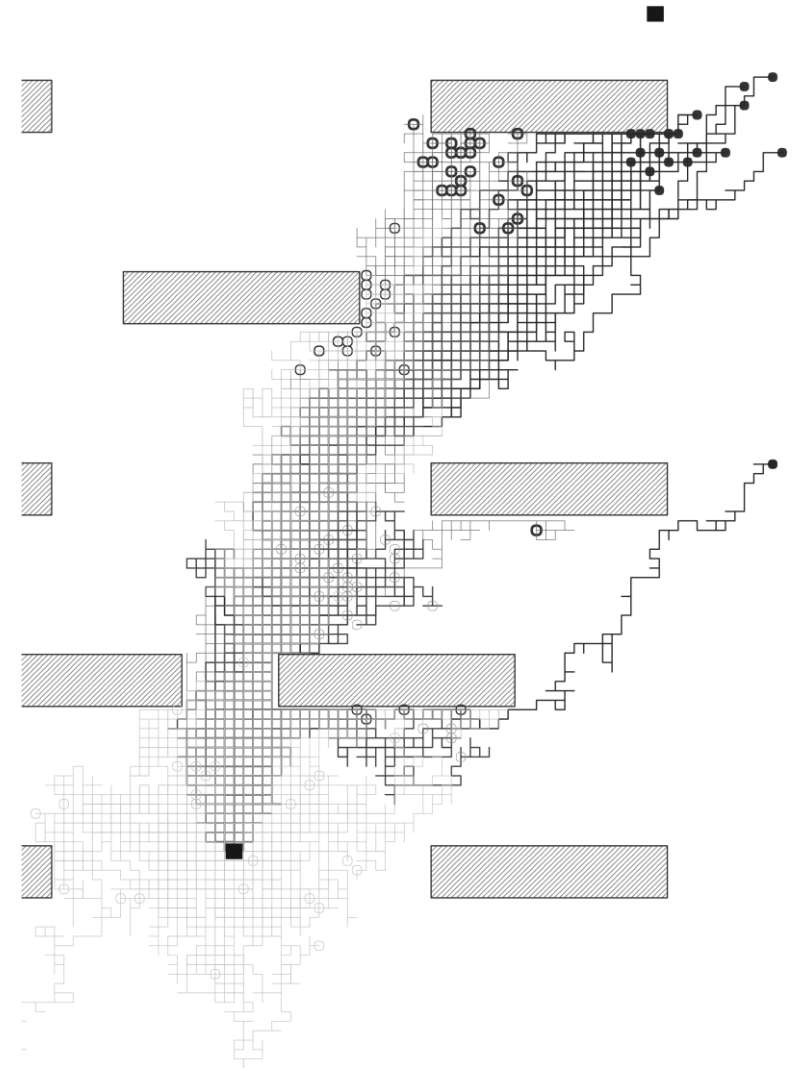
# Ecology + Evolution



Ecosystem Disturbance

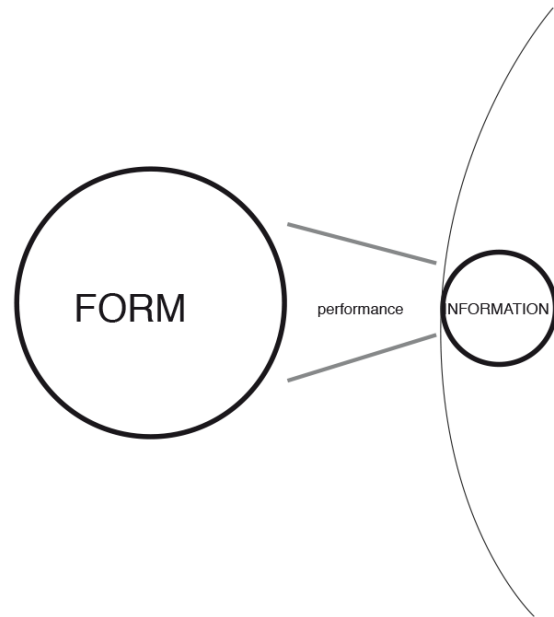


Plant Succession

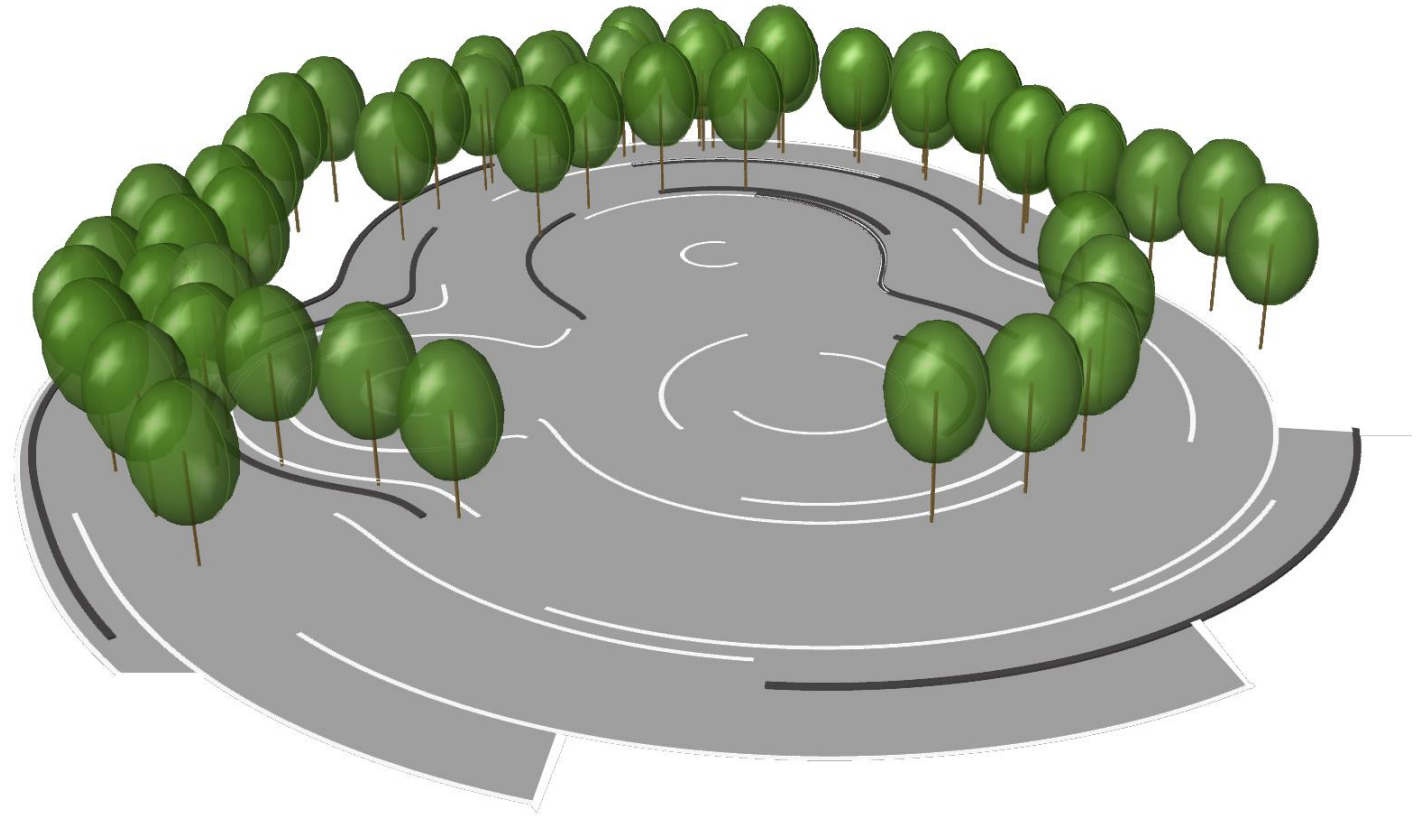


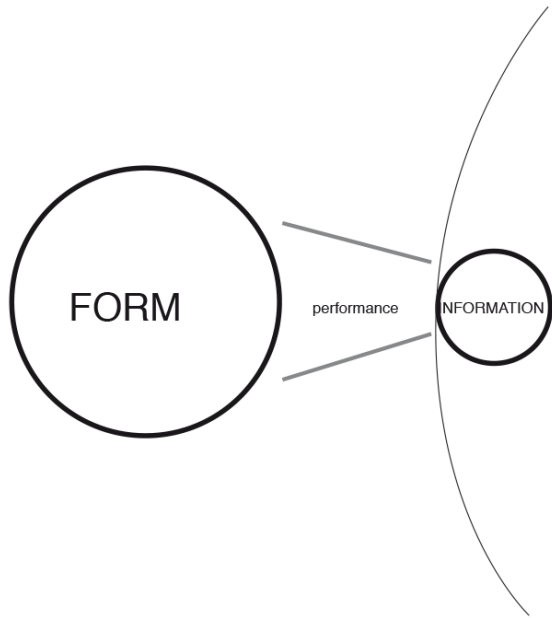
Genetically Evolved Random Walkers



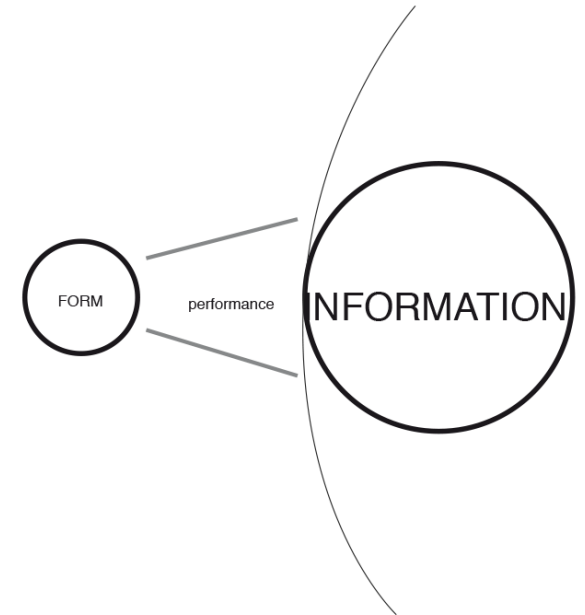


small size



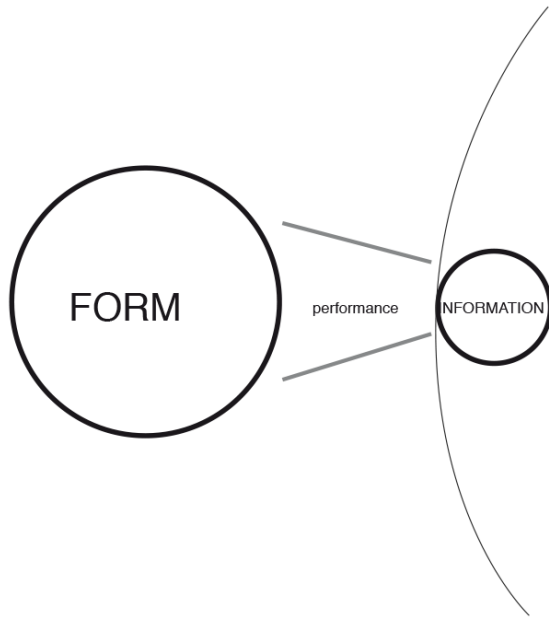


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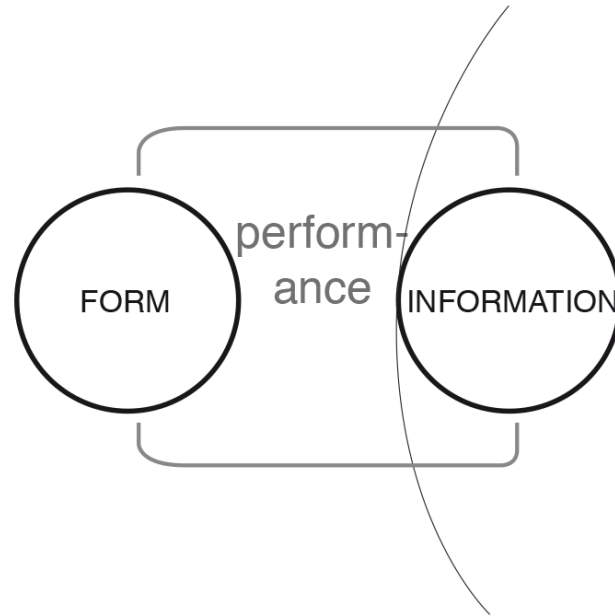


large size

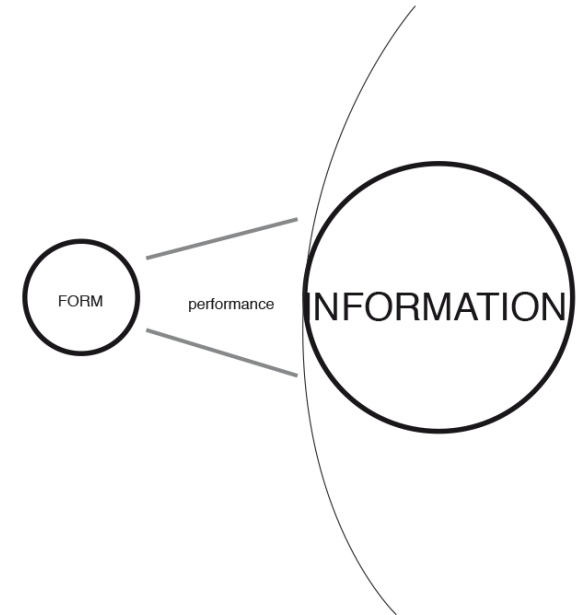




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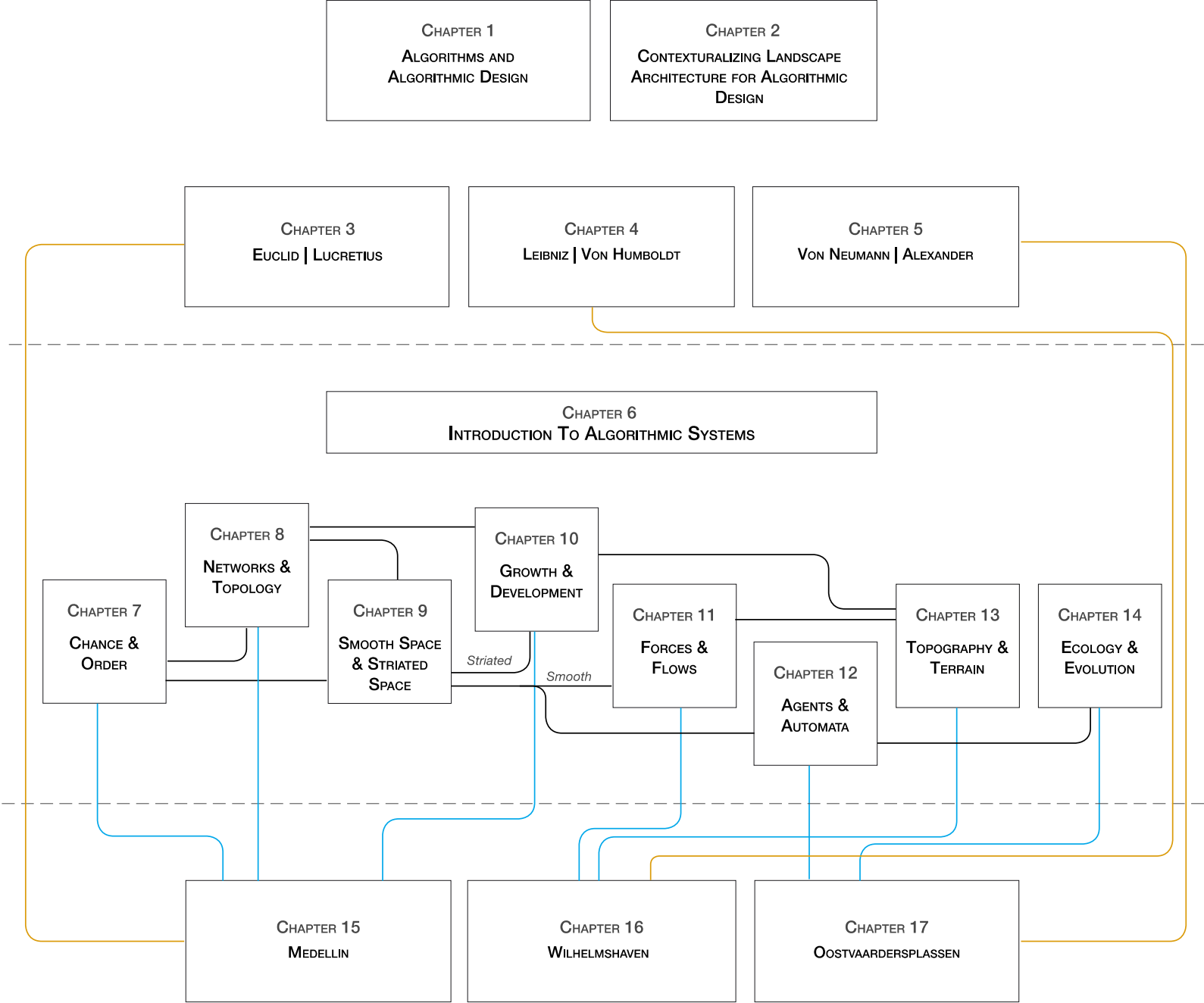


