

LANDSCAPE DESIGN METHODOLOGY: Pattern formation through the use of Cellular Automata

Abellan Sergi, Bilurbina Marcel, Christodoulou Marilena
DLA May 2019

AELAND //LANDSCAPE ARCHITECTURE
/////////////////////////BARCELONA

// CONCEPT

// SELF - ORGANIZATION



// CONCEPT

// CURRENT DESIGN METHOD

//natural development

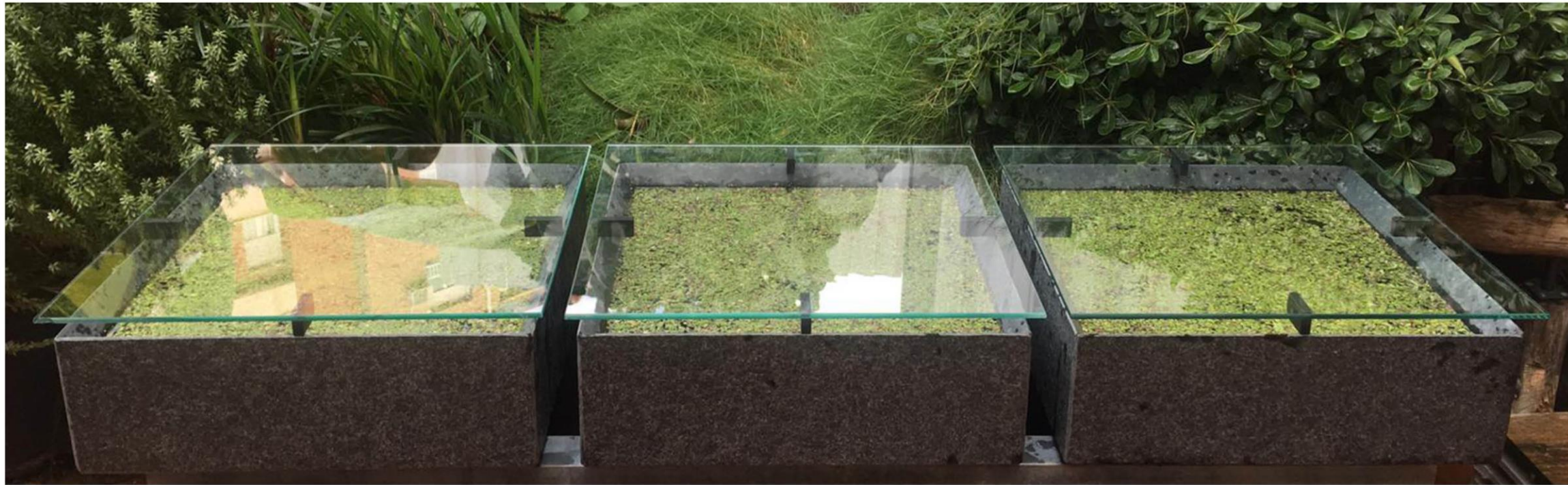


//plantation



// CONCEPT

// RELATION BETWEEN INDIVIDUALS - EXPERIMENT



//azolla caroliniana



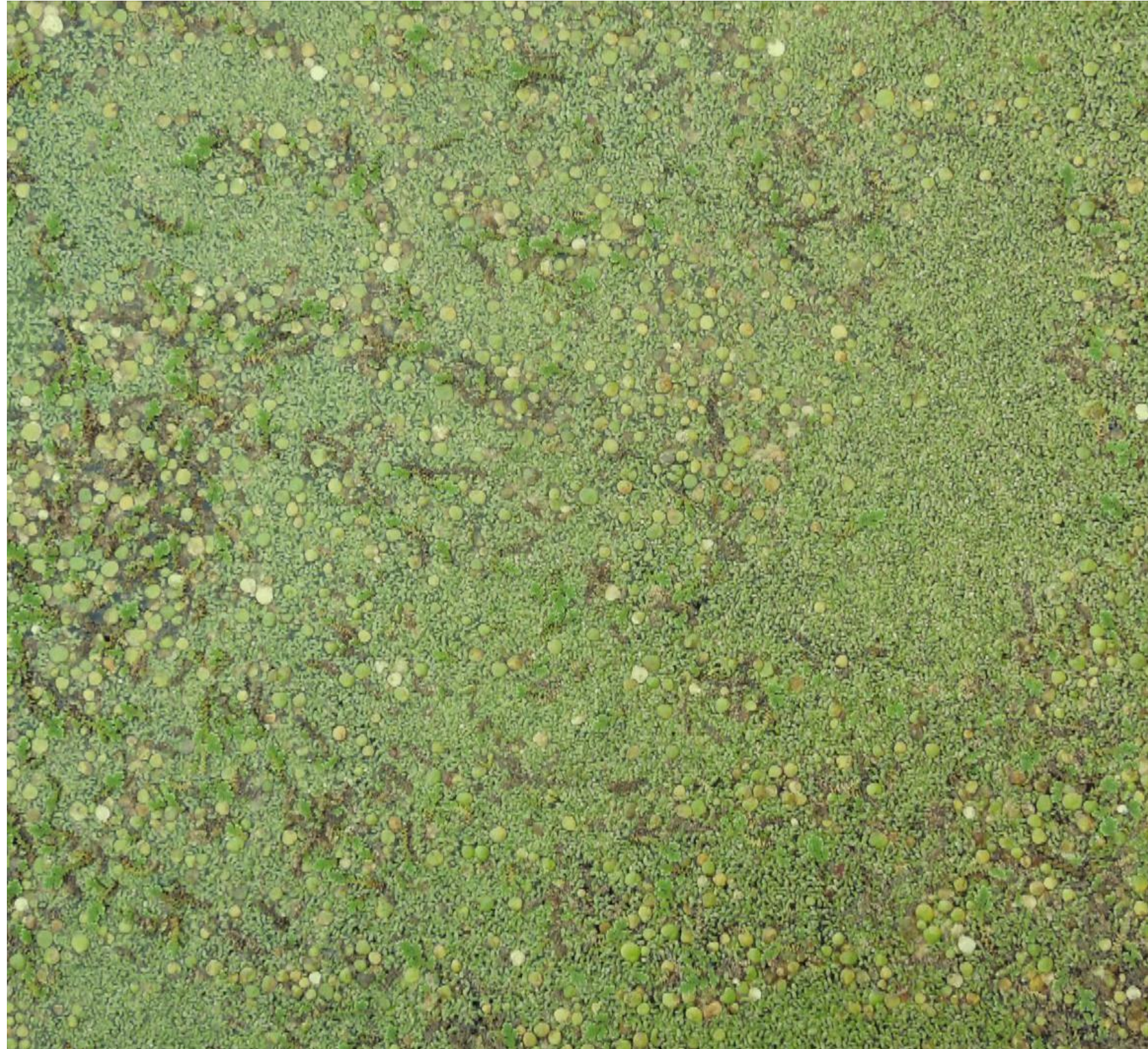
//lemma minor



//spirodela polyrrhiza

// CONCEPT

// RELATION BETWEEN INDIVIDUALS - EXPERIMENT