intermediate size



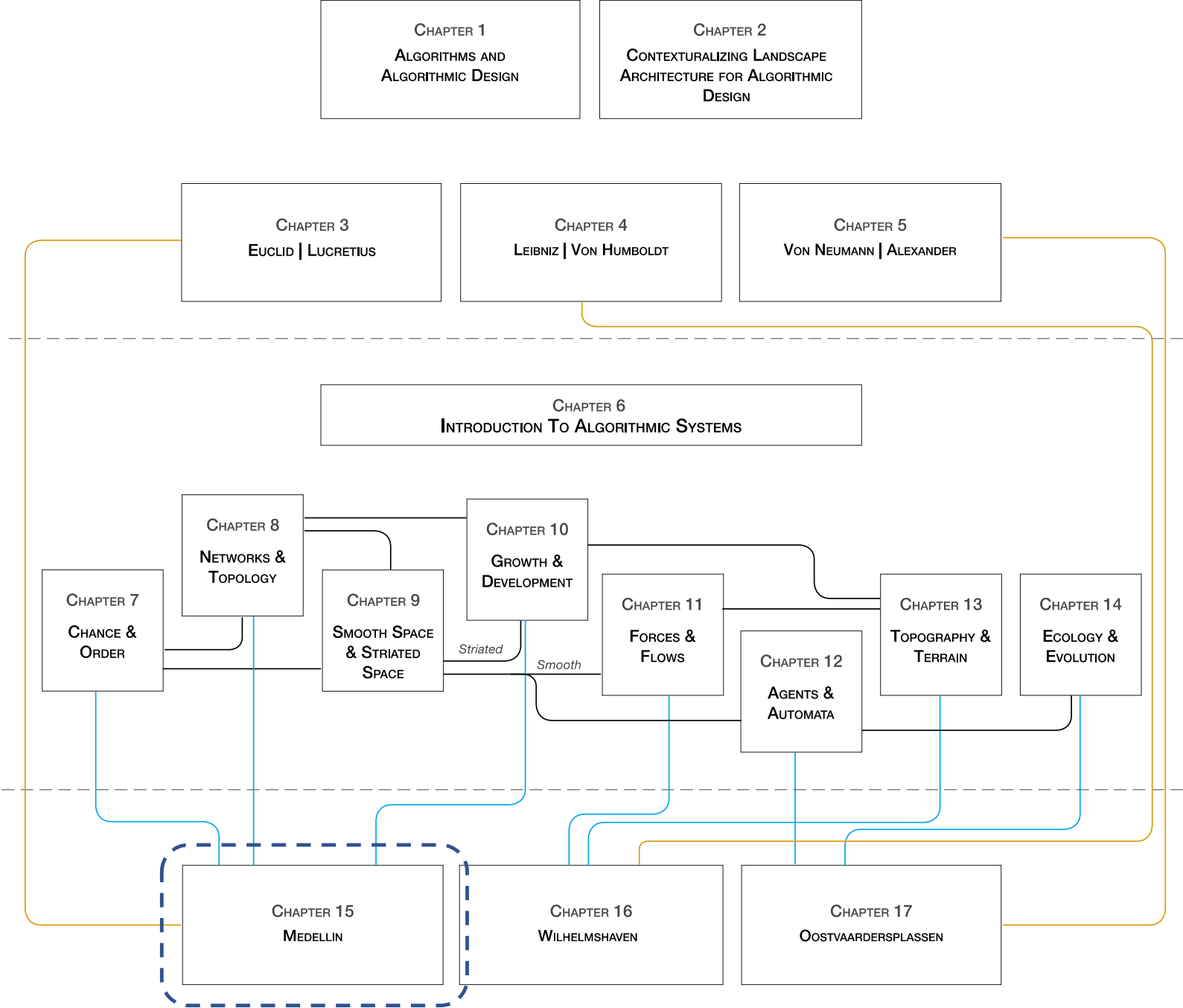
large size

# Overall Thesis Structure

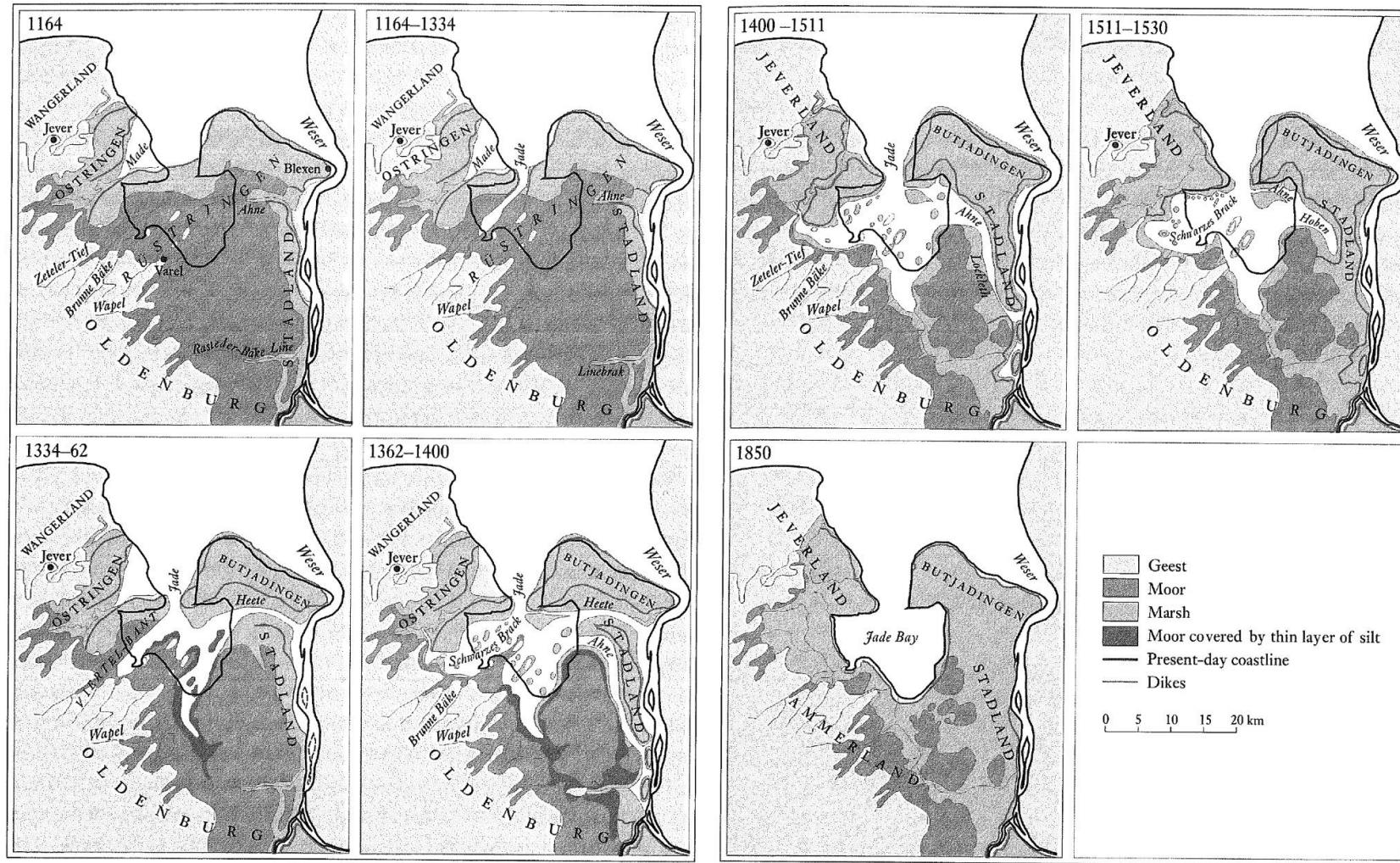




# Overall Thesis Structure



# Wilhelmshaven



The formation of the Jade Bay.

Image: from Blackbourn, *The Conquest of Nature: Water, Landscape and the Making of Modern Germany*

# Wilhelmshaven

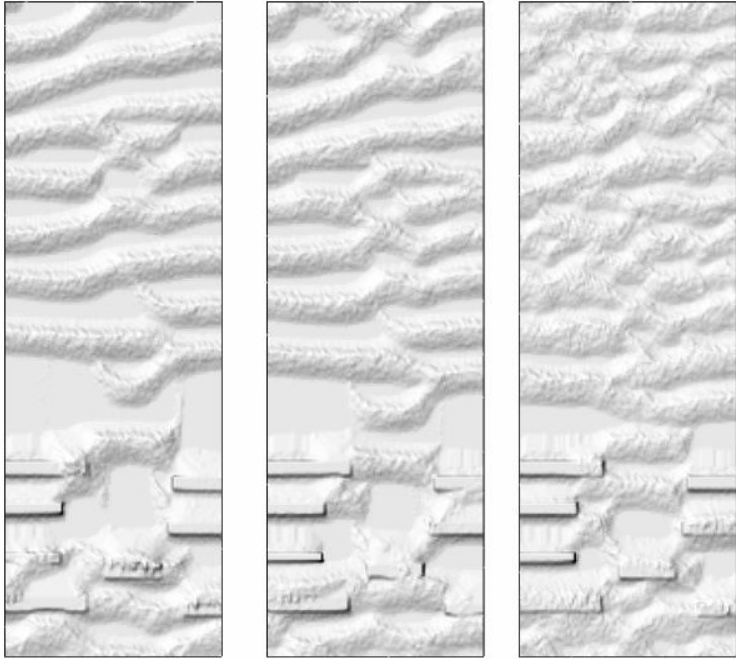
- Algorithms to model physical processes in the landscape
- Algorithmic models to bridge engineering and landscape design



Initial Sand Supply avg 8 units  
100 x 300 cells  
barrier height 16

Initial Sand Supply avg 4 units  
100 x 300 cells  
barrier height 16

Initial Sand Supply avg 2 units  
100 x 300 cells  
barrier height 16

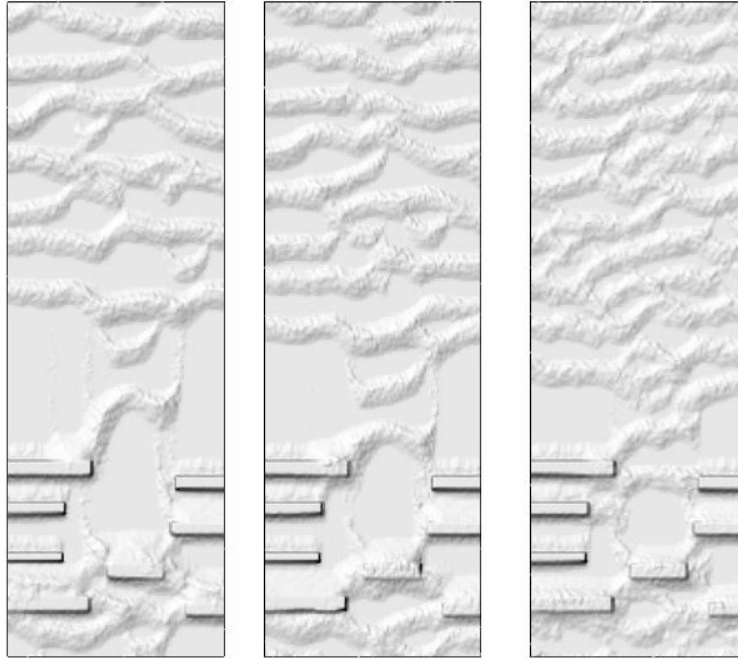


100

70

35

Recursions

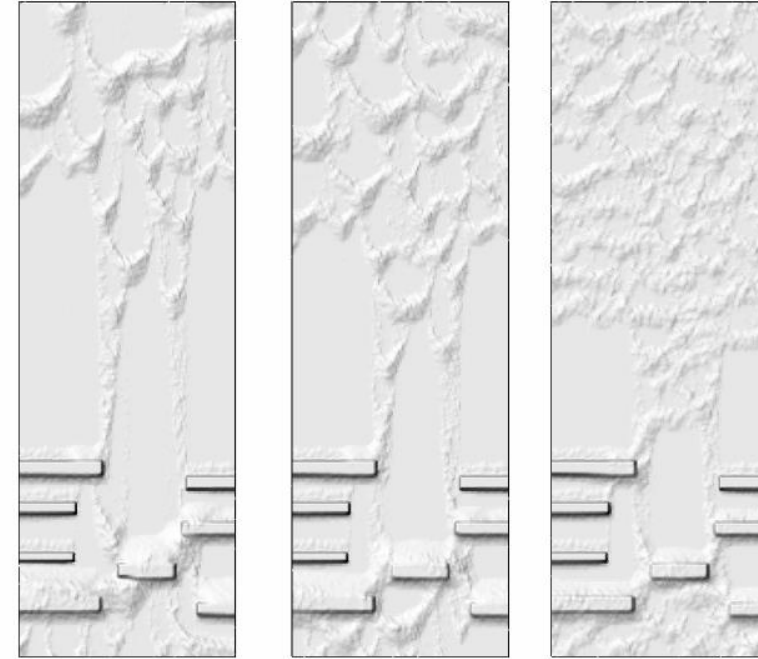


100

70

35

Recursions



100

70

35

Recursions

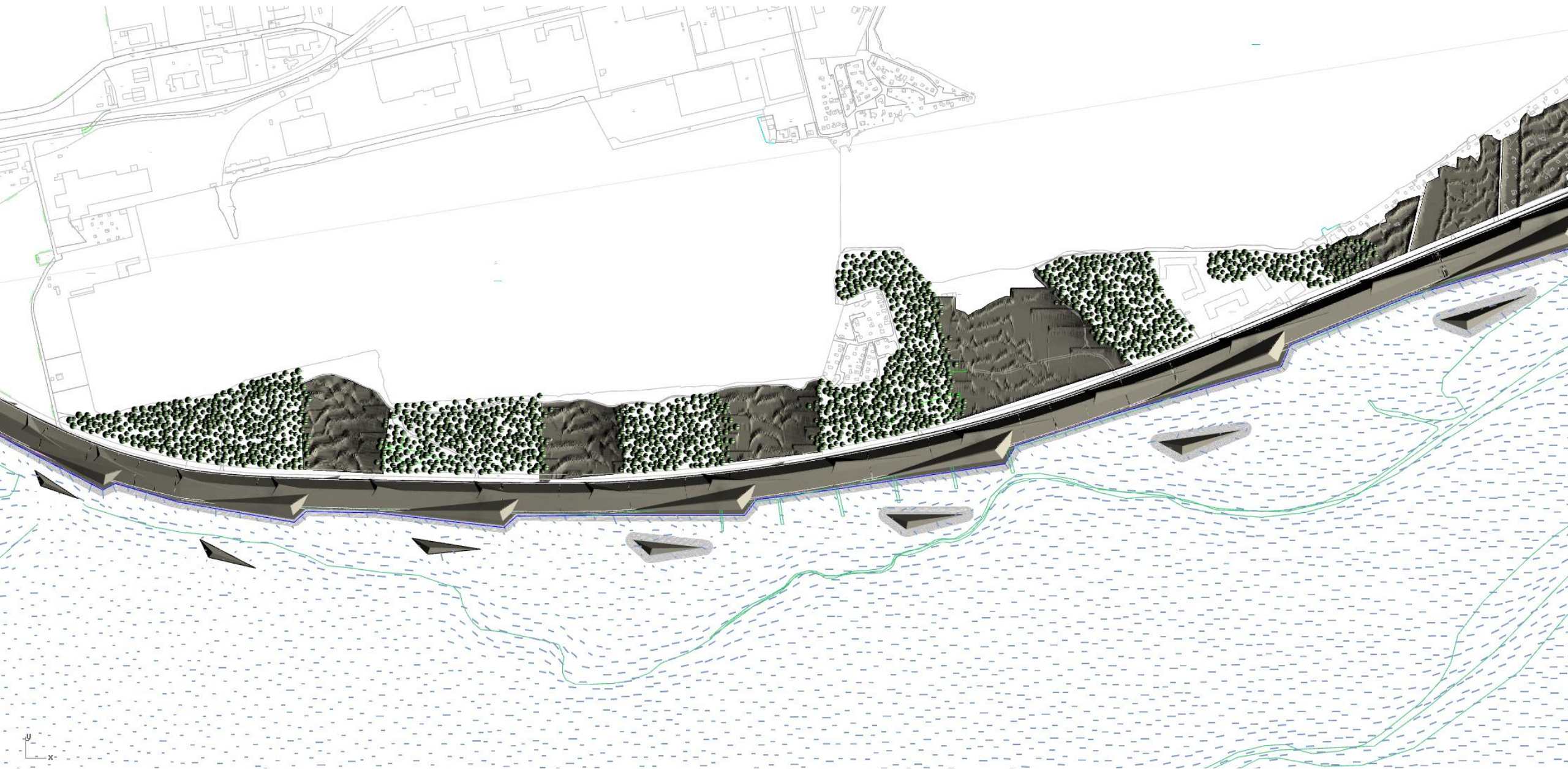
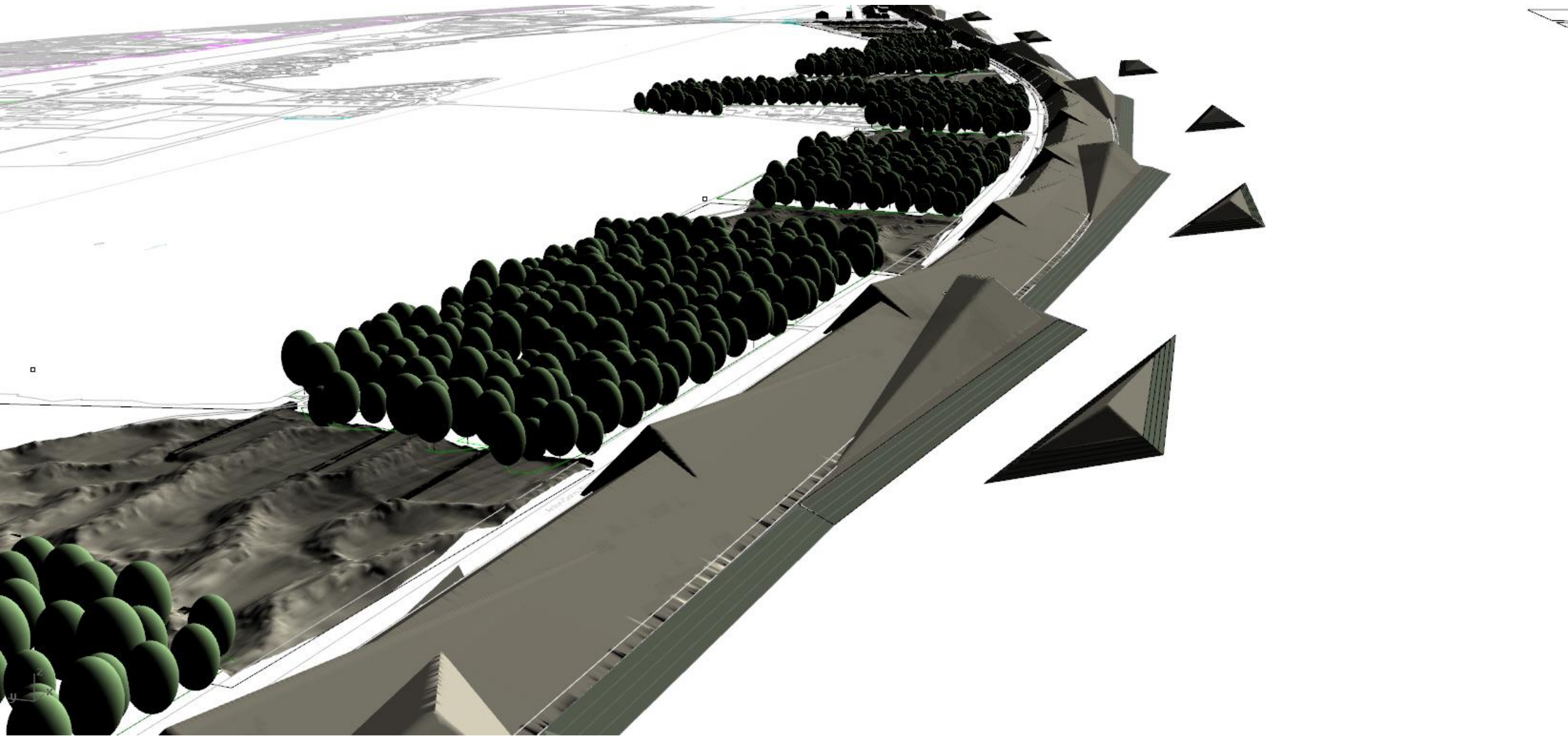


Image: Claghorn, 379







# Oostvaardersplassen

- Algorithms to mediate between actors with divergent interests
- Algorithmic models for flexible, adaptive masterplanning
- Questions of individual agency (for humans and animals), paternalistic control, and collective responsibility

# FERAL

GEORGE  
MONBIOT

Searching for enchantment on  
the frontiers of rewilding





Die nieuwe Wildernis?

Image: [www.staatsbosbeheer.nl](http://www.staatsbosbeheer.nl)





Die nieuwe Wildernis?

Image from Film: Die nieuwe Wildernix – Ruben Smit





Image from Film: Die nieuwe Wildernix



Die nieuwe Wildernix?



© nach-holland.de



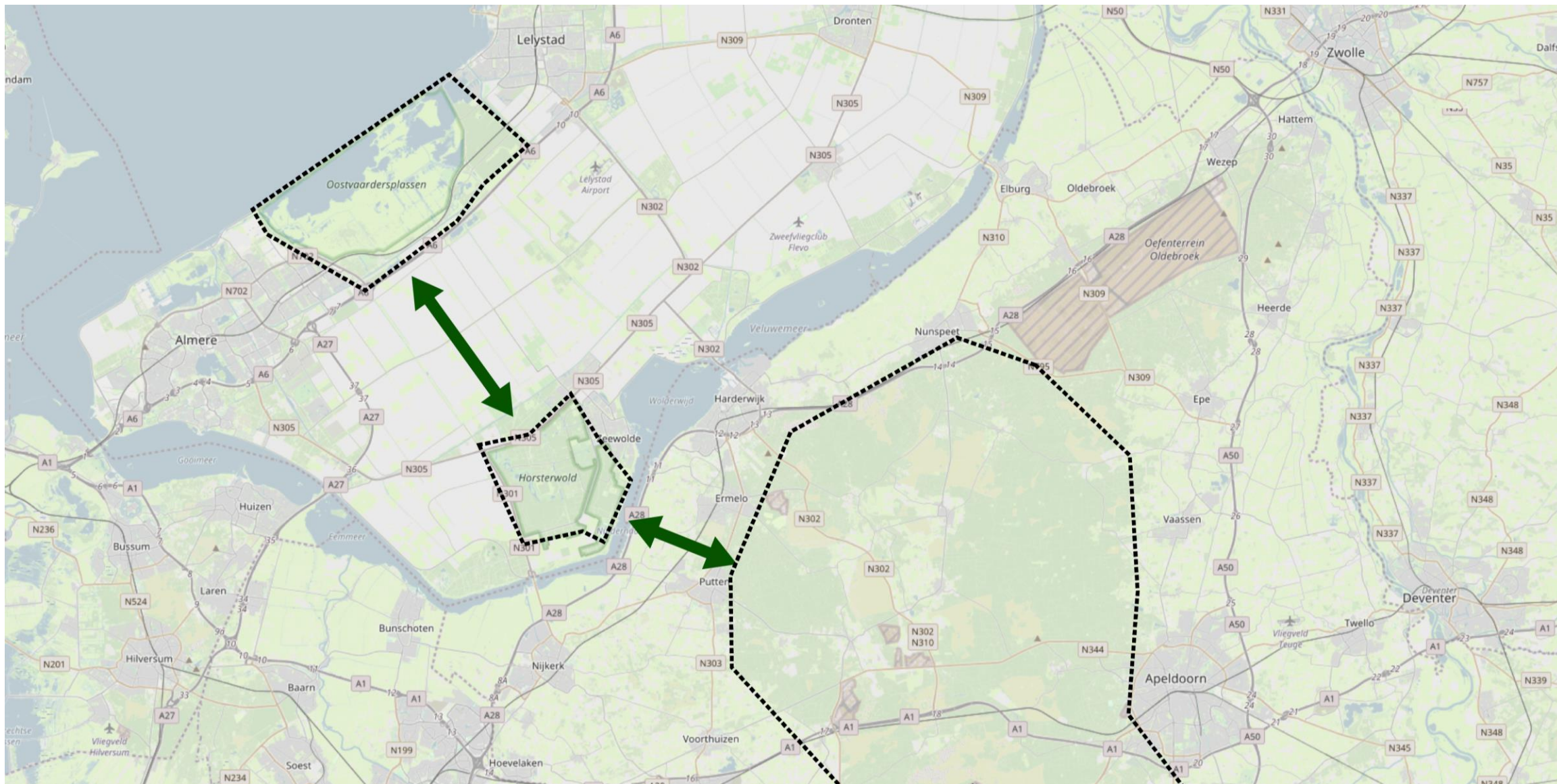


Image: Claghorn, 385 – Map Data from openstreetmap





Image: Province of Flevoland,  
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the economy and ecology of the  
Netherlands,” PDF leaflet. (Provincie  
Flevoland, 2010).



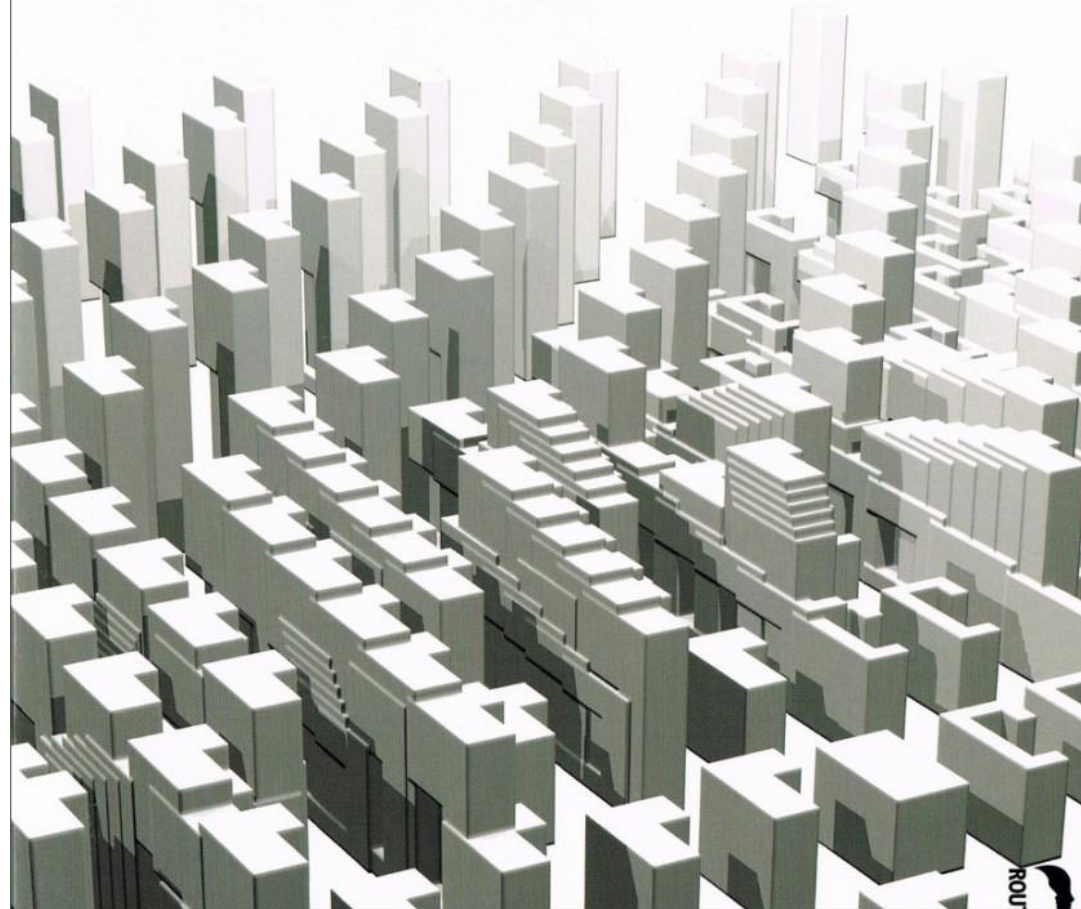


Images: Province of Flevoland, “Oostvaardersland: Strengthening the economy and ecology of the Netherlands,” PDF leaflet. (Provincie Flevoland, 2010).

Edited by **Tom Verebes**

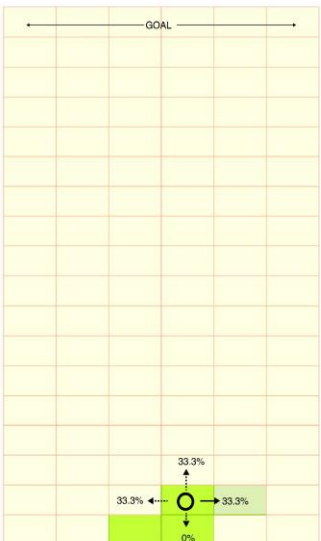
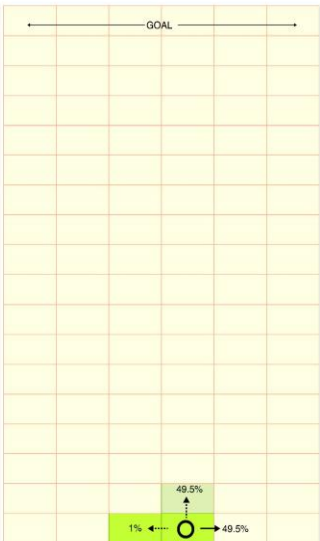
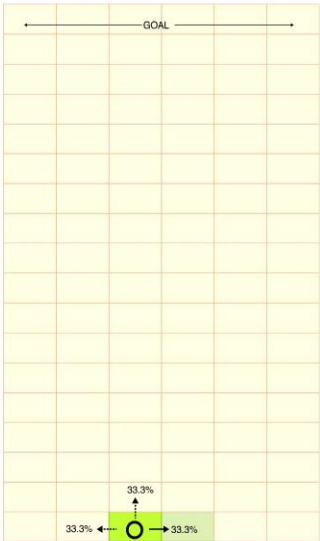
# **MASTERPLANNING** THE ADAPTIVE CITY

Computational Urbanism in the Twenty-First Century

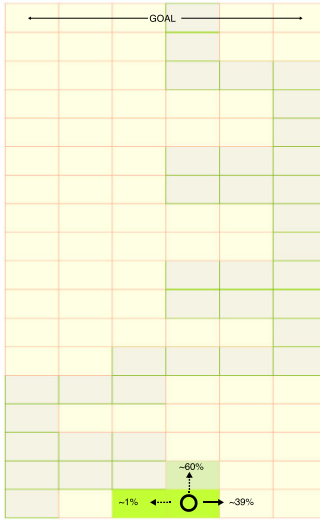
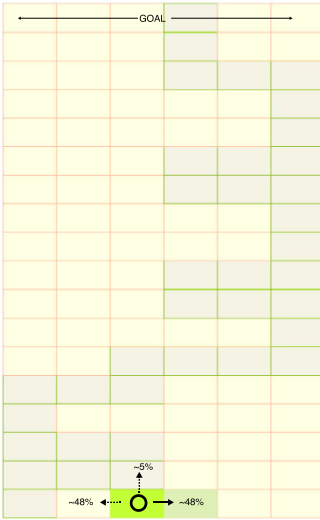




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48	49	50	51	52	53
42	43	44	45	46	47
36	37	38	39	40	41
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24	25	26	27	28	29
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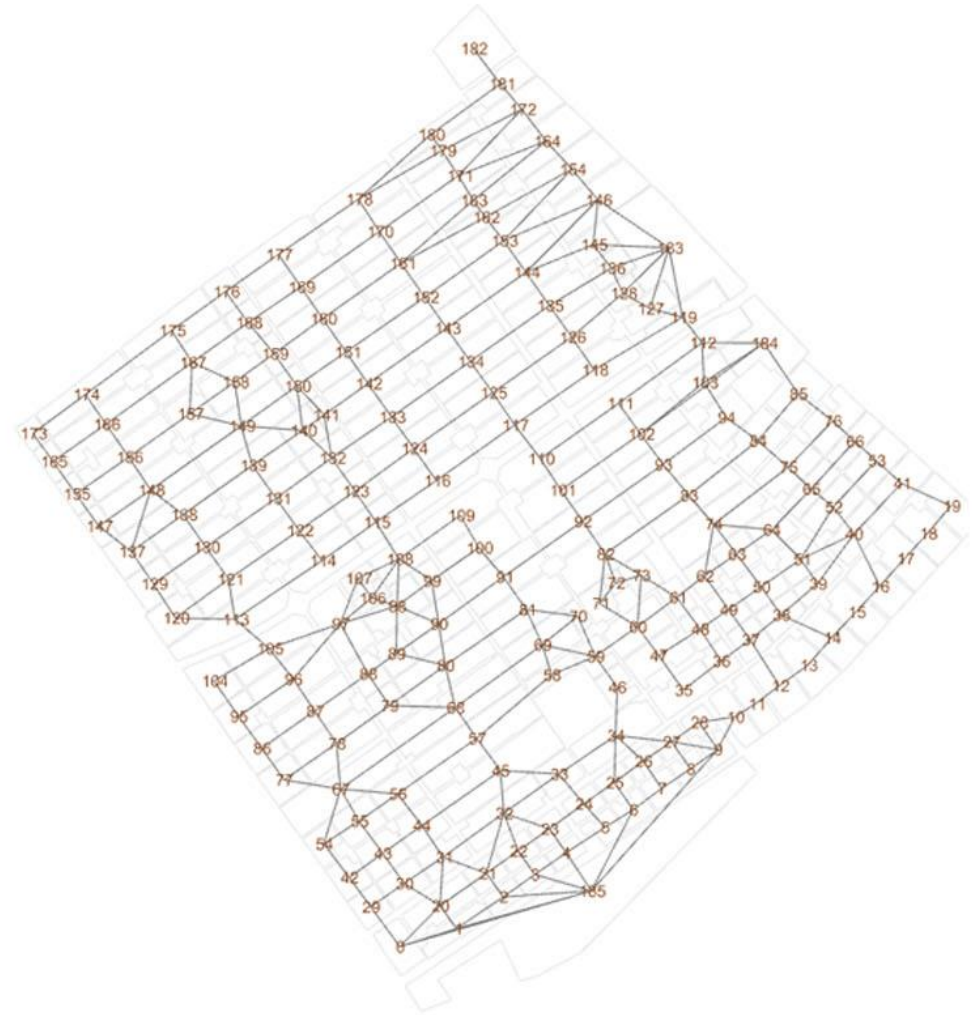


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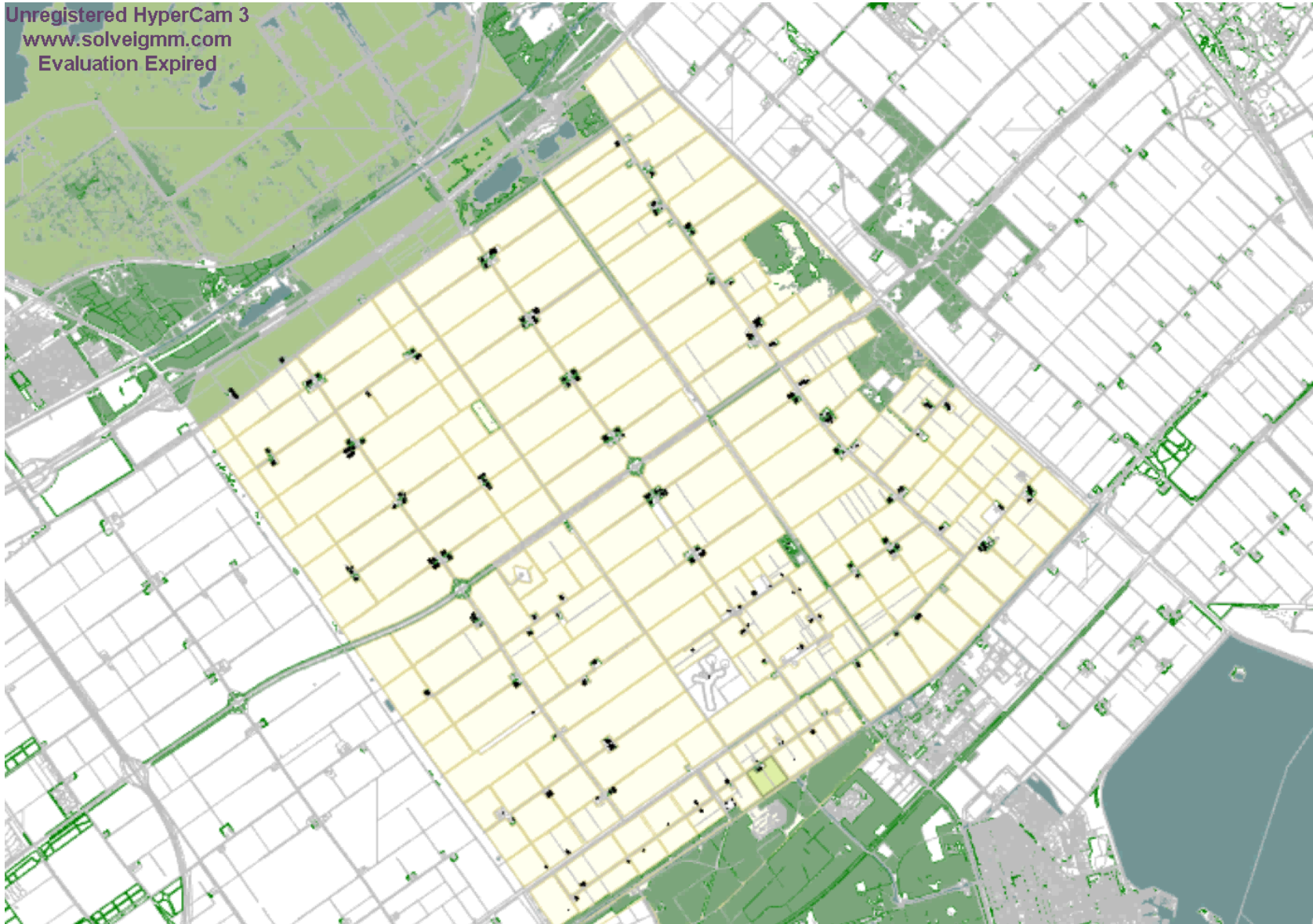


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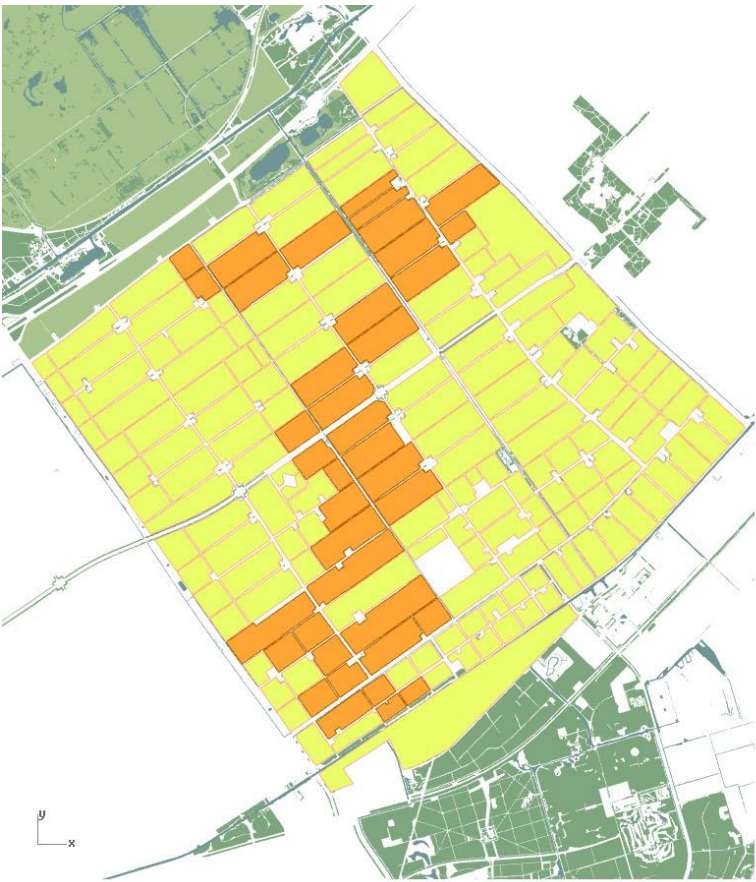
Image: Claghorn, 390 - 391