// CONCEPT

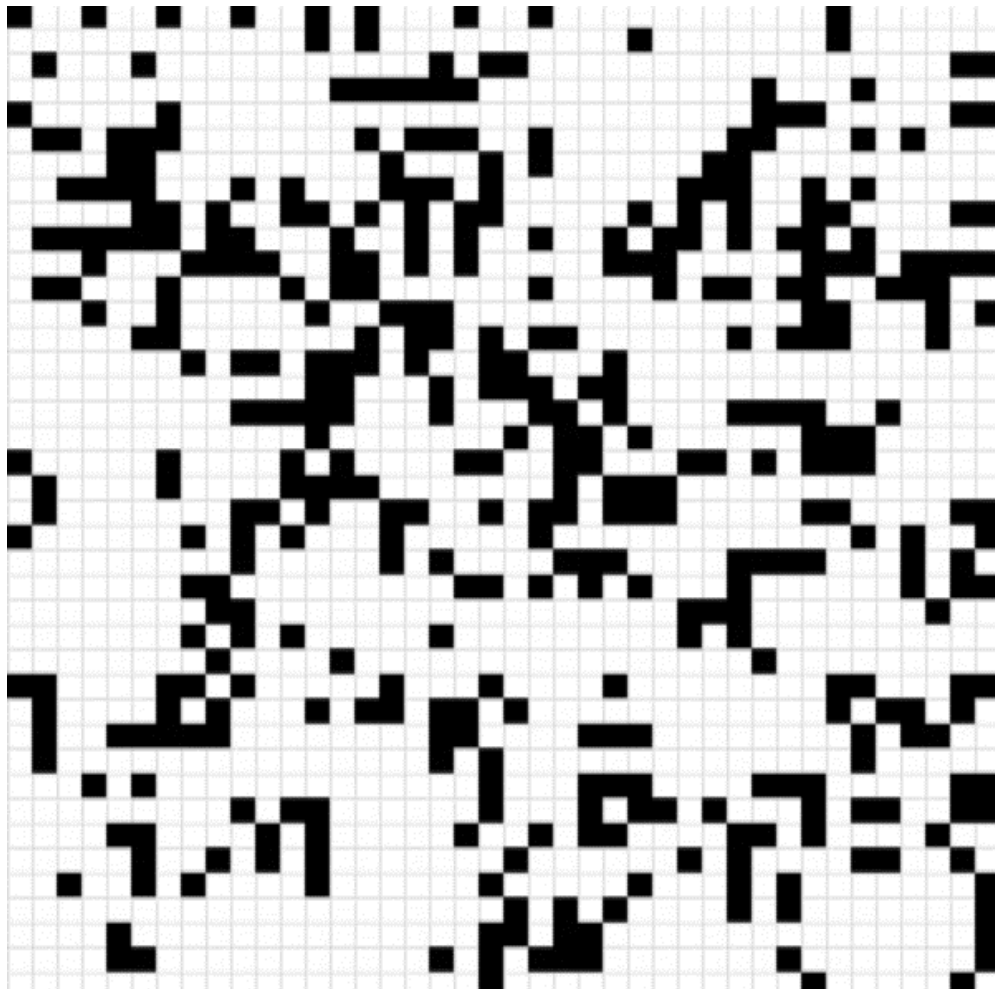
// CELLULAR AUTOMATON - ALGORITHM

			dead neighbor	dead neighbor	dead neighbor			
			dead neighbor	alive	dead neighbor			
			dead neighbor	dead neighbor	dead neighbor			

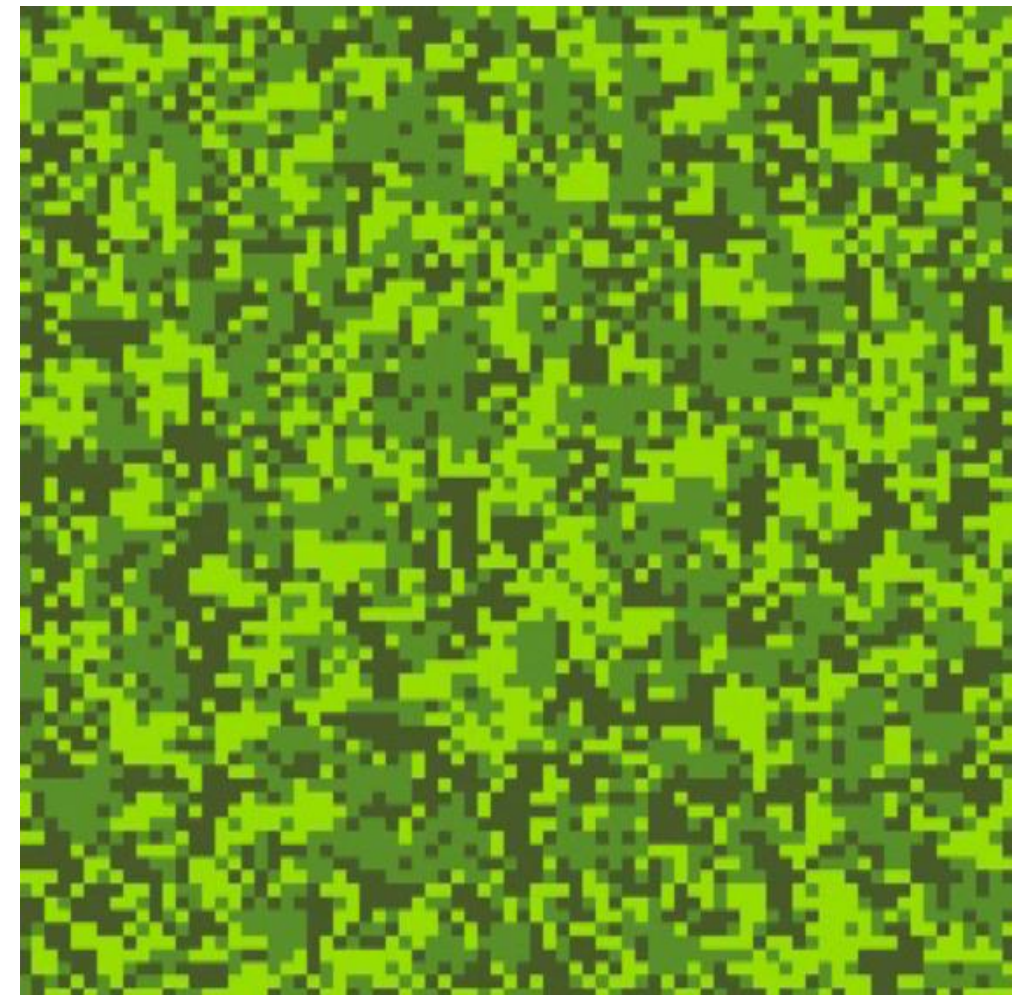
// CONCEPT

// CELLULAR AUTOMATON - ALGORITHM

GOL



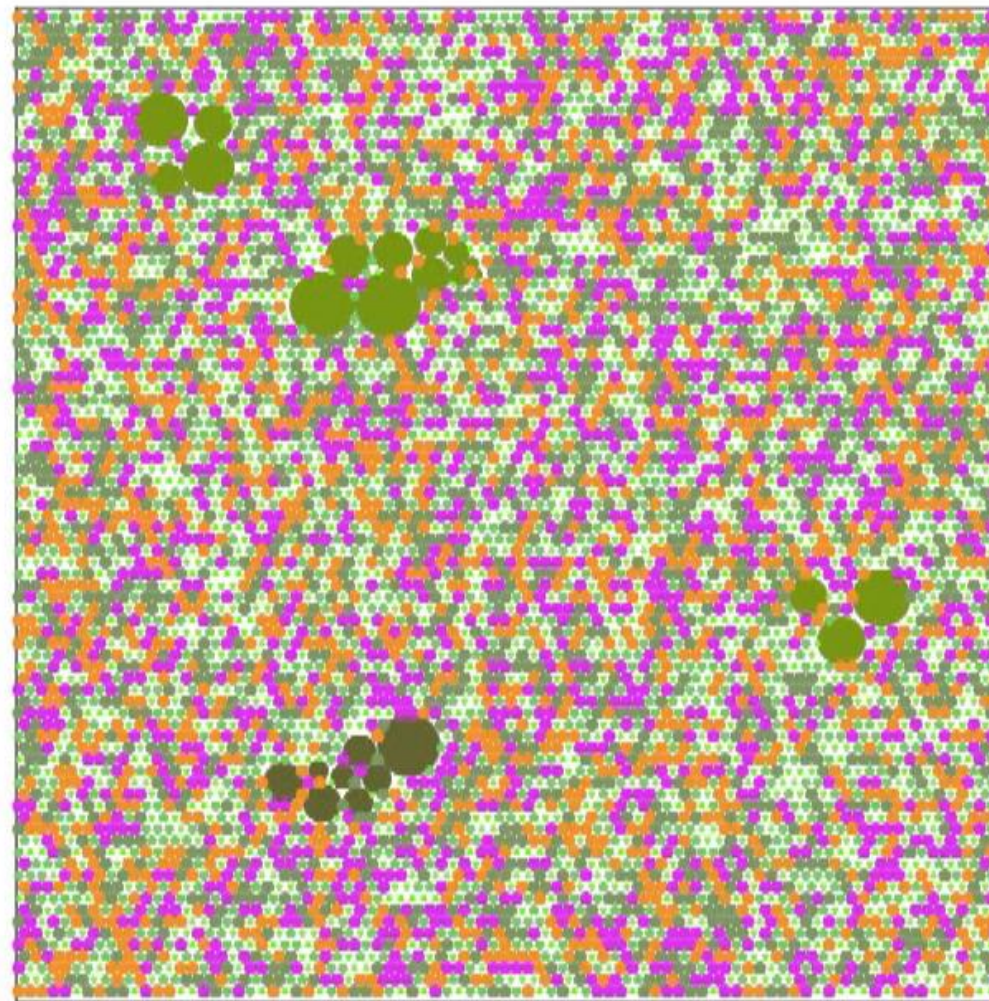
NNB-CA



// CONCEPT

// NNB - CA: NATURAL NEIGHBOURING BEHAVIOUR CELLULAR AUTOMATON . V0

ALLAND LAB
// LANDSCAPE ARCHITECTURE
BARCELONA



TOTAL POPULATION : 8252
GENERATIONS : 0
Evolving species : 5
Preexisting species : 2



Rosmarinus officinalis prostratus
Individuals: 1872



Weibmilla fruticosa
Individuals: 1419



Protea laurifolia
Individuals: 1871



Salvia officinalis
Individuals: 1430



Artemisia 'Fons Capivi'
Individuals: 1438



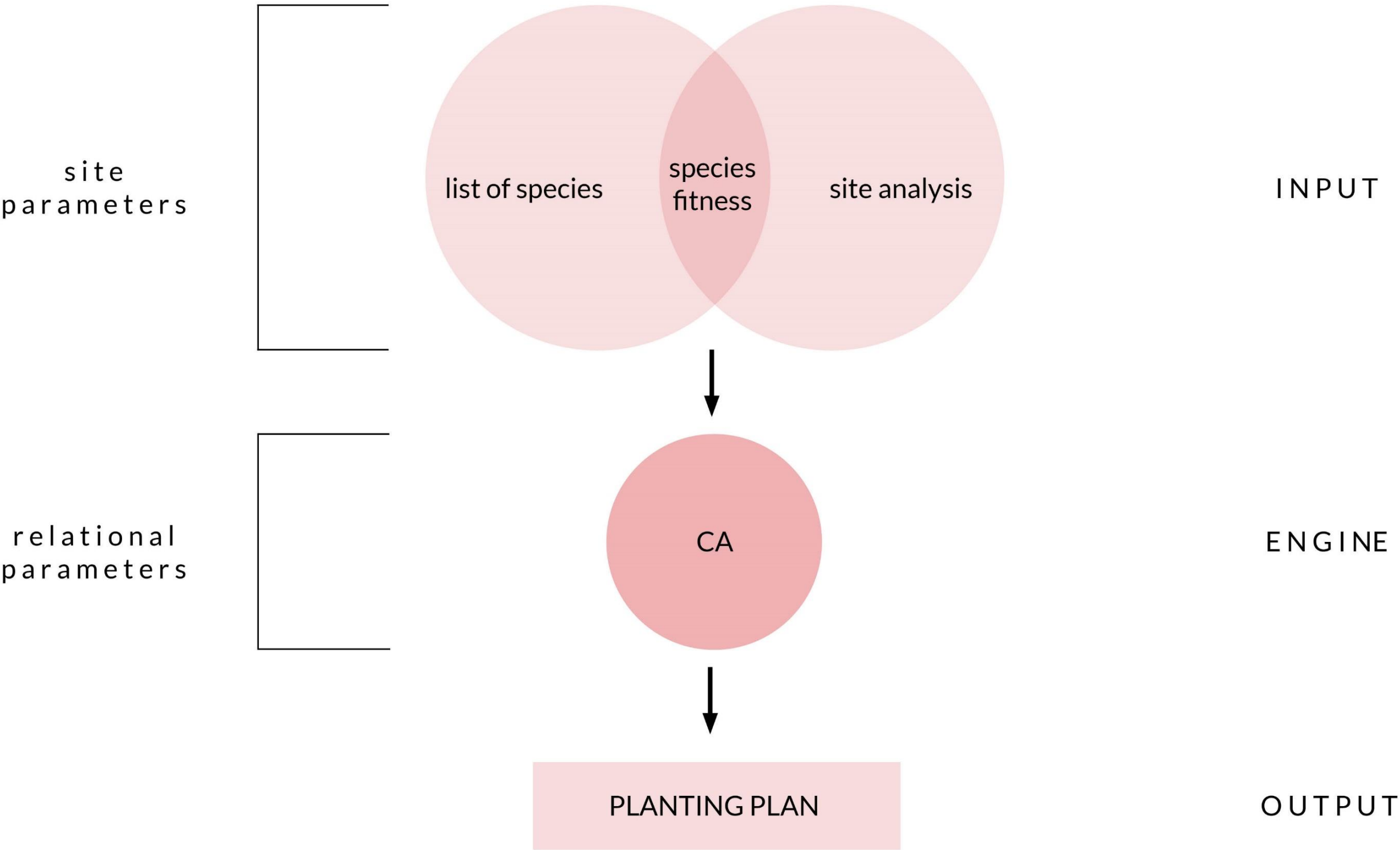
Rosmarinus officinalis
Preexisting Individuals



Juniperus phoenicea
Preexisting Individuals

// DESIGN PROCESS

// NNB - CA: NATURAL NEIGHBOURING BEHAVIOUR CELLULAR AUTOMATON



// DESIGN PROCESS

// PRESELECTION - LIST OF SPECIES



Rosmarinus officinalis



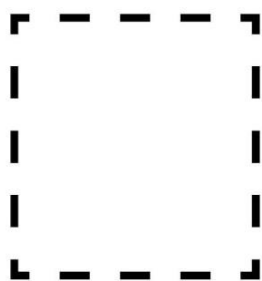
Hedera helix



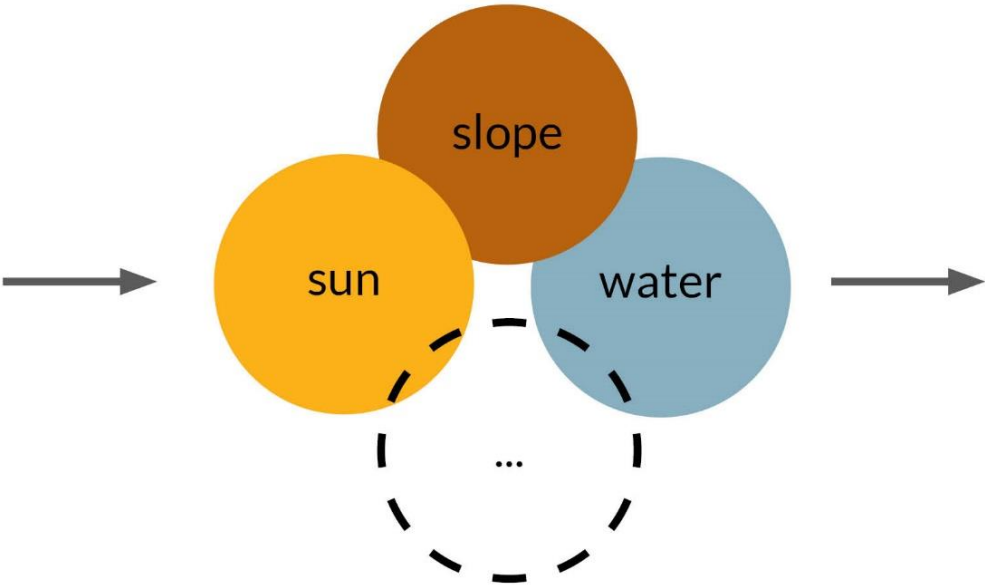
Iris pseudoacorus



Pistacia lentiscus



...



	min	max
0. <i>Rosmarinus officinalis</i>	2	10
1. <i>Hedera helix</i>	0	6
2. <i>Iris pseudoacorus</i>	1	8
3. ...	...	...

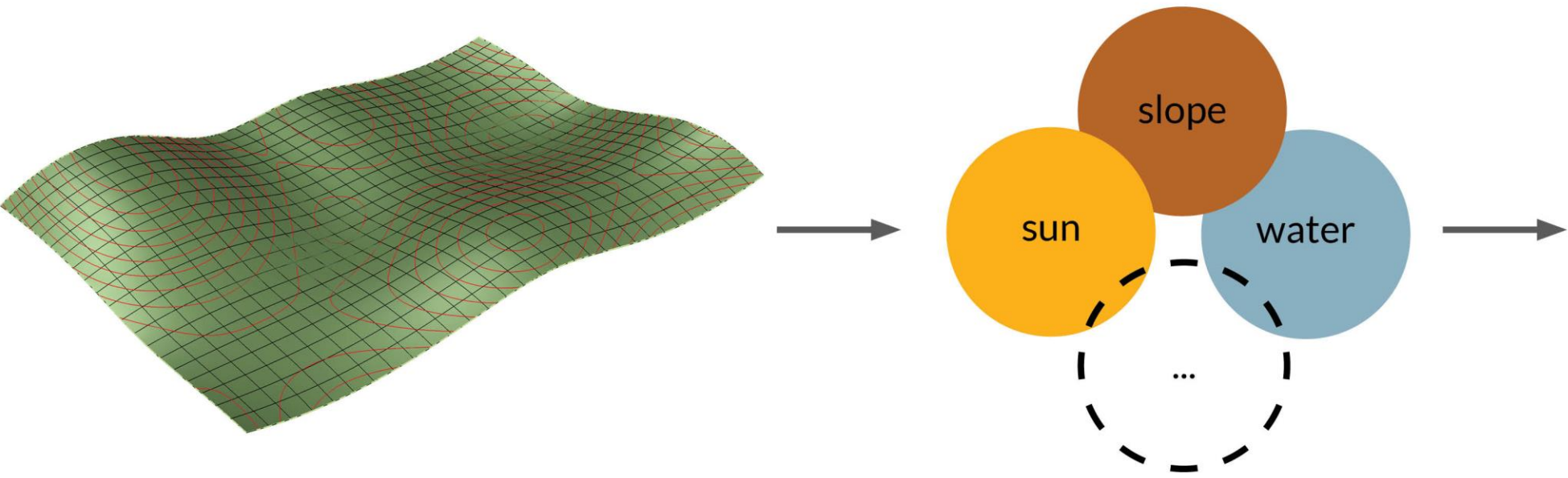
	min	max
0. <i>Rosmarinus officinalis</i>	2	8
1. <i>Hedera helix</i>	0	10
2. <i>Iris pseudoacorus</i>	0	6
3. ...	...	...

	min	max
0. <i>Rosmarinus officinalis</i>	0	6
1. <i>Hedera helix</i>	2	7
2. <i>Iris pseudoacorus</i>	2	6
3. ...	...	...