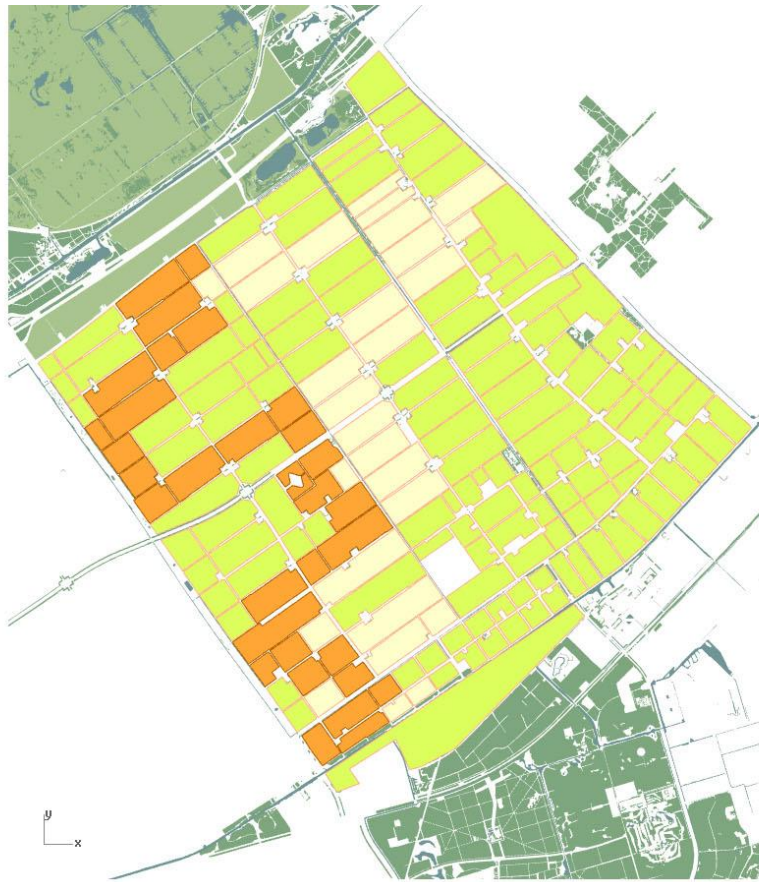
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www.solveigmm.com  
Evaluation Expired



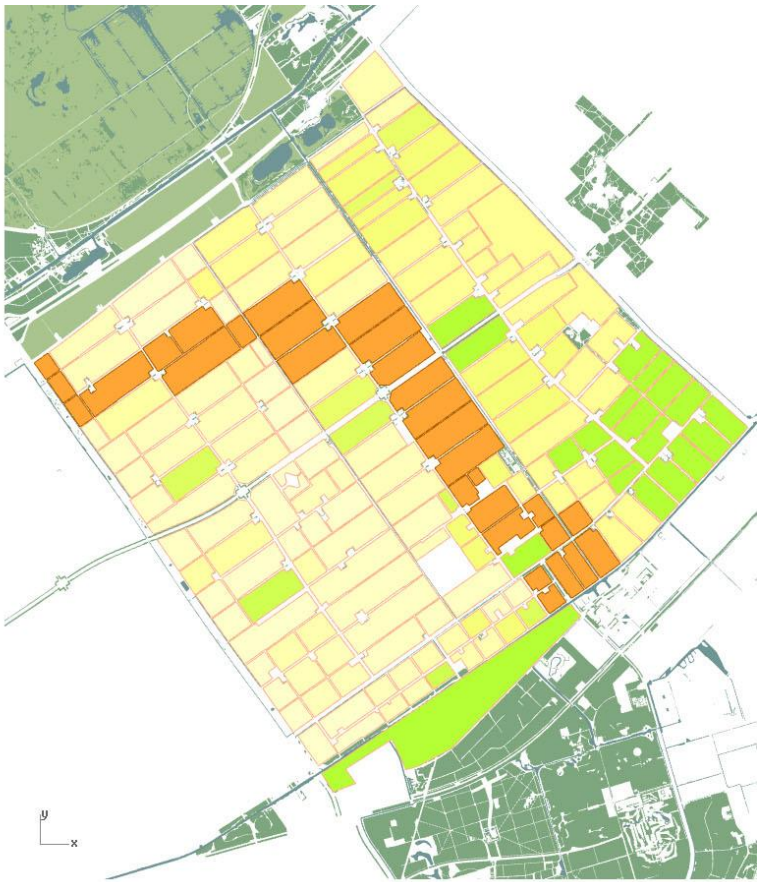




Year 01



Year 02



Year 30



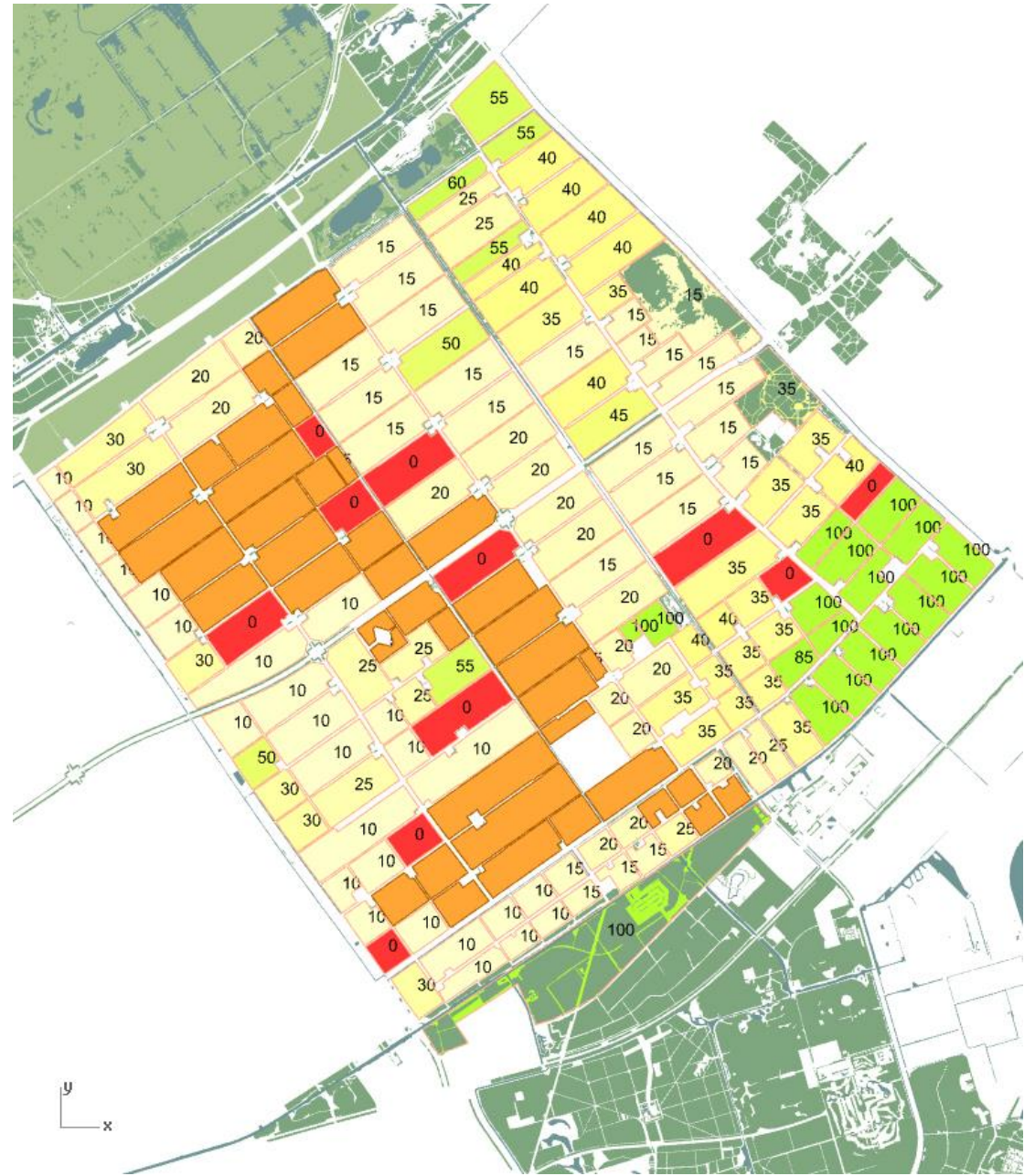
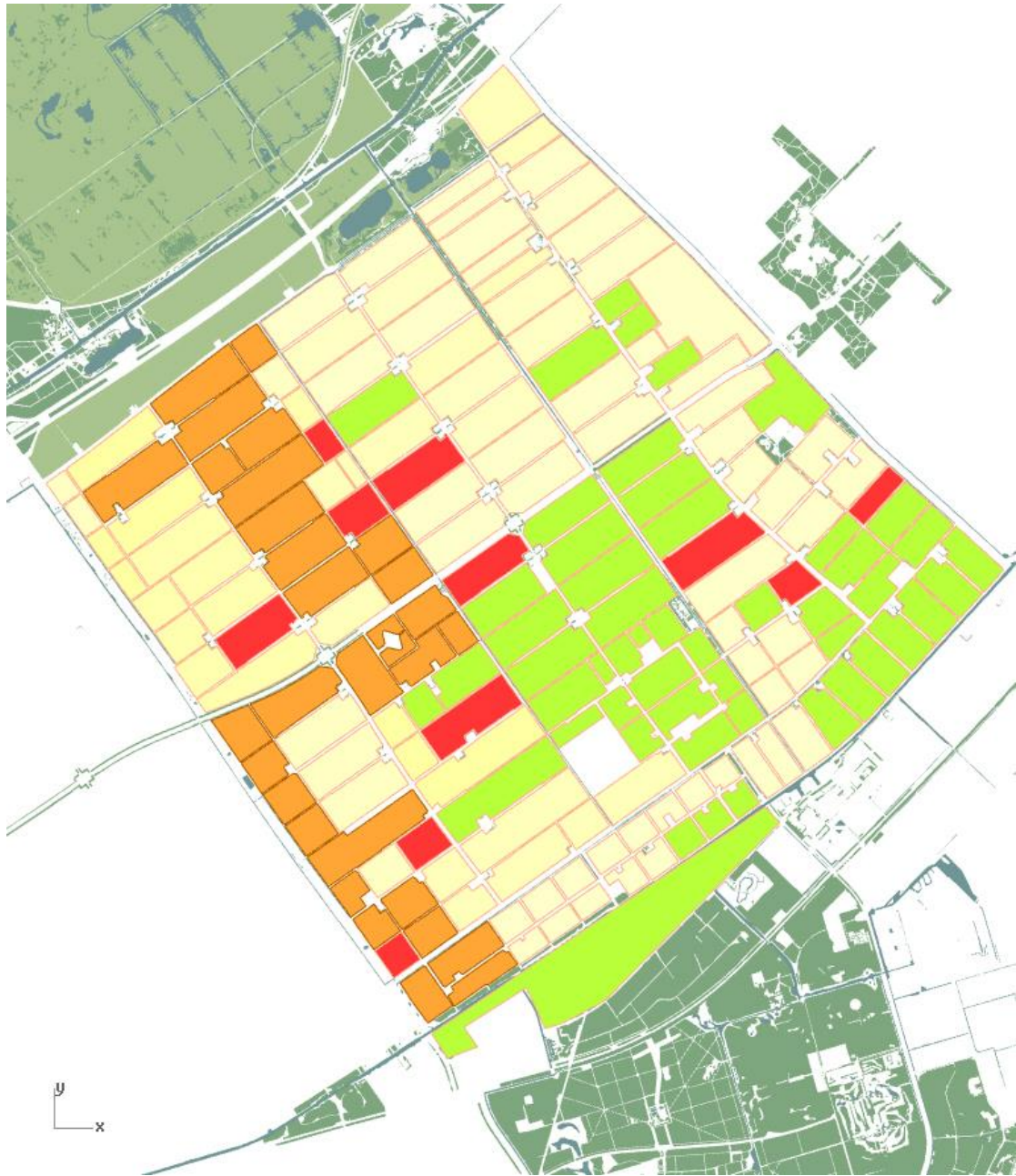