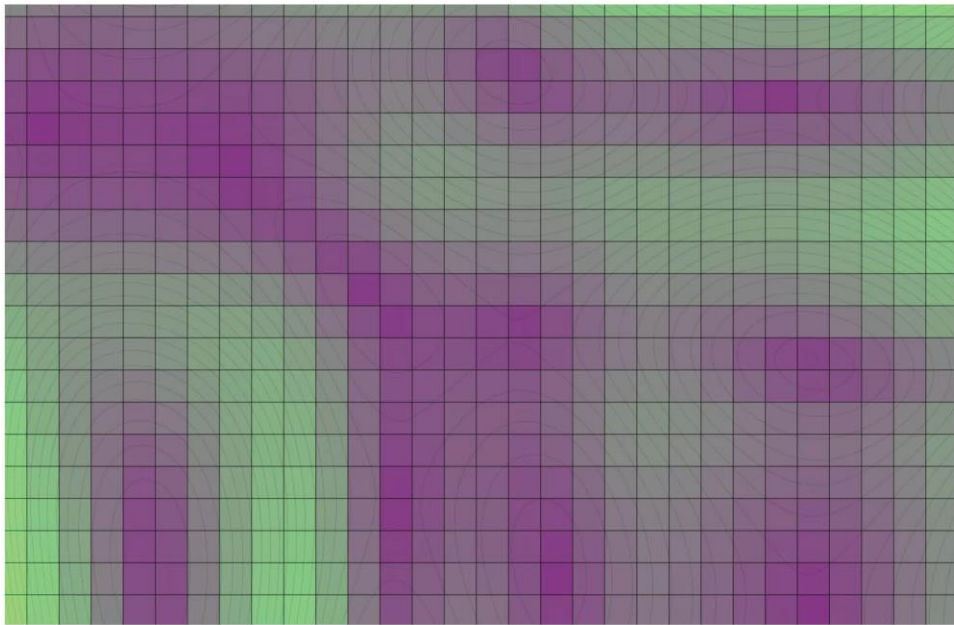
	min	max
0. <i>Rosmarinus officinalis</i>	...	...
1. <i>Hedera helix</i>	...	...
2. <i>Iris pseudoacorus</i>	...	...
3. ...	...	...

// DESIGN PROCESS

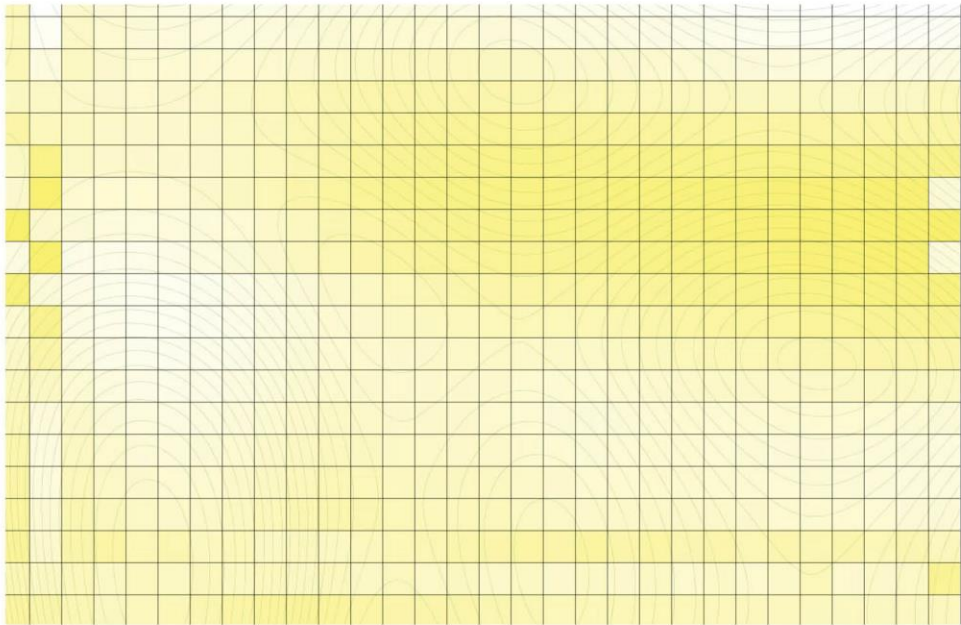
// PRESELECTION - SITE ANALYSIS



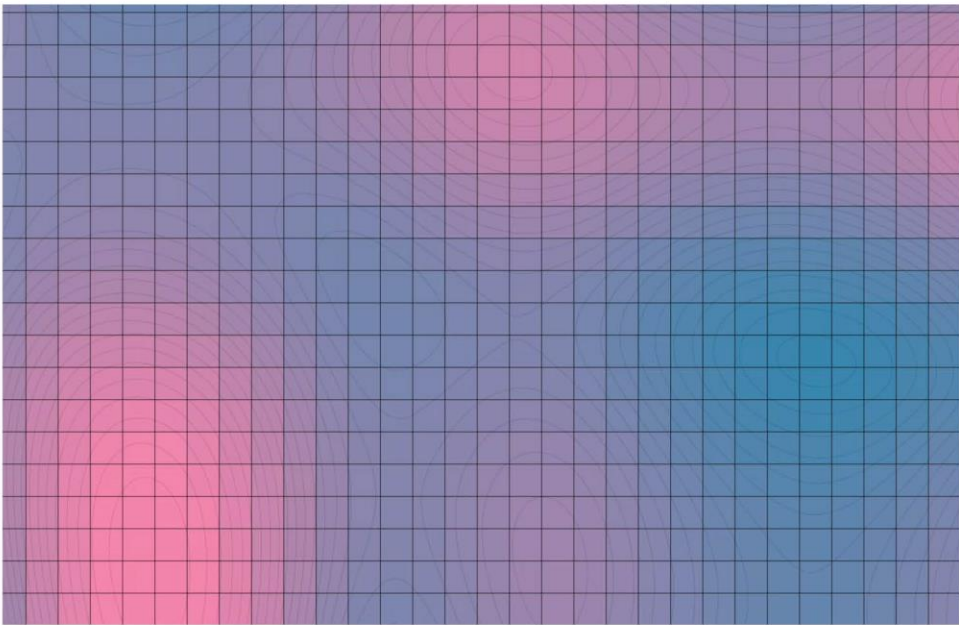
sun: 5 slope: 4 water: 5	sun: 2 slope: 3 water: 3	sun: 7 slope: 4 water: 5	sun: 7 slope: 5 water: 3	sun: 2 slope: 3 water: 6
sun: 4 slope: 2 water: 5	sun: 5 slope: 4 water: 5	sun: 3 slope: 4 water: 7	sun: 8 slope: 3 water: 3	sun: 3 slope: 5 water: 7
sun: 9 slope: 3 water: 6	sun: 7 slope: 4 water: 5	sun: 2 slope: 3 water: 3	sun: 5 slope: 4 water: 5	sun: 4 slope: 2 water: 5
sun: 5 slope: 4 water: 5	sun: 2 slope: 3 water: 3	sun: 4 slope: 2 water: 5	sun: 7 slope: 5 water: 3	sun: 6 slope: 2 water: 5
sun: 2 slope: 3 water: 6	sun: 8 slope: 5 water: 7	sun: 7 slope: 4 water: 5	sun: 3 slope: 5 water: 7	sun: 5 slope: 4 water: 5



// slope



// sun



// water

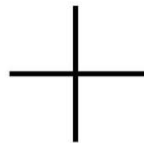
// DESIGN PROCESS

// PRESELECTION - SPECIES FITNESS

	min	max
0. <i>Rosmarius officinalis</i>	2	10
1. <i>Hedera helix</i>	0	6
2. <i>Iris pseudoacorus</i>	1	8
3. ...	...	...

	min	max
0. <i>Rosmarius officinalis</i>	2	8
1. <i>Hedera helix</i>	0	10
2. <i>Iris pseudoacorus</i>	0	6
3. ...	...	...

	min	max
0. <i>Rosmarius officinalis</i>	0	6
1. <i>Hedera helix</i>	2	7
2. <i>Iris pseudoacorus</i>	2	6
3. ...	...	...