Image: Claghorn, 394









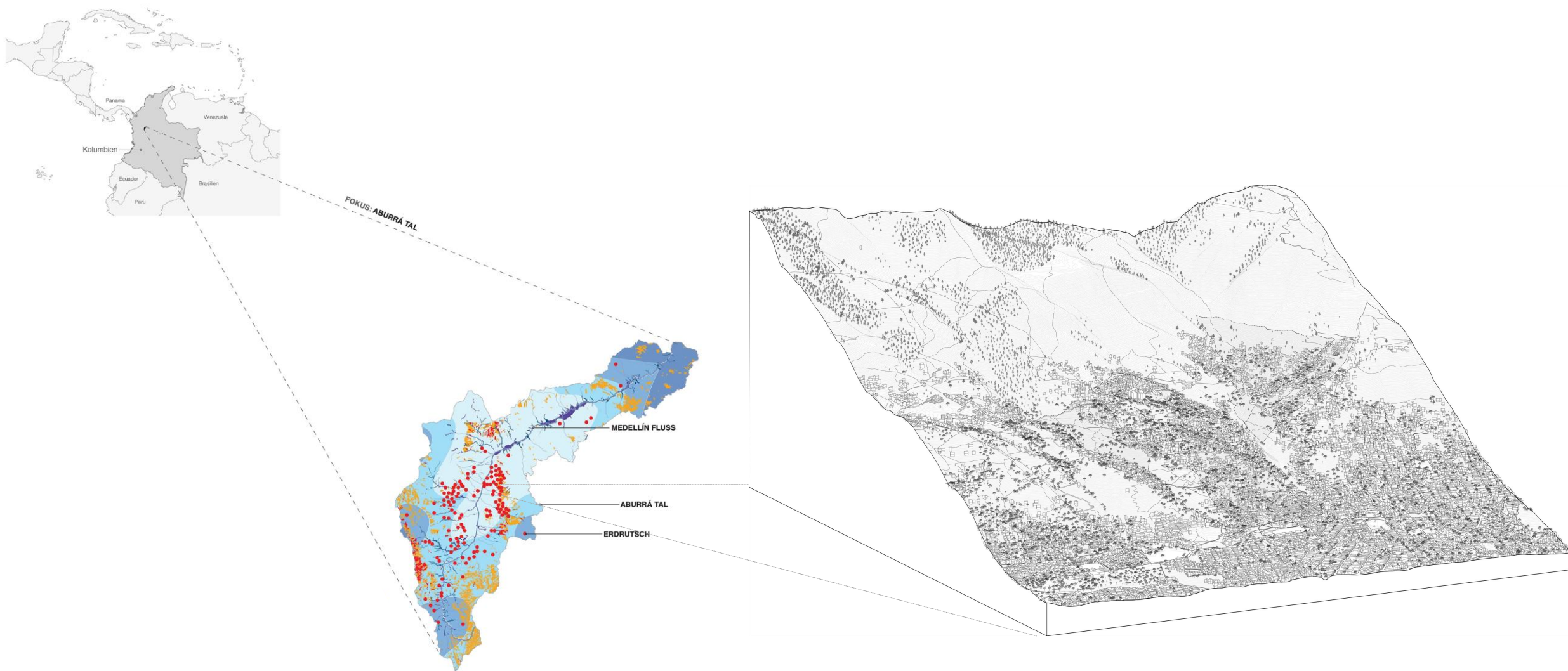


# Medellin



Photo: Joseph Claghorn





Metropolitan Area:  
Medellín – Aburrá Valley

Axonometric of Study Area:  
Neighbourhoods of La Cruz and La Honda

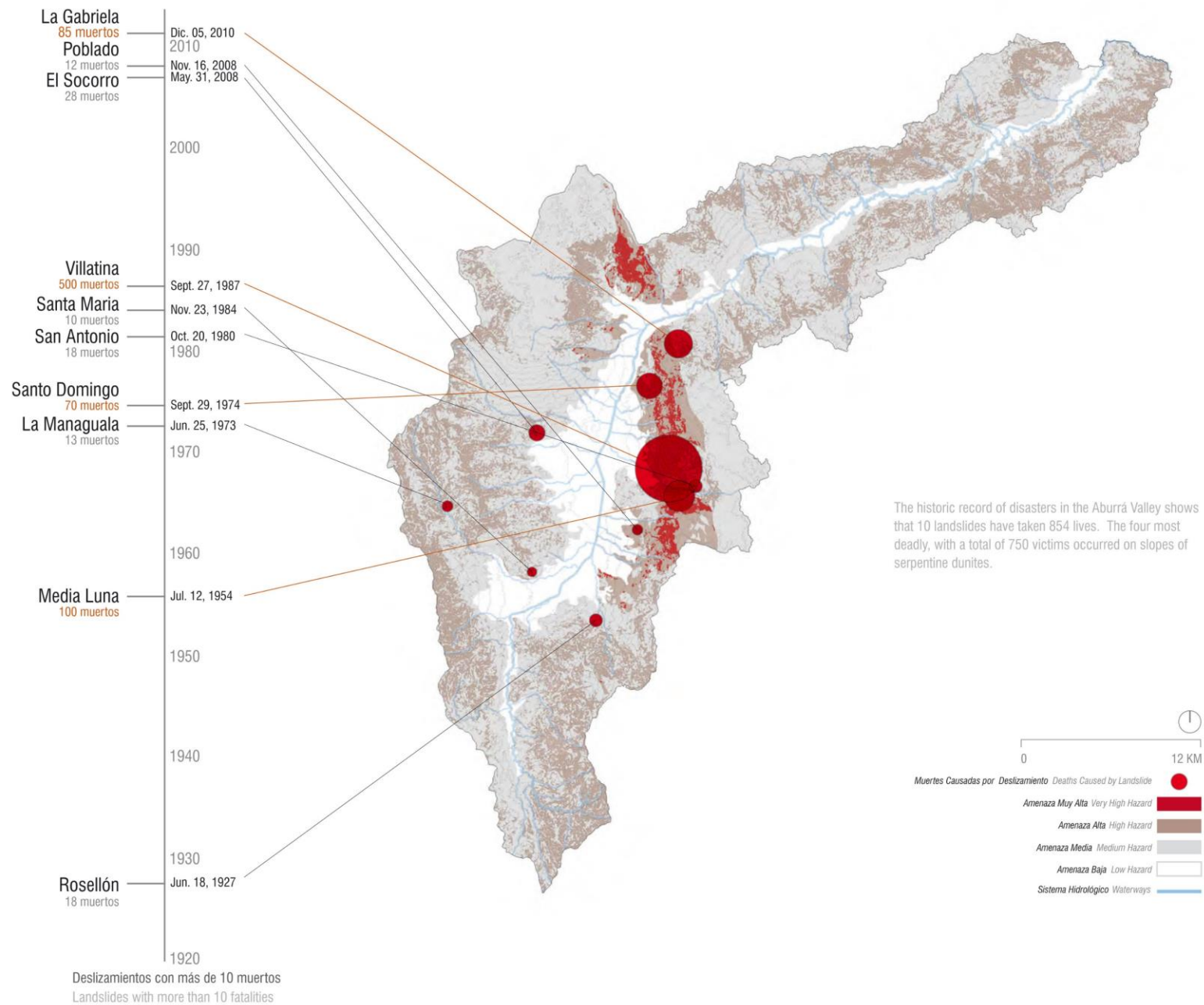




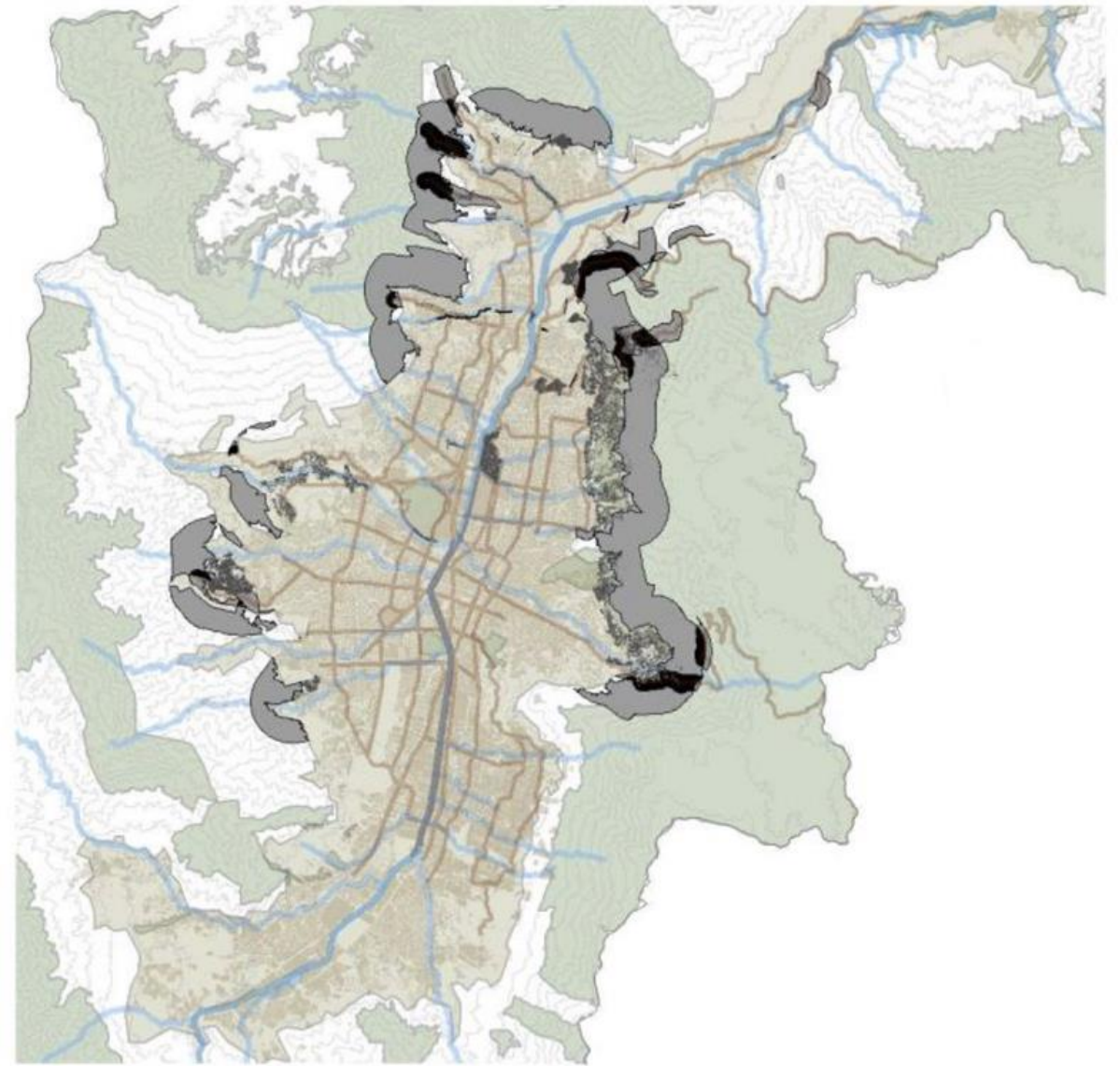
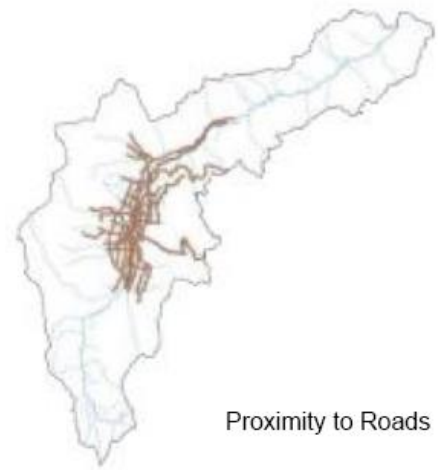
Landslide in La Cruz, Medellin, 2007 (Department of Administrative Planning, Medellin)



# Landslide Risk and Fatalities in Medellin (Echeverri, Werthmann, et al. *Shifting Ground*)

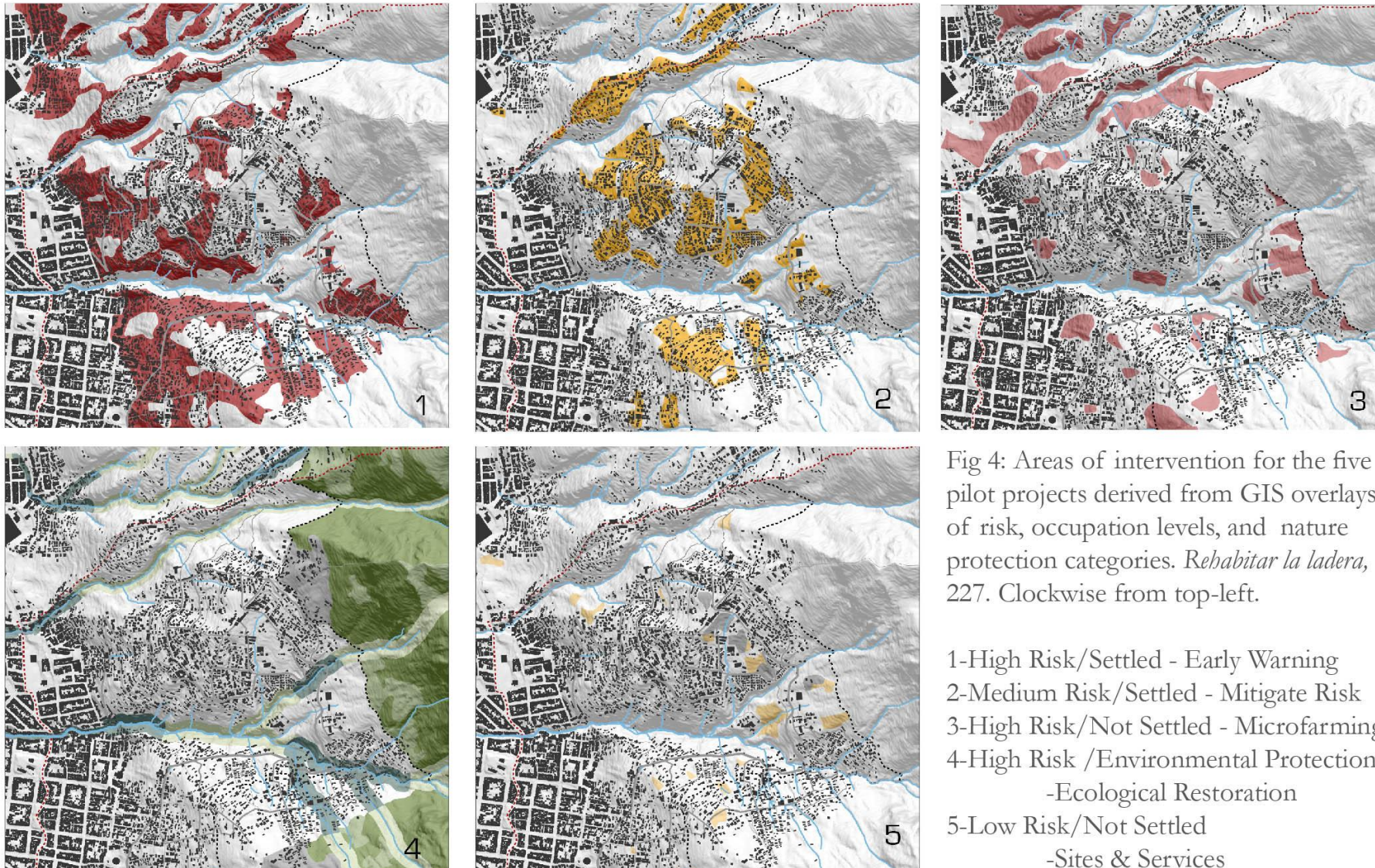


## Four Attractors to Growth in Medellin (Echeverri, Werthmann, et al. *Shifting Ground* 67-68)

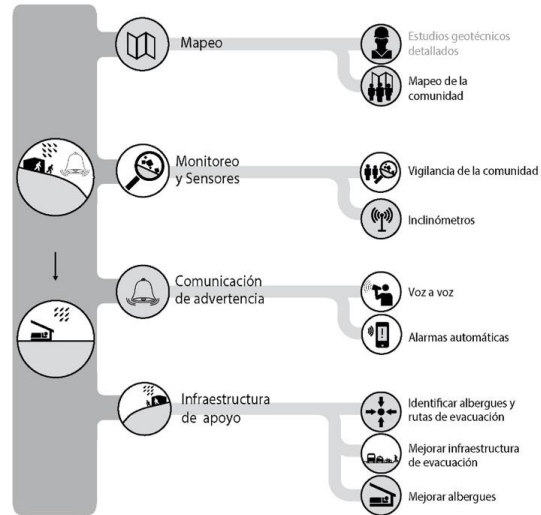




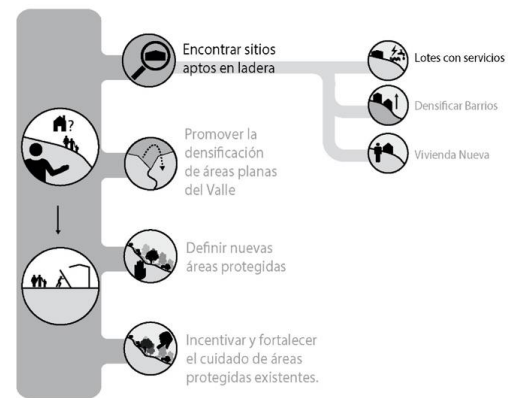
## Areas of Intervention for Pilot Projects (Echeverri, Werthmann, et al. *Rehabitar la montaña*, 227)



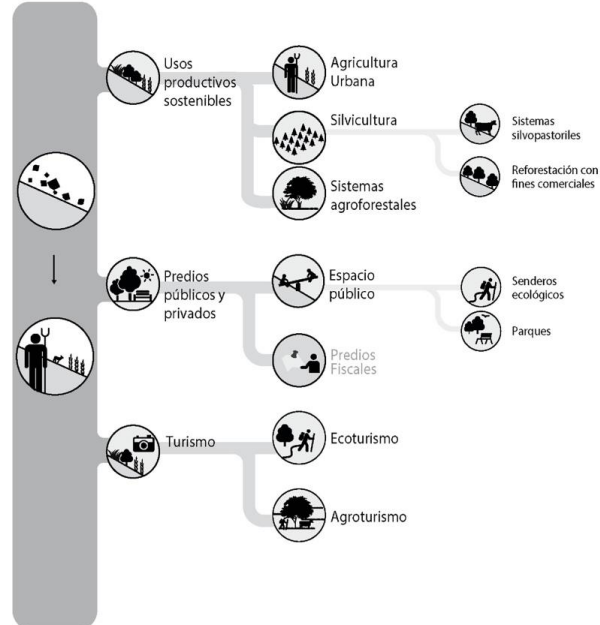
## 1. PREPARACIÓN ANTE DESASTRES NATURALES



## 3. DIRECCIONAR EL CRECIMIENTO

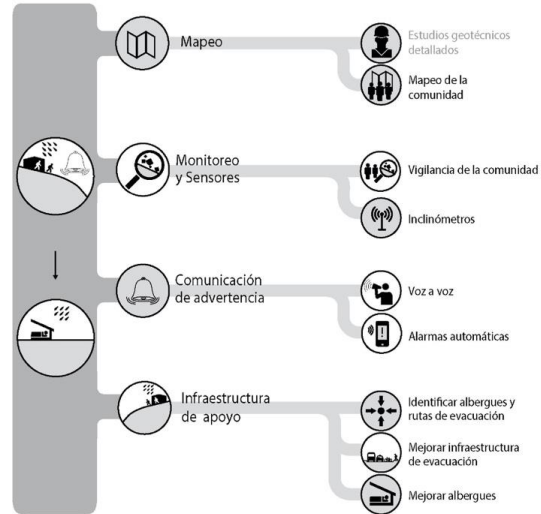


## 2. DESINCENTIVAR LA OCUPACIÓN

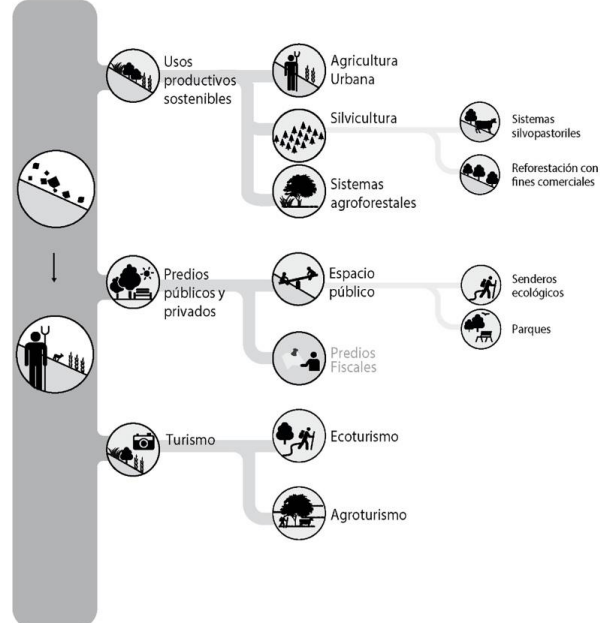




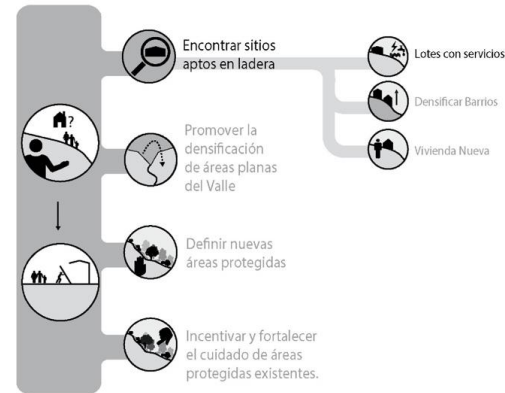
## 1. PREPARACIÓN ANTE DESASTRES NATURALES



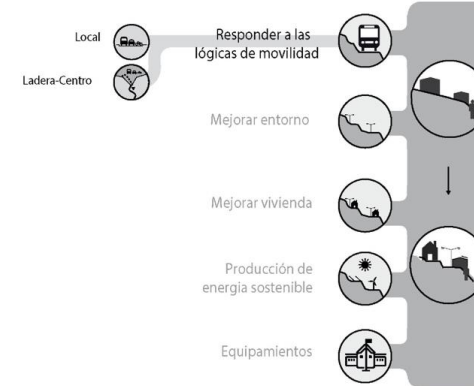
## 2. DESINCENTIVAR LA OCUPACIÓN



## 3. DIRECCIONAR EL CRECIMIENTO



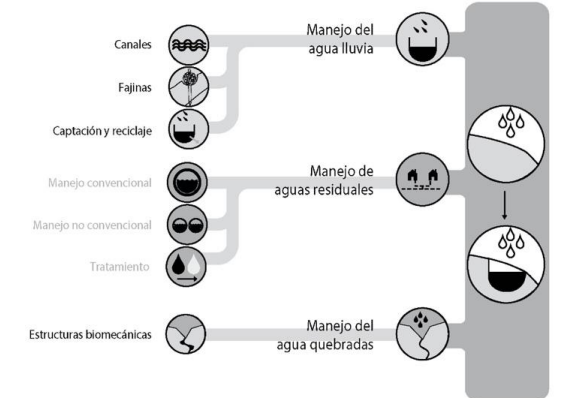
## 8. MEJORAR ASENTAMIENTOS EXISTENTES



## 4. ESTABILIZACIÓN DE TALUDES



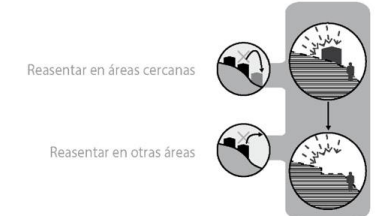
## 5. MANEJAR EL AGUA



## 6. MANEJAR RESIDUOS SOLIDOS



## 7. REASENTAR ASENTAMIENTOS EN ALTO RIESGO



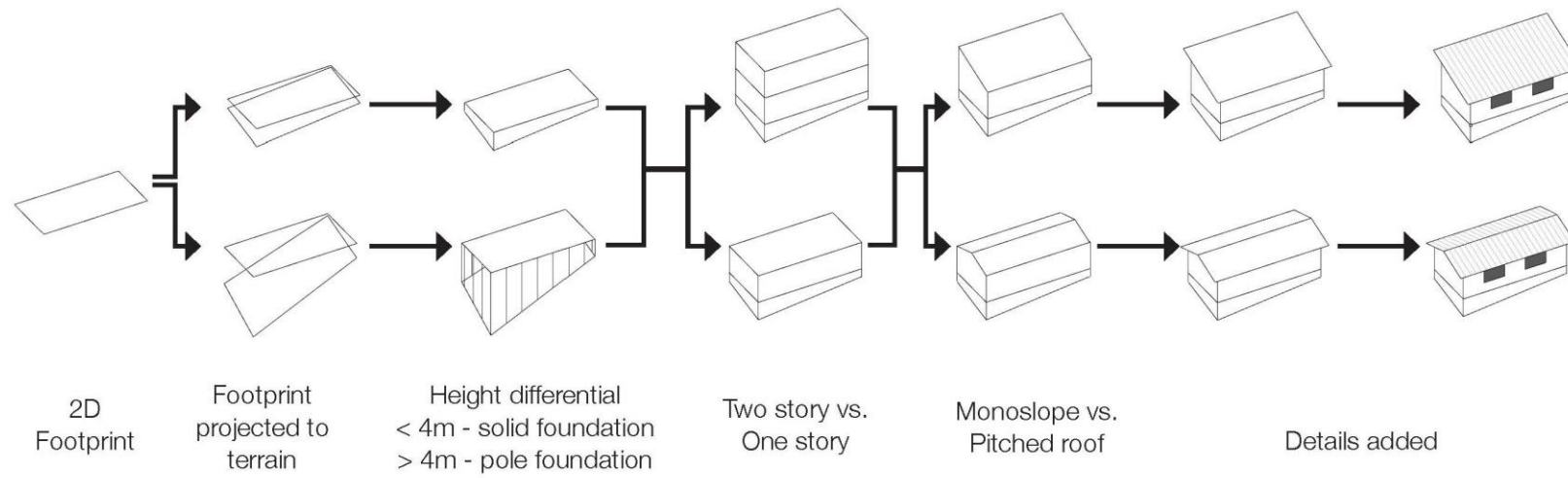




# Pilot Project 4 (Echeverri, Werthmann, et al. *Rehabitar la montaña*– Collage Florian Depenbrock)







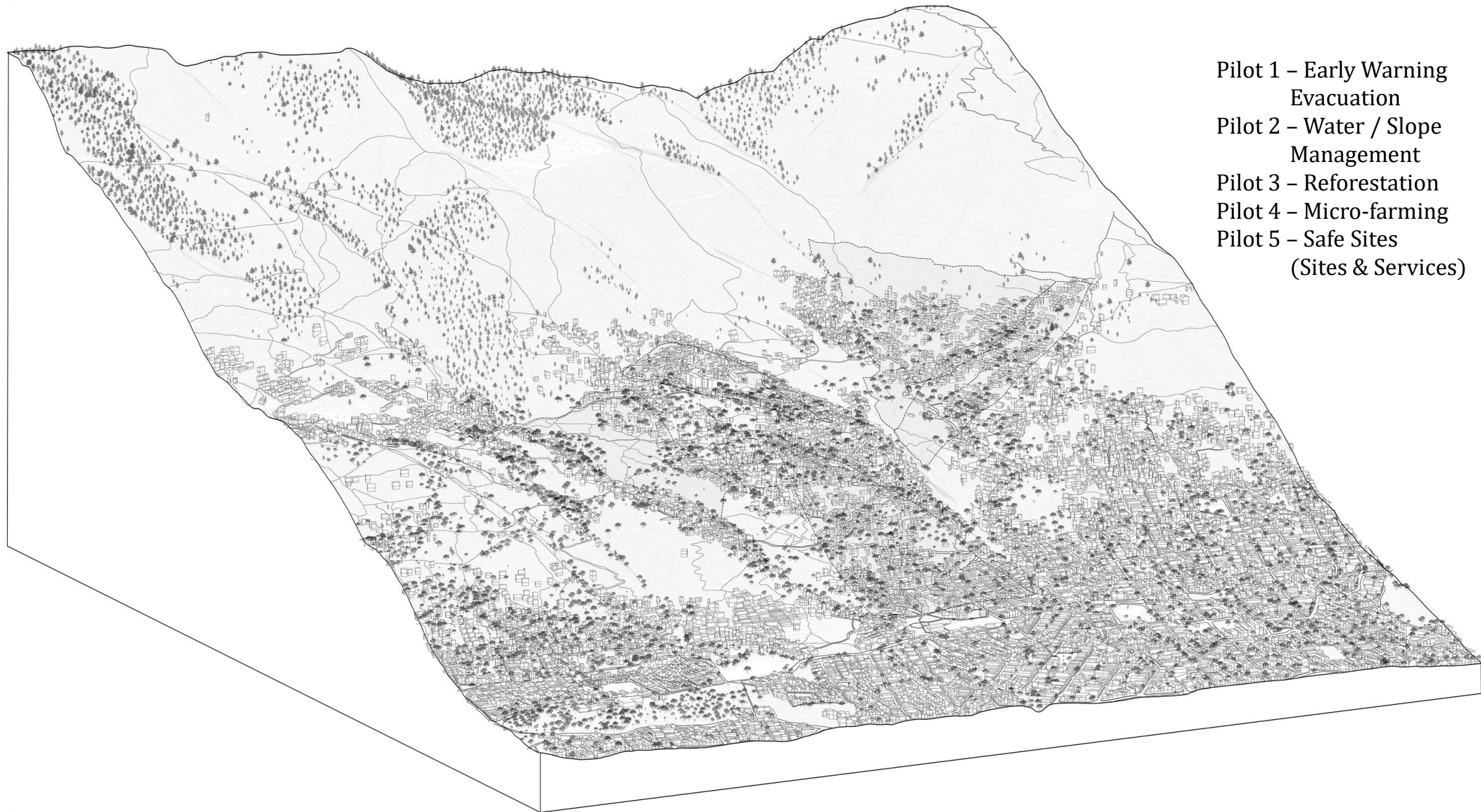
Algorithmic decision tree for generating buildings reflecting existing settlement character (above) with cumulative effect in part of the settlement shown below. Claghorn, 353





Design and Digital Modelling, Joseph Claghorn Construction: Julian Heikel, Jamin Grau, Sebastian Ballan Photo: Marcus Hanke



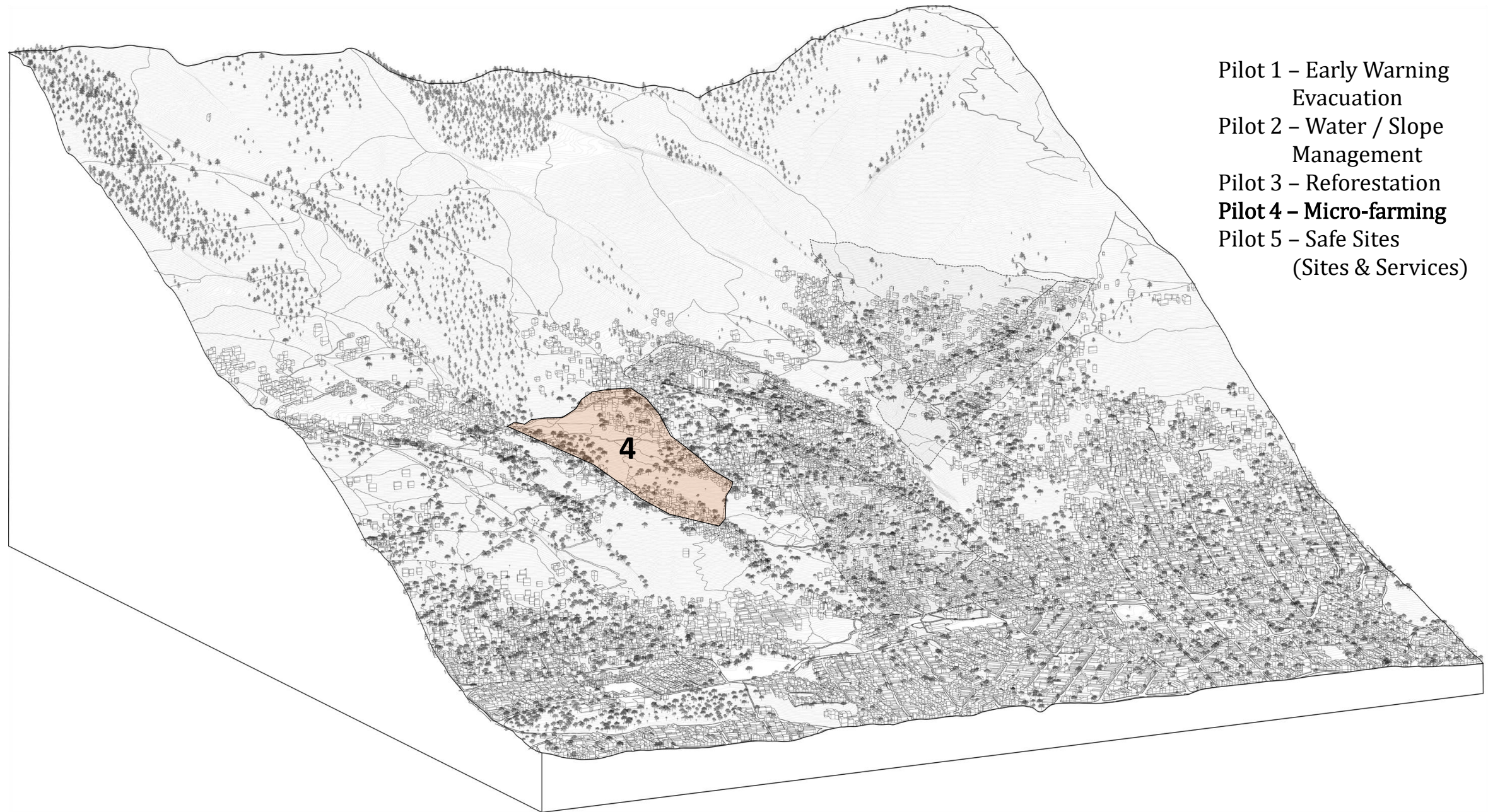


- Pilot 1 – Early Warning  
Evacuation
- Pilot 2 – Water / Slope  
Management
- Pilot 3 – Reforestation
- Pilot 4 – Micro-farming
- Pilot 5 – Safe Sites  
(Sites & Services)









- Pilot 1 – Early Warning  
Evacuation
- Pilot 2 – Water / Slope  
Management
- Pilot 3 – Reforestation
- Pilot 4 – Micro-farming**
- Pilot 5 – Safe Sites  
(Sites & Services)



# Pilot Project 4 (Echeverri, Werthmann, et al. *Rehabitar la montaña*– Collage Florian Depenbrock)



Imagen piloto diseñada para la  
ocupación con agricultura urbana  
y sistemas agroforestales.

Fuente: Echeverri, Werthmann, et al. 2014.





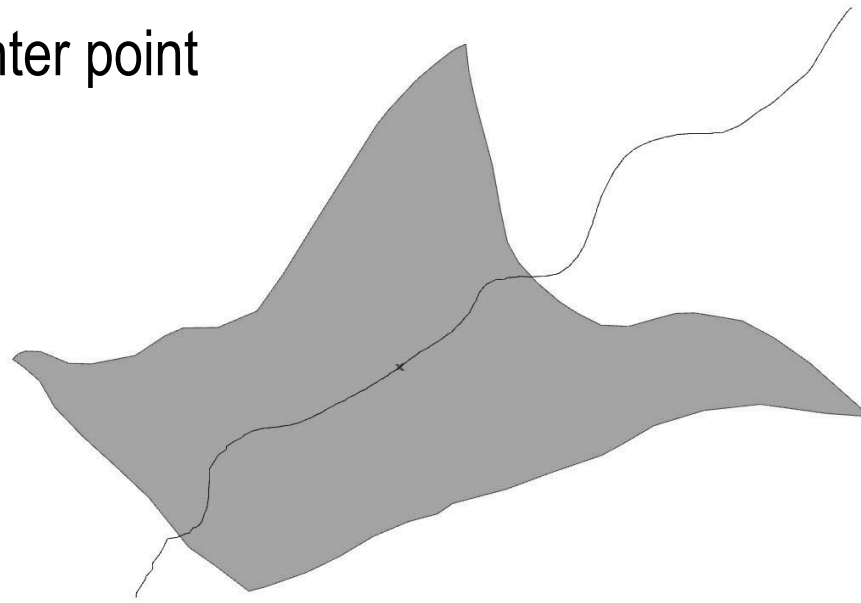
Photos: Joseph Claghorn



'Andina' Terraces in Pisac (mapio.net)



## Step 1 – Cut on contour through center point

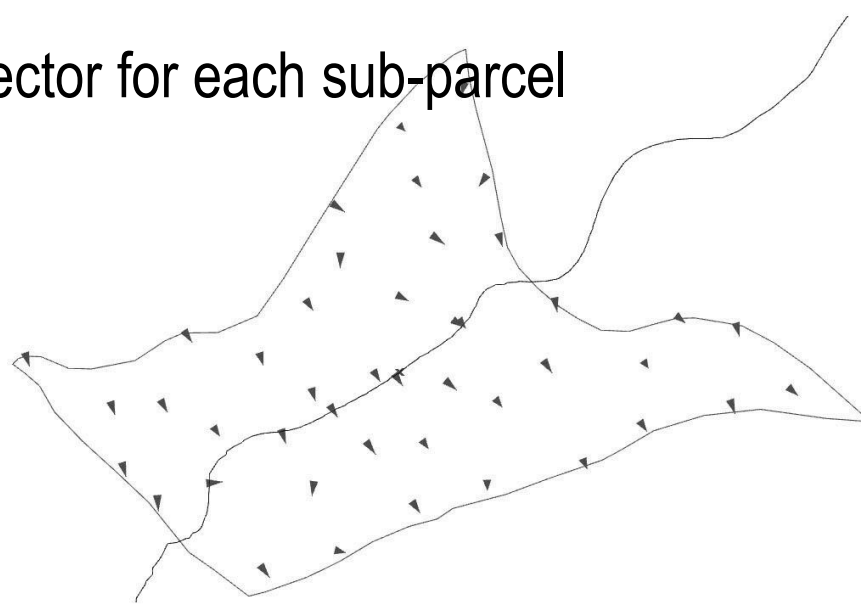


Plan



Axonometric

## Step 2 – Find average downslope vector for each sub-parcel



Plan



Axonometric



### Step 3 – Cut through center of each sub-parcel with average downslope vector



Plan



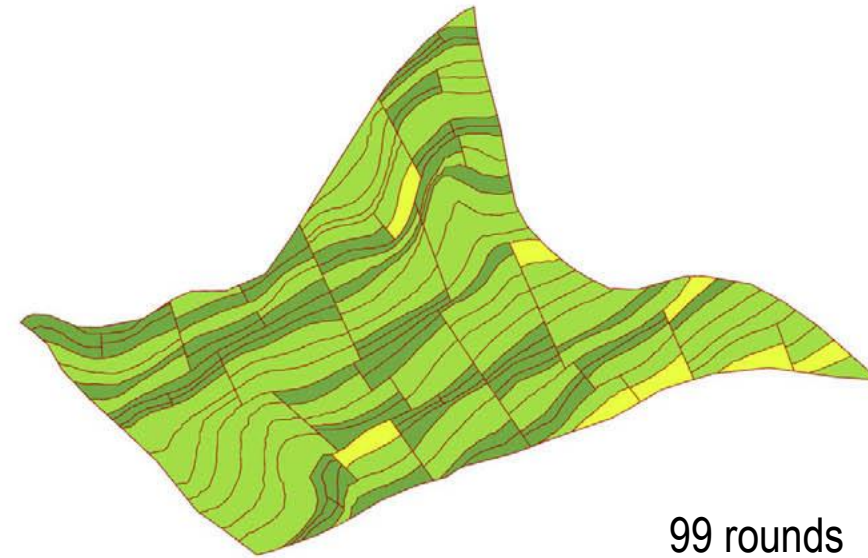
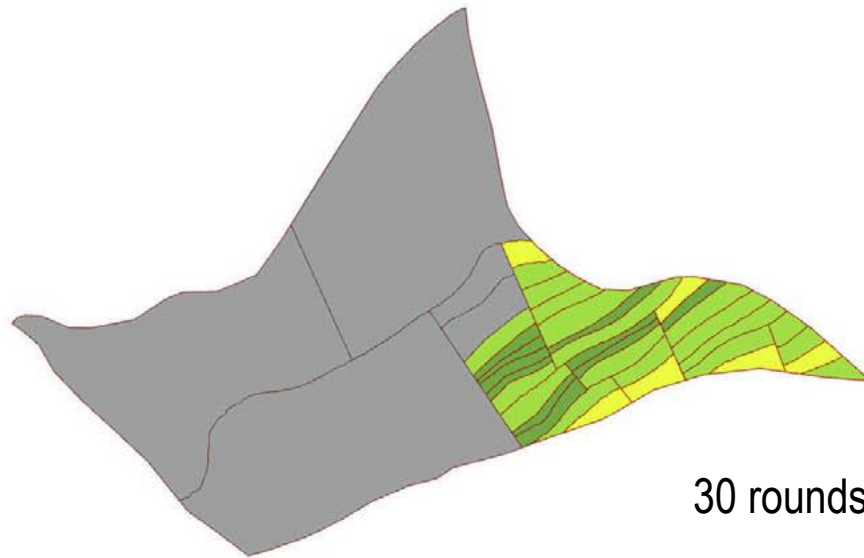
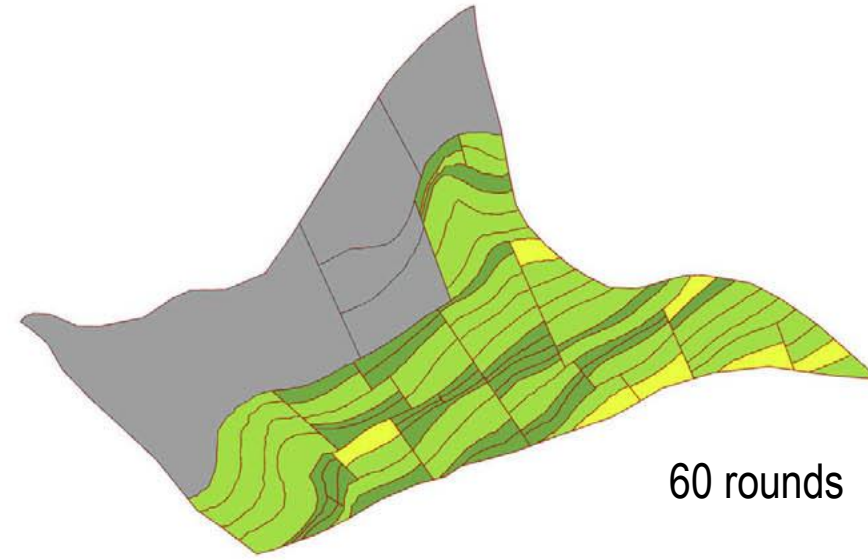
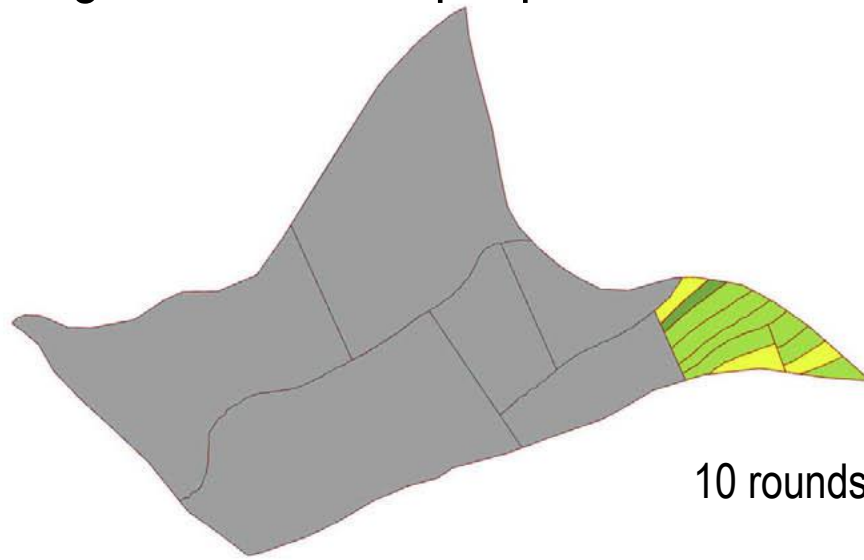
Axonometric