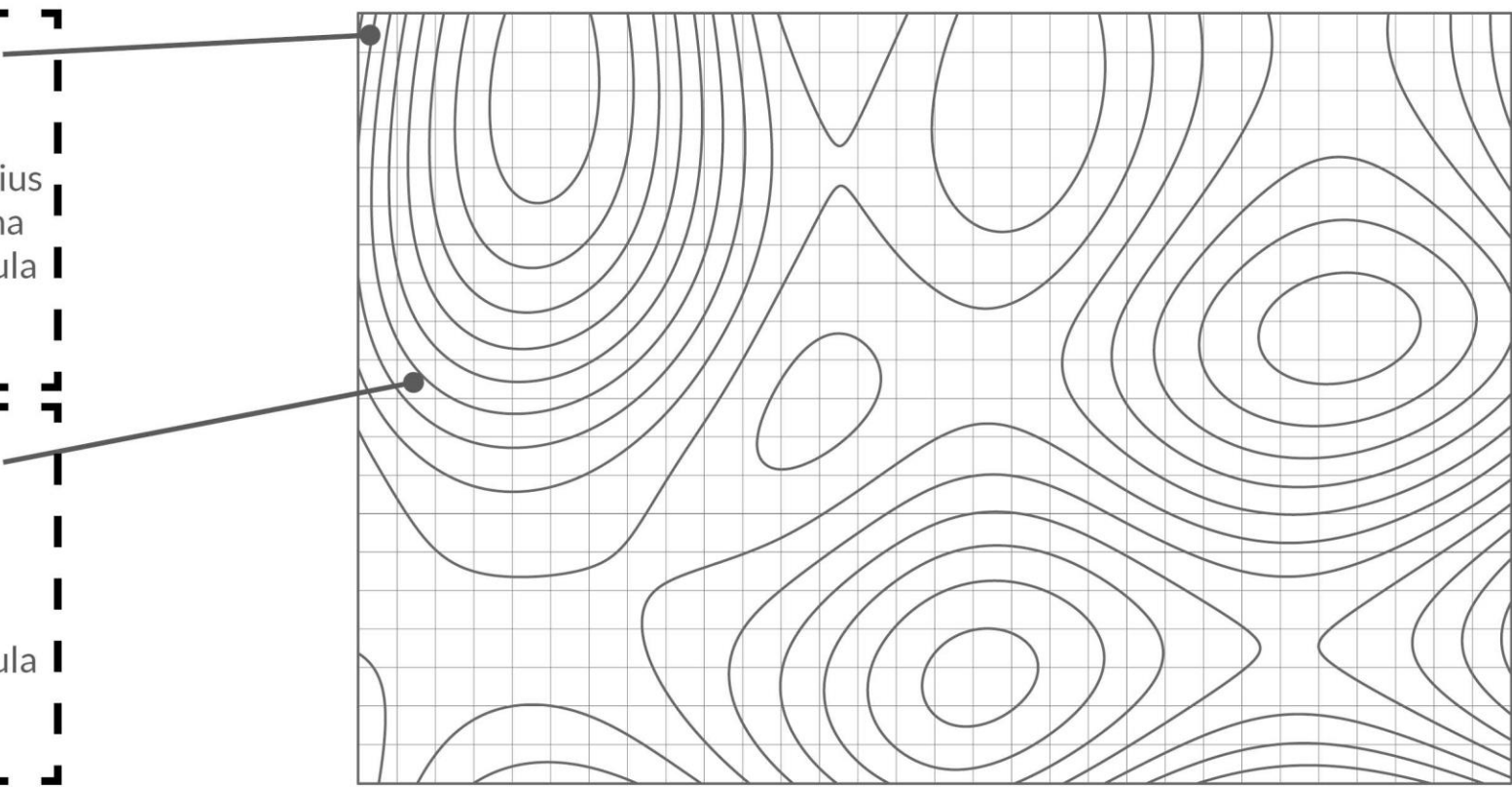


sun: 5 slope: 4 water: 5	sun: 2 slope: 3 water: 3	sun: 7 slope: 4 water: 5	sun: 7 slope: 5 water: 3	sun: 2 slope: 3 water: 6
sun: 4 slope: 2 water: 5	sun: 5 slope: 4 water: 5	sun: 3 slope: 4 water: 7	sun: 8 slope: 3 water: 3	sun: 3 slope: 5 water: 7
sun: 9 slope: 3 water: 6	sun: 7 slope: 4 water: 5	sun: 2 slope: 3 water: 3	sun: 5 slope: 4 water: 5	sun: 4 slope: 2 water: 5
sun: 5 slope: 4 water: 5	sun: 2 slope: 3 water: 3	sun: 4 slope: 2 water: 5	sun: 7 slope: 5 water: 3	sun: 6 slope: 2 water: 5
sun: 2 slope: 3 water: 6	sun: 8 slope: 5 water: 7	sun: 7 slope: 4 water: 5	sun: 3 slope: 5 water: 7	sun: 5 slope: 4 water: 5



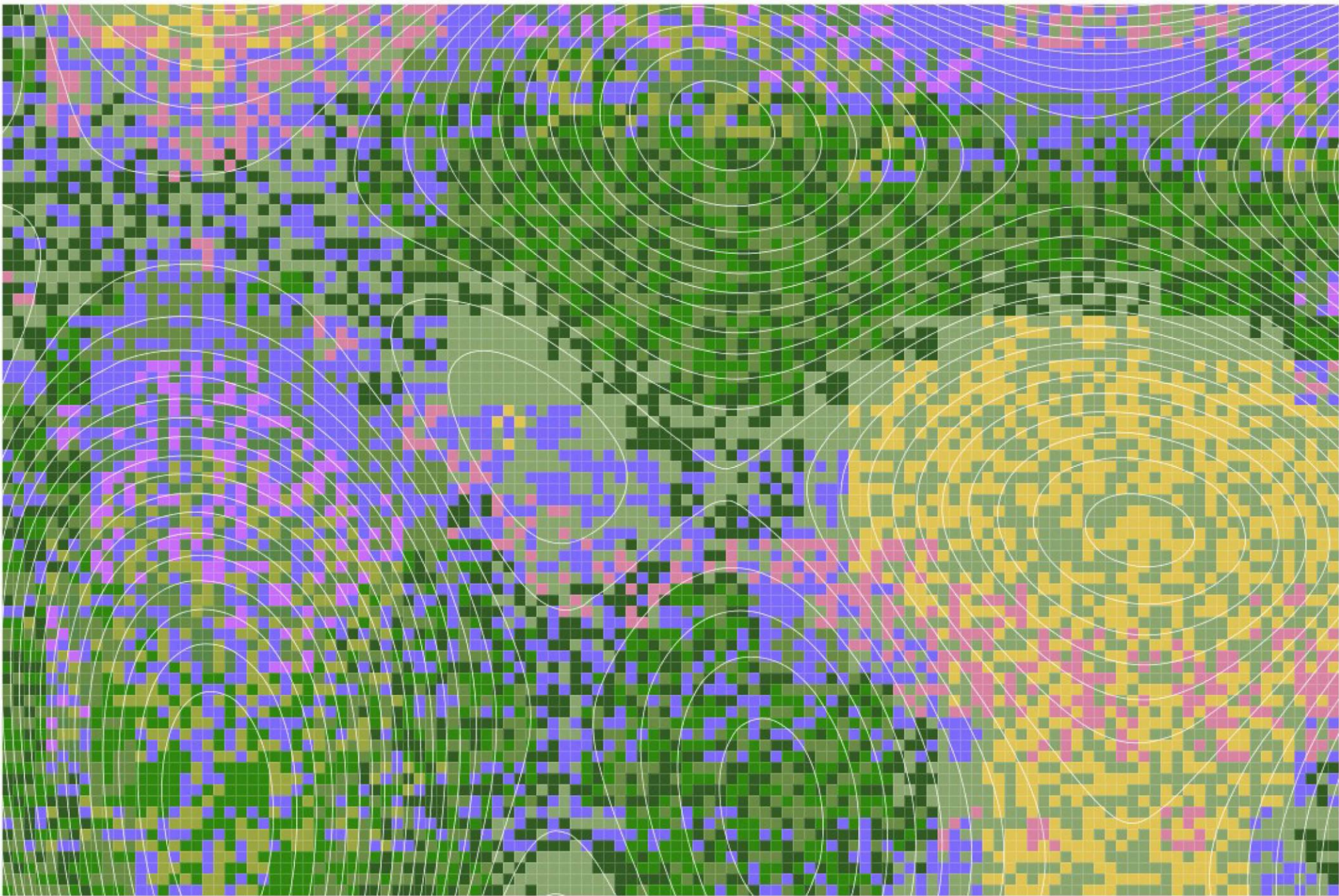
0. <i>Rosmarius</i> 4. <i>Santolina</i> 5. <i>Lavandula</i>	2. <i>Viburnum</i> 4. <i>Santolina</i> 6. <i>Arbutus</i> 8. <i>Scirpus</i>	5. <i>Lavandula</i> 7. <i>Salvia</i>	0. <i>Rosmarius</i> 4. <i>Santolina</i> 5. <i>Lavandula</i>	1. <i>Hedera</i> 4. <i>Santolina</i> 7. <i>Salvia</i>
1. <i>Hedera</i> 3. <i>Iris</i> 4. <i>Santolina</i> 8. <i>Scirpus</i>	0. <i>Rosmarius</i> 5. <i>Lavandula</i>	8. <i>Scirpus</i>	0. <i>Rosmarius</i> 1. <i>Hedera</i> 9. <i>Nerium</i>	3. <i>Iris</i> 4. <i>Santolina</i>
4. <i>Santolina</i> 6. <i>Arbutus</i>	2. <i>Viburnum</i> 4. <i>Santolina</i> 7. <i>Salvia</i>	1. <i>Hedera</i> 4. <i>Santolina</i> 6. <i>Arbutus</i> 8. <i>Scirpus</i>	4. <i>Santolina</i>	4. <i>Santolina</i> 5. <i>Lavandula</i>
1. <i>Hedera</i> 2. <i>Viburnum</i> 4. <i>Santolina</i> 5. <i>Lavandula</i>	3. <i>Iris</i> 4. <i>Santolina</i>	3. <i>Iris</i> 4. <i>Santolina</i> 5. <i>Lavandula</i>	5. <i>Lavandula</i>	1. <i>Hedera</i> 4. <i>Santolina</i> 6. <i>Arbutus</i> 8. <i>Scirpus</i>
2. <i>Viburnum</i> 4. <i>Santolina</i> 5. <i>Lavandula</i> 6. <i>Arbutus</i> 8. <i>Scirpus</i>	4. <i>Santolina</i> 5. <i>Lavandula</i> 6. <i>Arbutus</i>	0. <i>Rosmarius</i> 4. <i>Santolina</i> 5. <i>Lavandula</i>	2. <i>Viburnum</i> 4. <i>Santolina</i> 7. <i>Salvia</i>	0. <i>Rosmarius</i> 4. <i>Santolina</i> 5. <i>Lavandula</i>