# Overview of three steps in each recursion





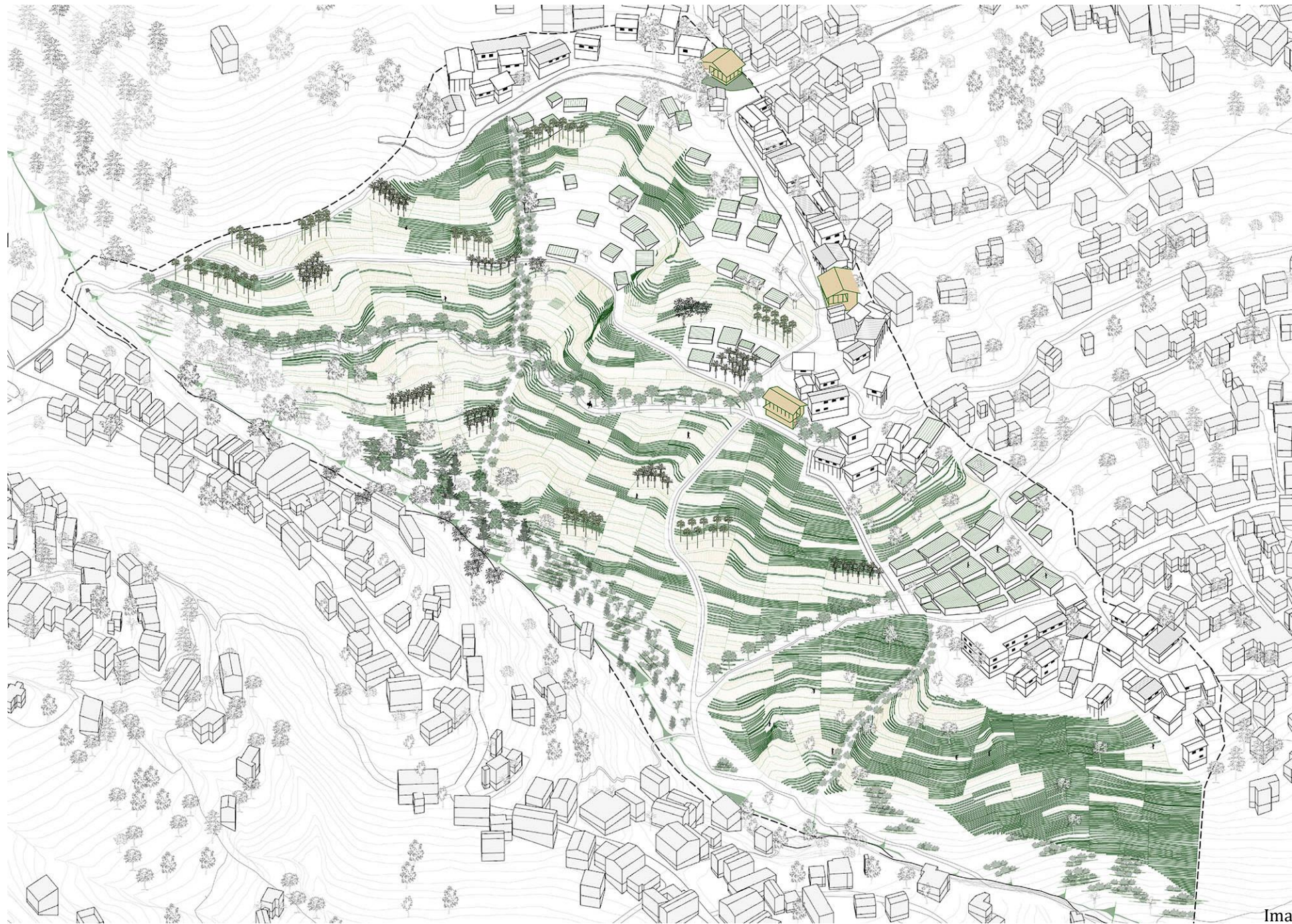
# Progression of algorithm on sample parcel (colored parcels have met exit conditions)



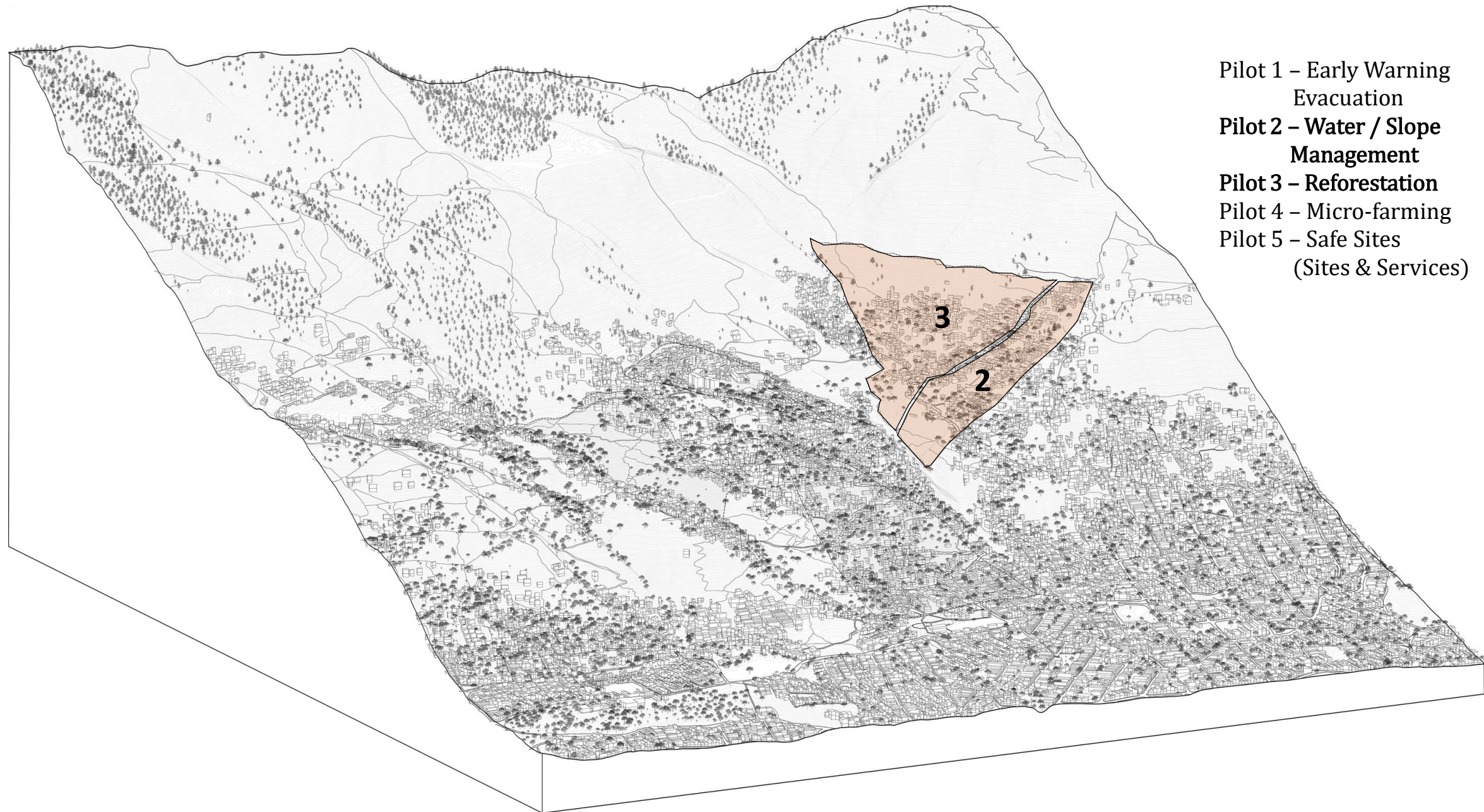
Overall plan view of study site after 684 recursions











- Pilot 1 – Early Warning  
Evacuation
- Pilot 2 – Water / Slope  
Management
- Pilot 3 – Reforestation
- Pilot 4 – Micro-farming
- Pilot 5 – Safe Sites  
(Sites & Services)

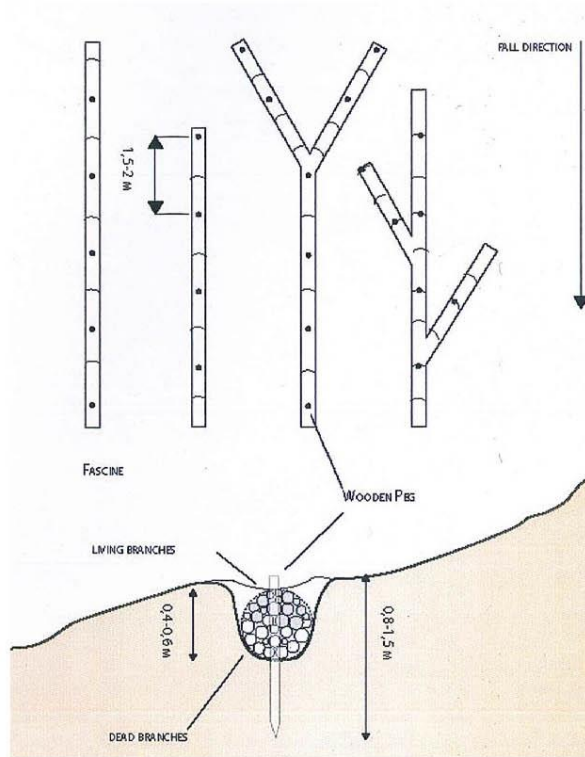




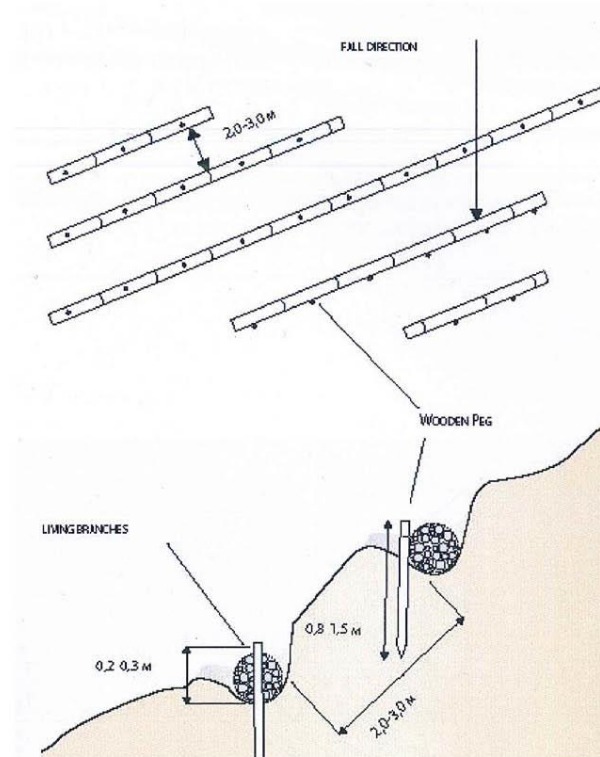
Image: Claghorn, 360



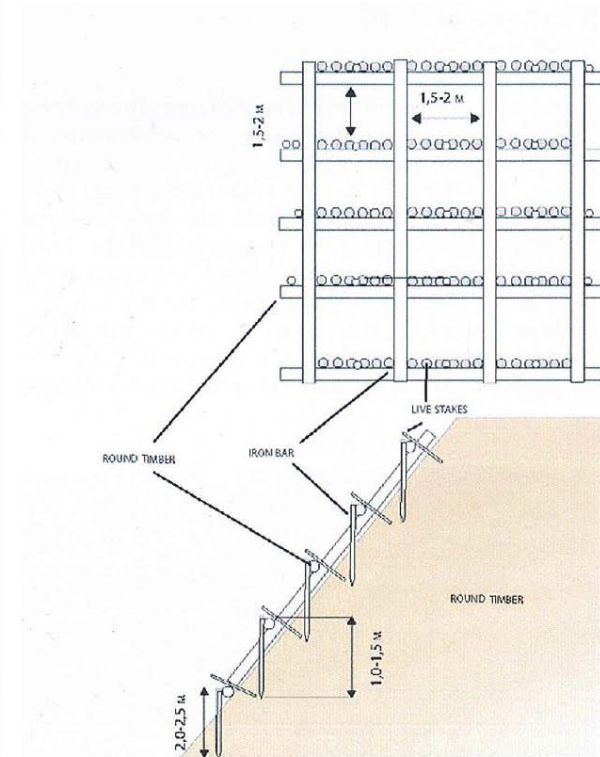
# Three recommended fascine conditions (Studer and Zeh, *Soil Bioengineering*, 2007. 234-235)