Cell 0:
sun: 5 0. <i>Rosmarius</i>
slope: 4 4. <i>Santolina</i>
water: 5 5. <i>Lavandula</i>
Cell 272:
sun: 9 1. <i>Hedera</i>
slope: 4 2. <i>Iris</i>
water: 6 5. <i>Lavandula</i>
7. <i>Salvia</i>



// DESIGN PROCESS

// PRESELECTION - CA - INITIAL RANDOM POPULATION



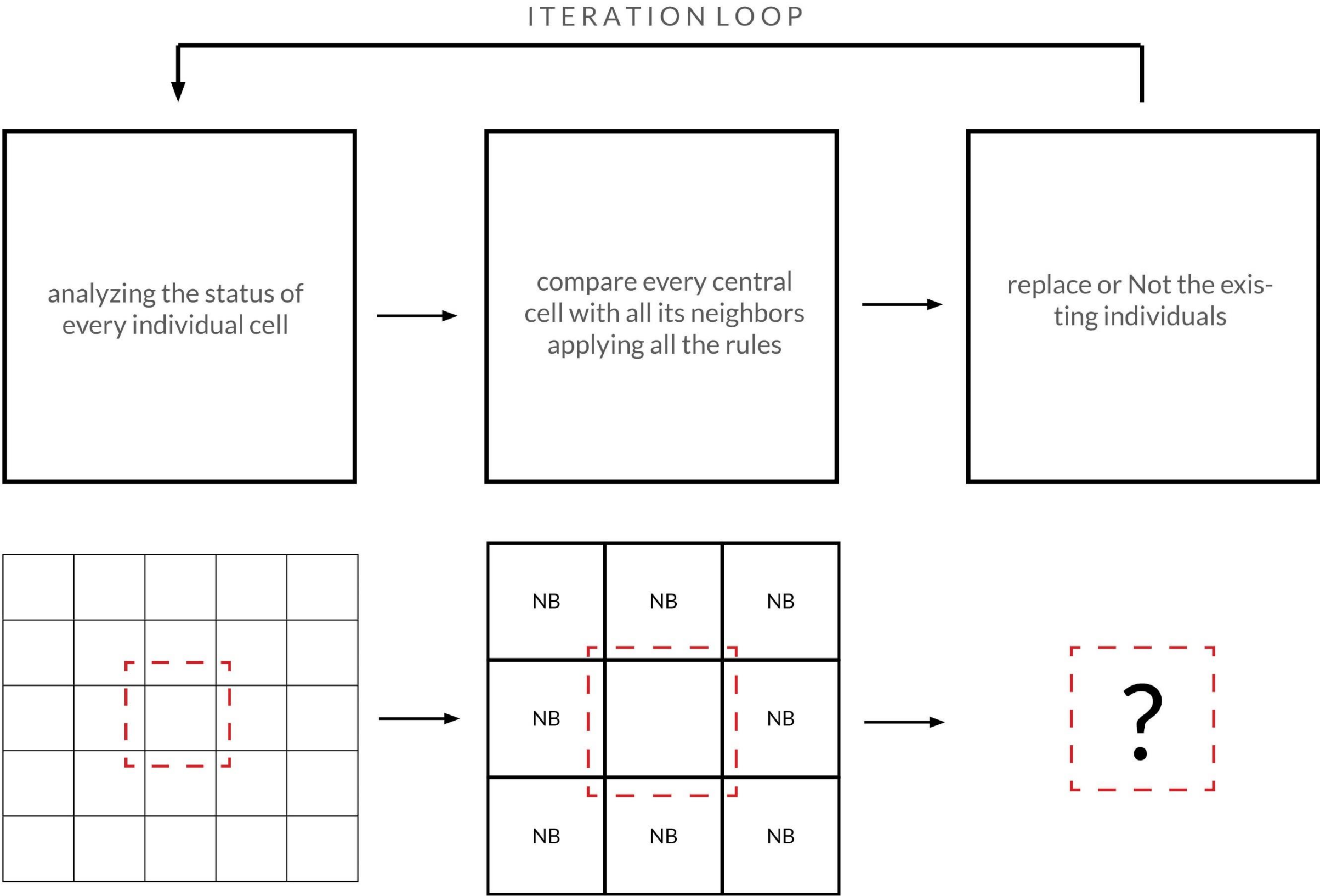
SPECIES	INDIVIDUALS	
Rosmarinus officinalis	308	
Hedera helix	1362	
Viburnum tinus	1158	
Iris pseudoacorus	852	
Santolina chamaecyparissus	375	
Lavandula dentata	231	
Arbutus unedo	1240	
Salvia officinalis	1714	
Scirpus holoschoenus	1896	
Nerium oleander	464	
TOTAL POPULATION :		2400
GENERATIONS :		
CELL : [60][40]		
EXPOSITION :		5,32
SLOPE :		2,62
WATER :		6,39

Hedera helix	Hedera helix	Hedera helix
Health : 3,04	Health : 3,54	Health : 3,54
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,23	Opposition : 0,23	Opposition : 0,23
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00
Scirpus holoschoenus	Hedera helix	Hedera helix
Health : 4,85	Health : 1,96	Health : 1,96
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,13	Opposition : 0,23	Opposition : 0,23
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00
Scirpus holoschoenus	Scirpus holoschoenus	Hedera helix
Health : 4,85	Health : 4,35	Health : 1,96
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,13	Opposition : 0,13	Opposition : 0,23
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00

NNB//CA. NATURAL NEIGHBOUR BEHAVIOUR CA. 2019.05

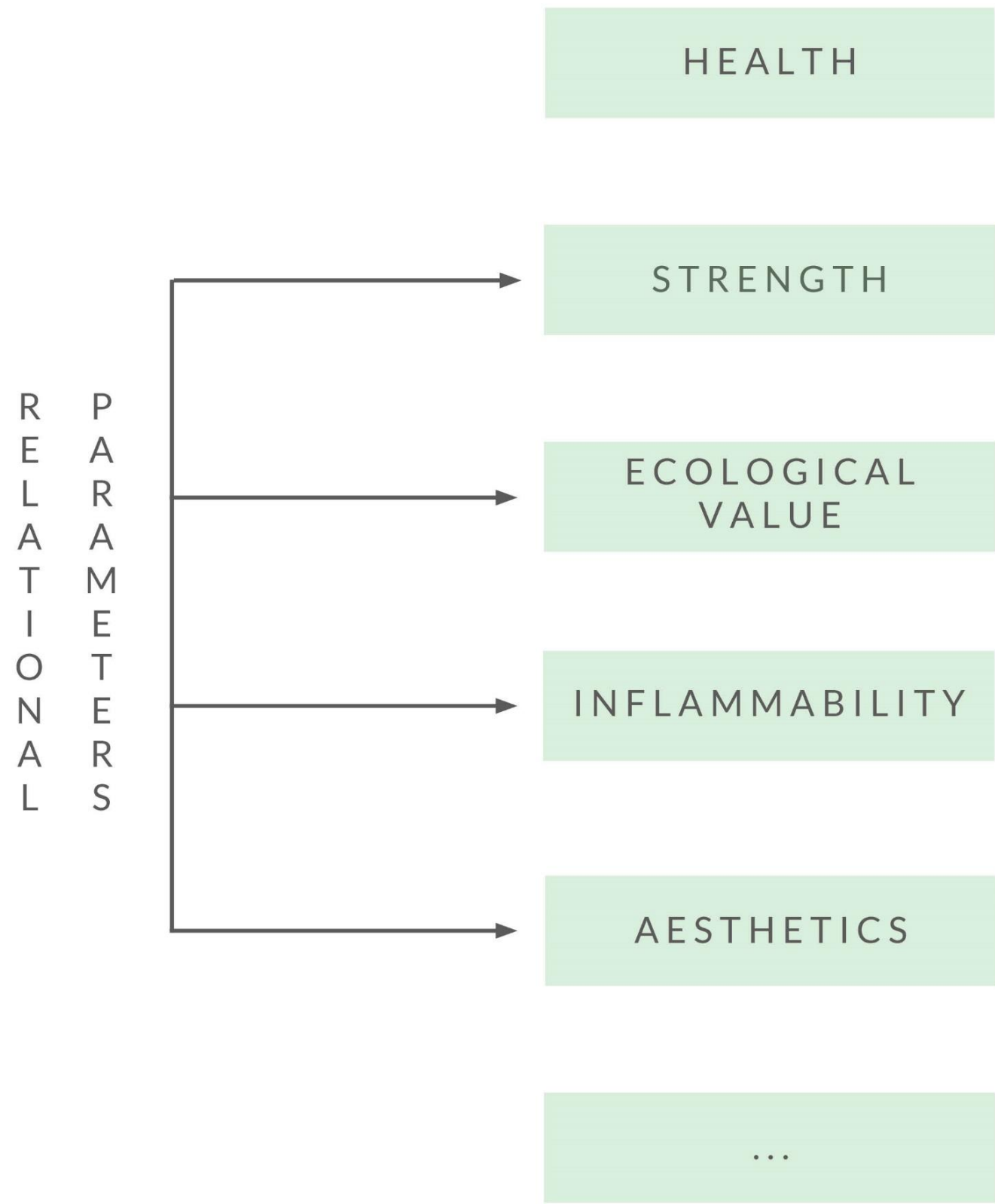
// DESIGN PROCESS

// ITERATIVE PROCESS - CA



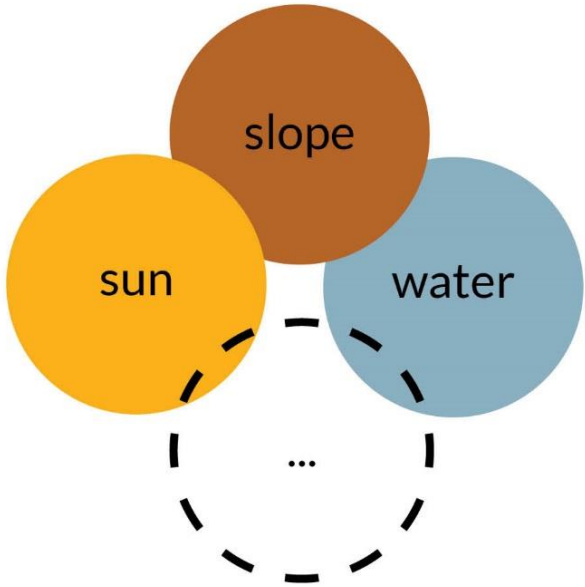
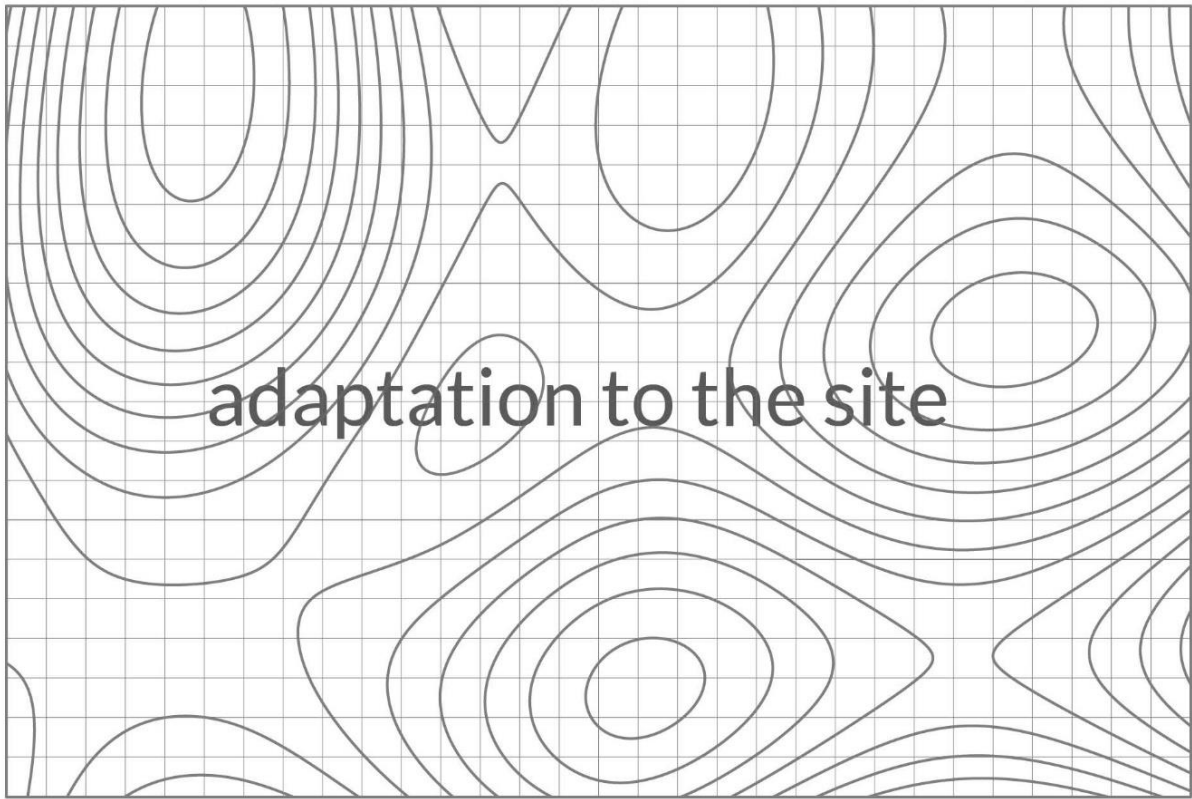
// DESIGN PROCESS