Fascine arrangement for 20-50% slope



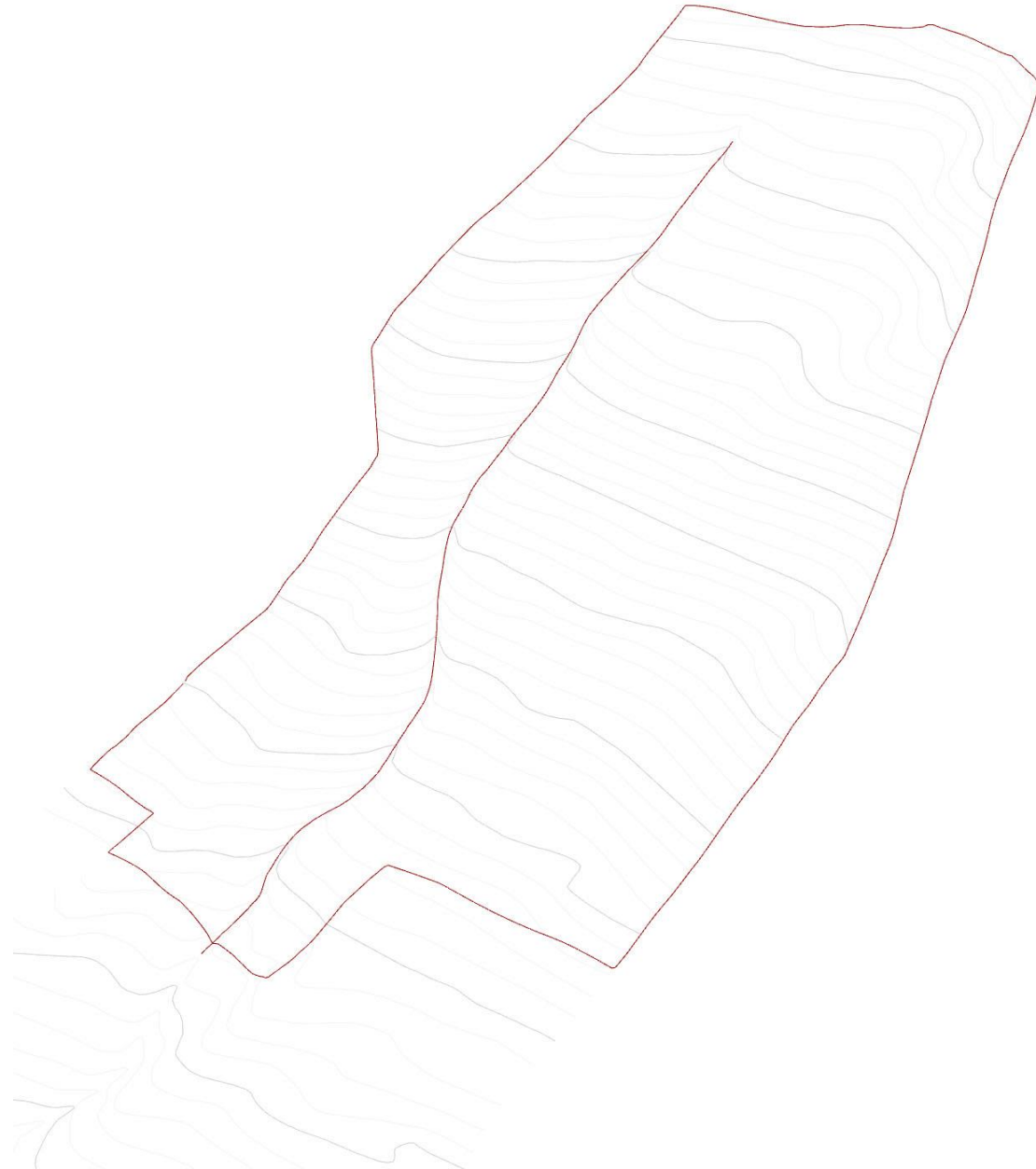
Fascine arrangement for 50-70% slope



Fascine arrangement for 70%+ slope



# Axonometric view of area for slope stabilization (Receiving stream indicated)

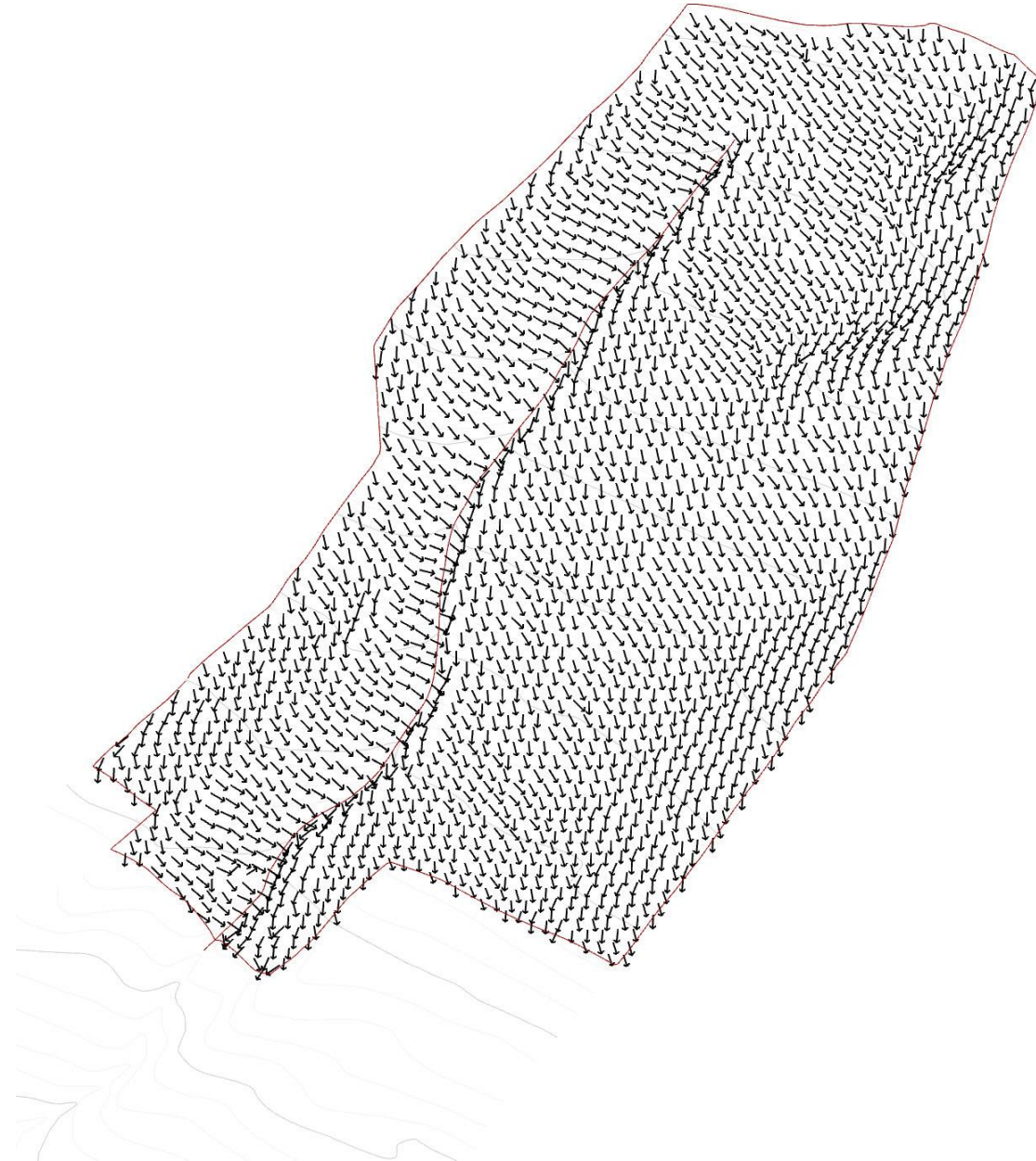


# Slope steepness (Points in 2m grid)

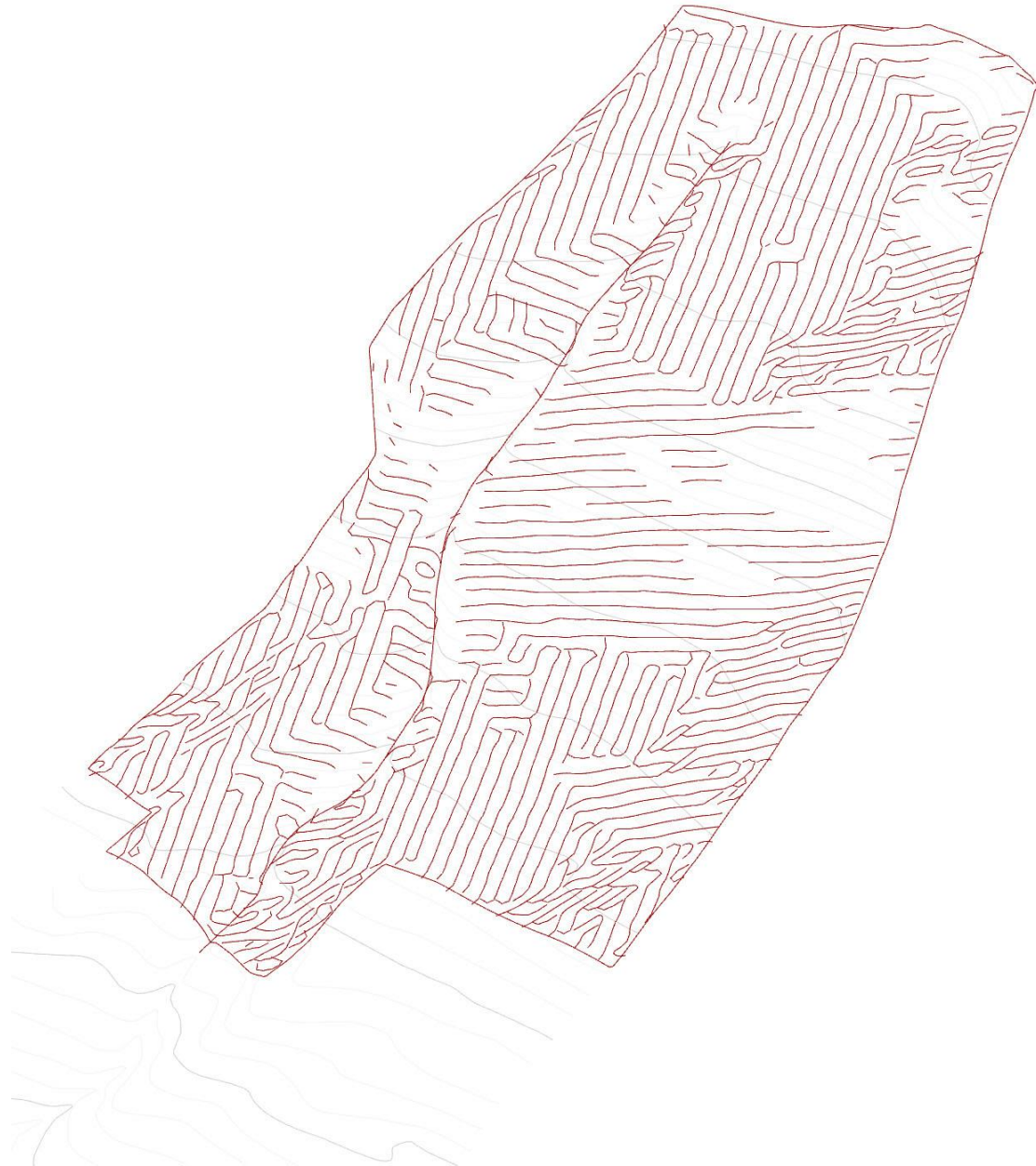




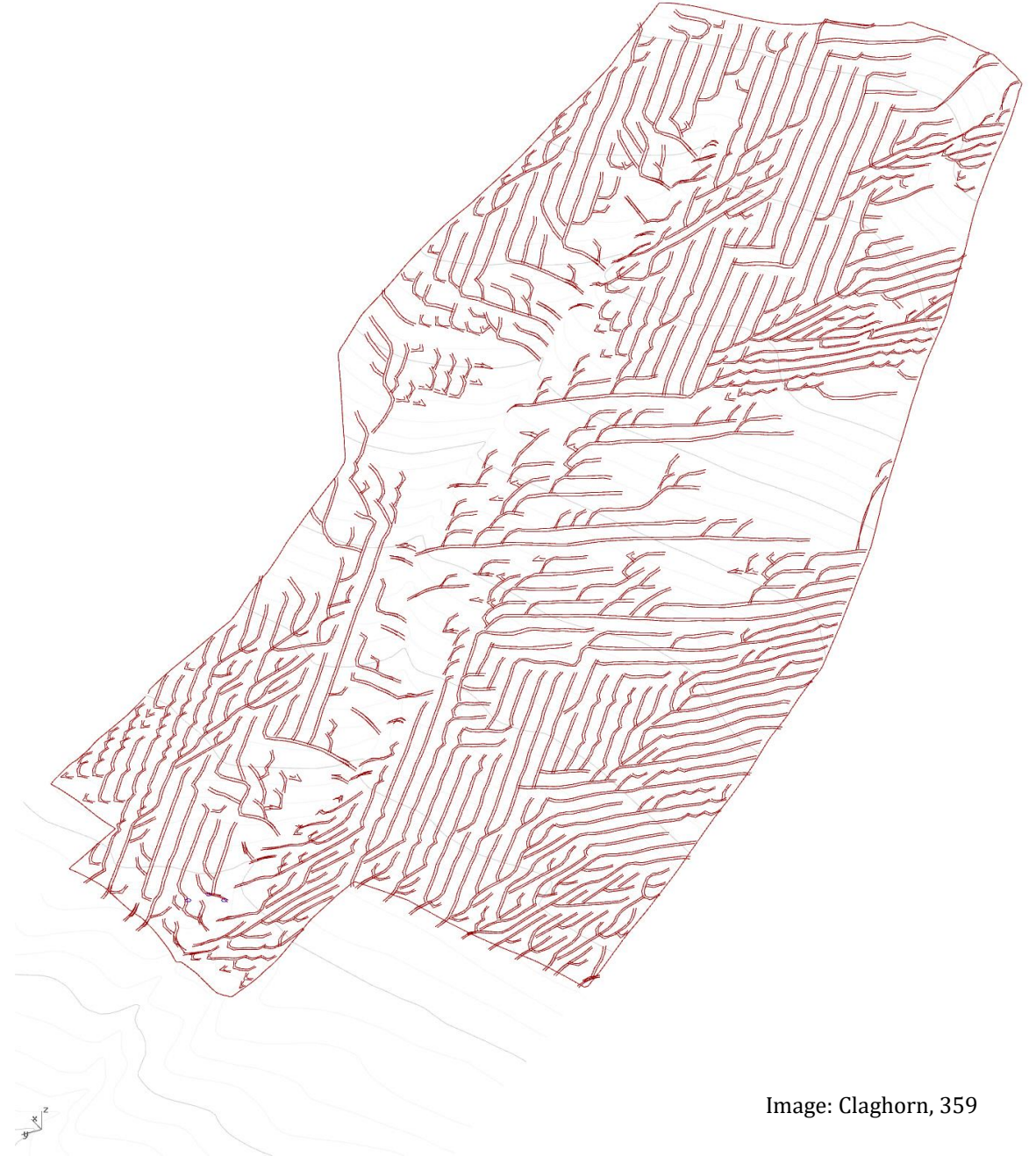
# Downslope drainage vector rotated based on slope steepness



Fascines connected in network – Method 1 Nearest Neighbor



Fascines connected in network – Method 2 Auxin Canalization





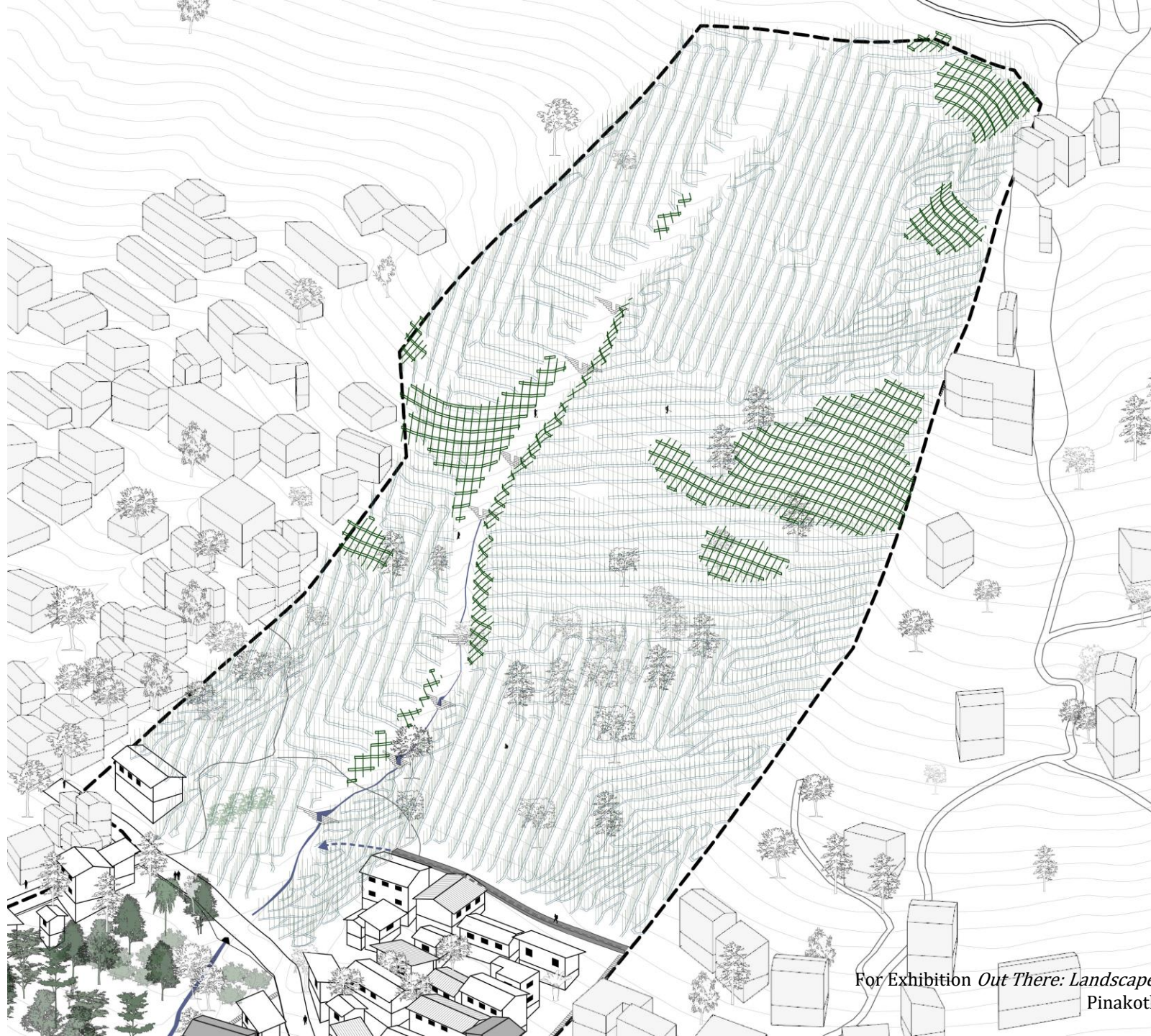


Image: Joseph Claghorn  
For Exhibition *Out There: Landscape Architecture on Global Terrain*  
Pinakothek der Moderne, Munich, 2017





- Pilot 1 – Early Warning  
Evacuation**
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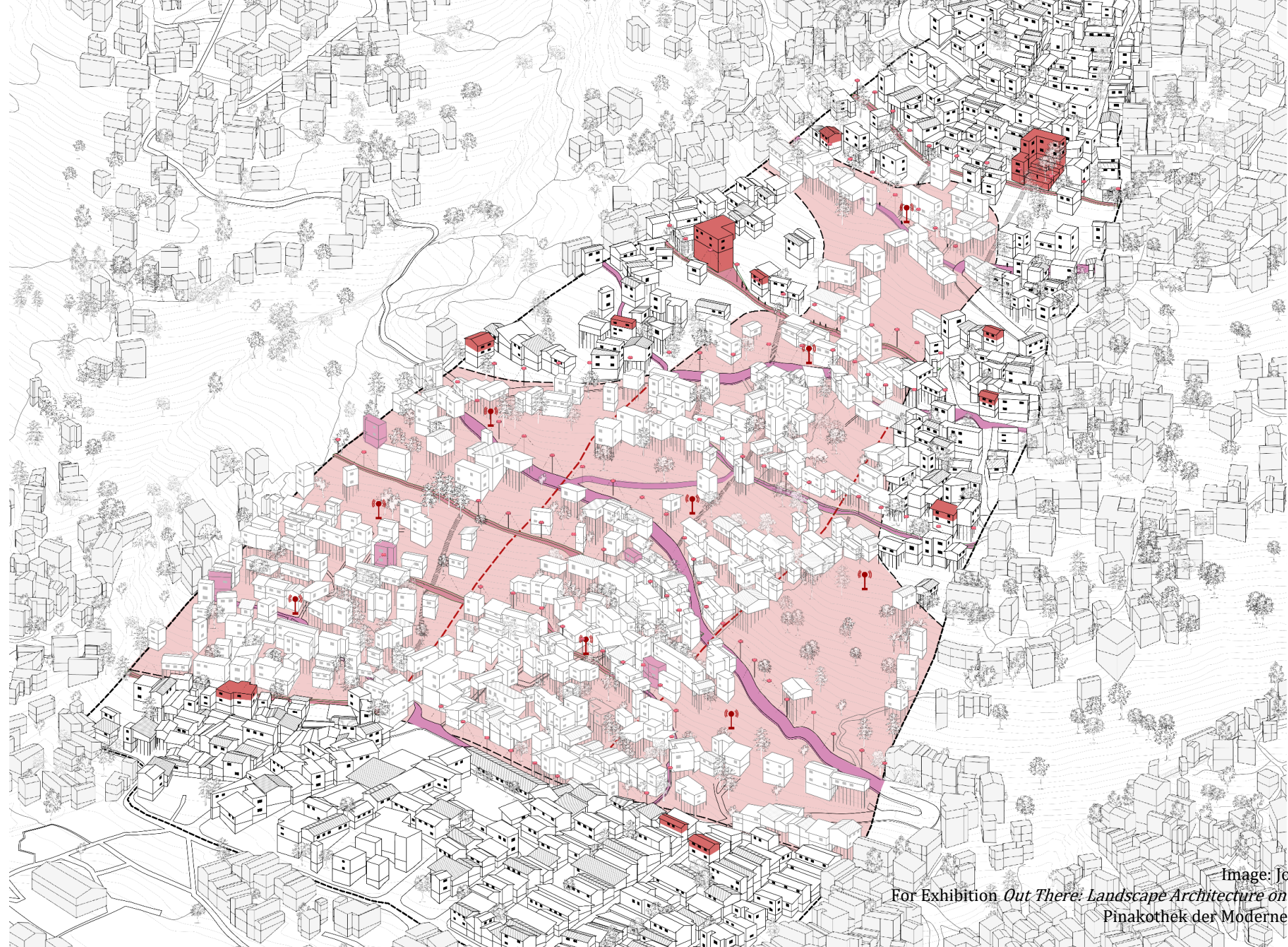


Image: Joseph Claghorn  
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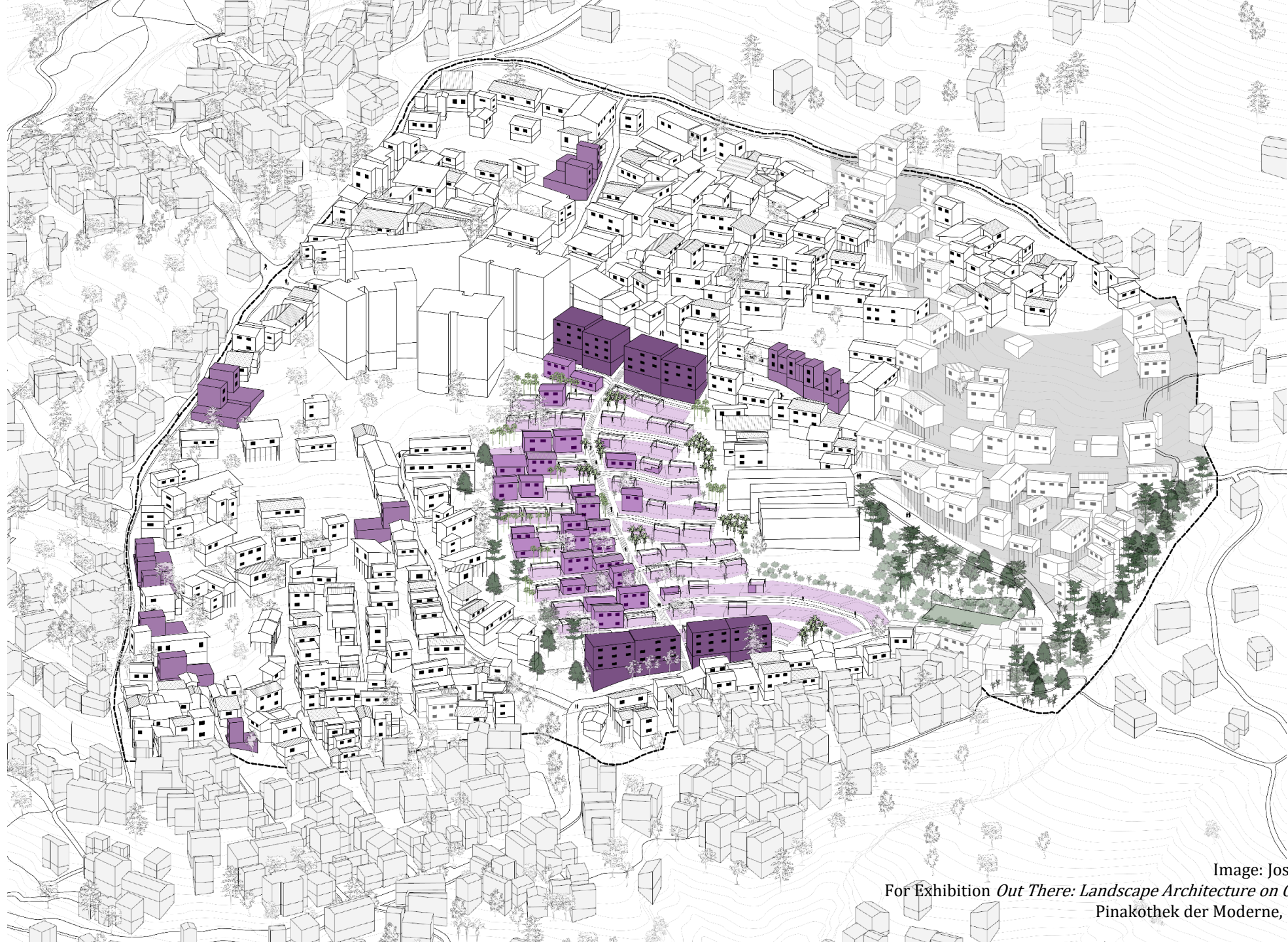


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