// PARAMETERS



// DESIGN PROCESS

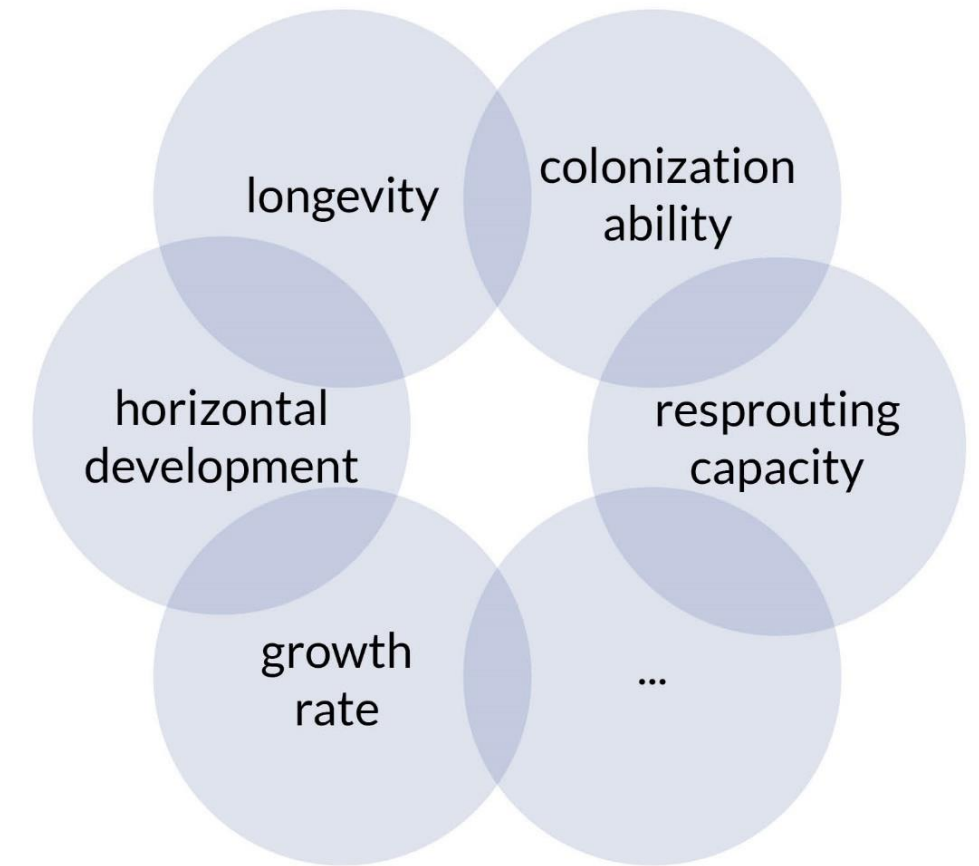
// PARAMETERS - HEALTH



// DESIGN PROCESS

// RELATIONAL PARAMETERS - STRENGTH

strength



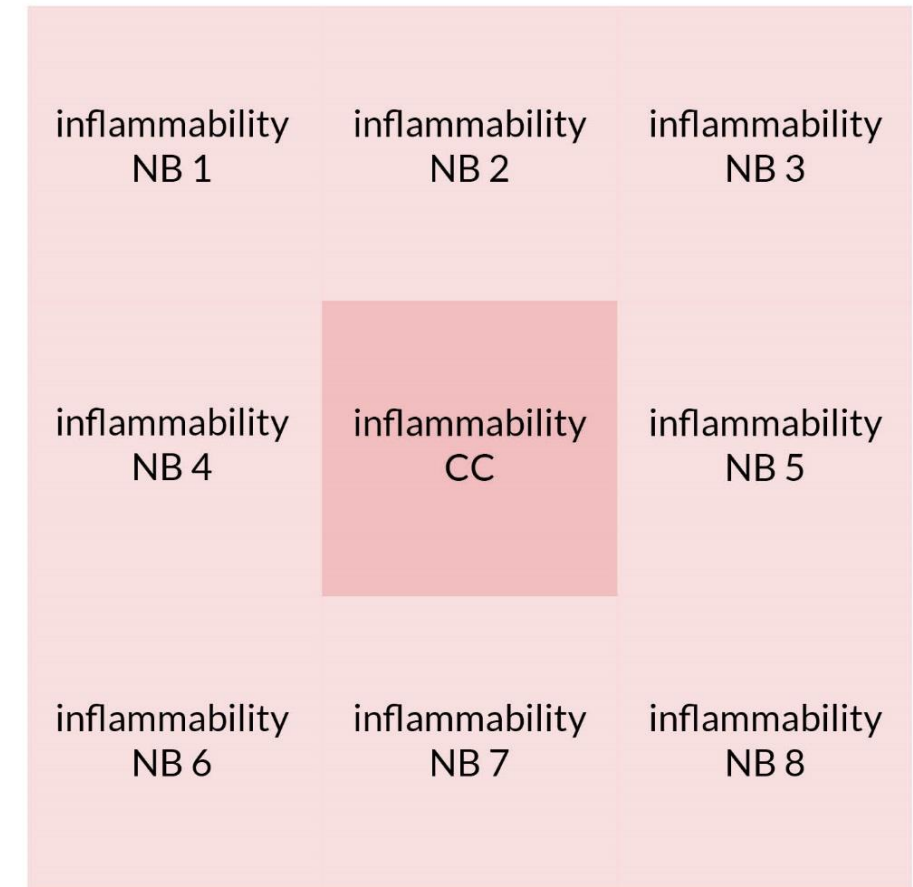
name	Rosmarinus_officinalis	Hedera_helix	Viburnum_tinus	Iris_pseudoacorus	Santolina_chamaecyparissus	Lavandula_dentata	Arbutus_unedo	Salvia_officinalis	Scirpus_holoschoenus	Nerium_oleander
Rosmarinus_officinalis	0,23	0,18	0,43	0,29	0,78	0,65	0,36	0,58	0,37	0,20
Hedera_helix	0,30	0,23	0,52	0,38	1,00	0,85	0,43	0,72	0,47	0,25
Viburnum_tinus	0,19	0,14	0,23	0,25	0,57	0,53	0,20	0,39	0,28	0,14
Iris_pseudoacorus	0,21	0,17	0,38	0,23	0,65	0,57	0,33	0,58	0,30	0,17
Santolina_chamaecyparissus	0,08	0,06	0,12	0,09	0,23	0,20	0,11	0,21	0,11	0,06
Lavandula_dentata	0,08	0,07	0,15	0,10	0,27	0,23	0,13	0,22	0,13	0,07
Arbutus_unedo	0,20	0,15	0,26	0,26	0,62	0,56	0,23	0,42	0,31	0,15
Salvia_officinalis	0,11	0,08	0,16	0,14	0,36	0,31	0,14	0,23	0,17	0,08
Scirpus_holoschoenus	0,17	0,13	0,29	0,18	0,52	0,47	0,25	0,44	0,23	0,13
Nerium_oleander	0,29	0,22	0,47	0,35	0,93	0,82	0,41	0,69	0,43	0,23

// DESIGN PROCESS

// RELATIONAL PARAMETERS - INFLAMMABILITY

inflammability

$$\sum \text{NB\&CC} < \text{Threshold}$$



// DESIGN PROCESS

// RELATIONAL PARAMETERS - ECOLOGICAL VALUE



// DESIGN PROCESS

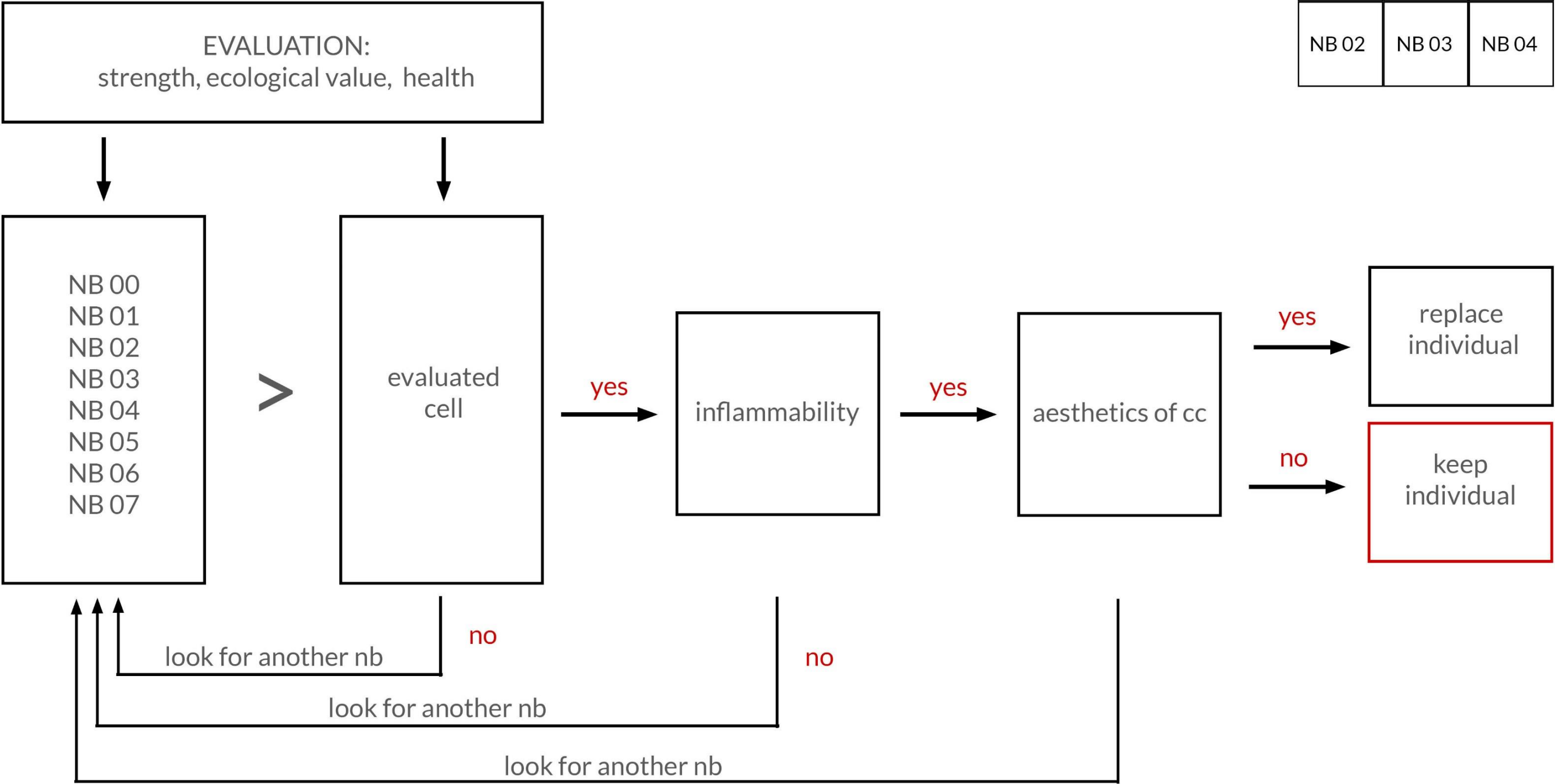
// RELATIONAL PARAMETERS - AESTHETICS



// DESIGN PROCESS

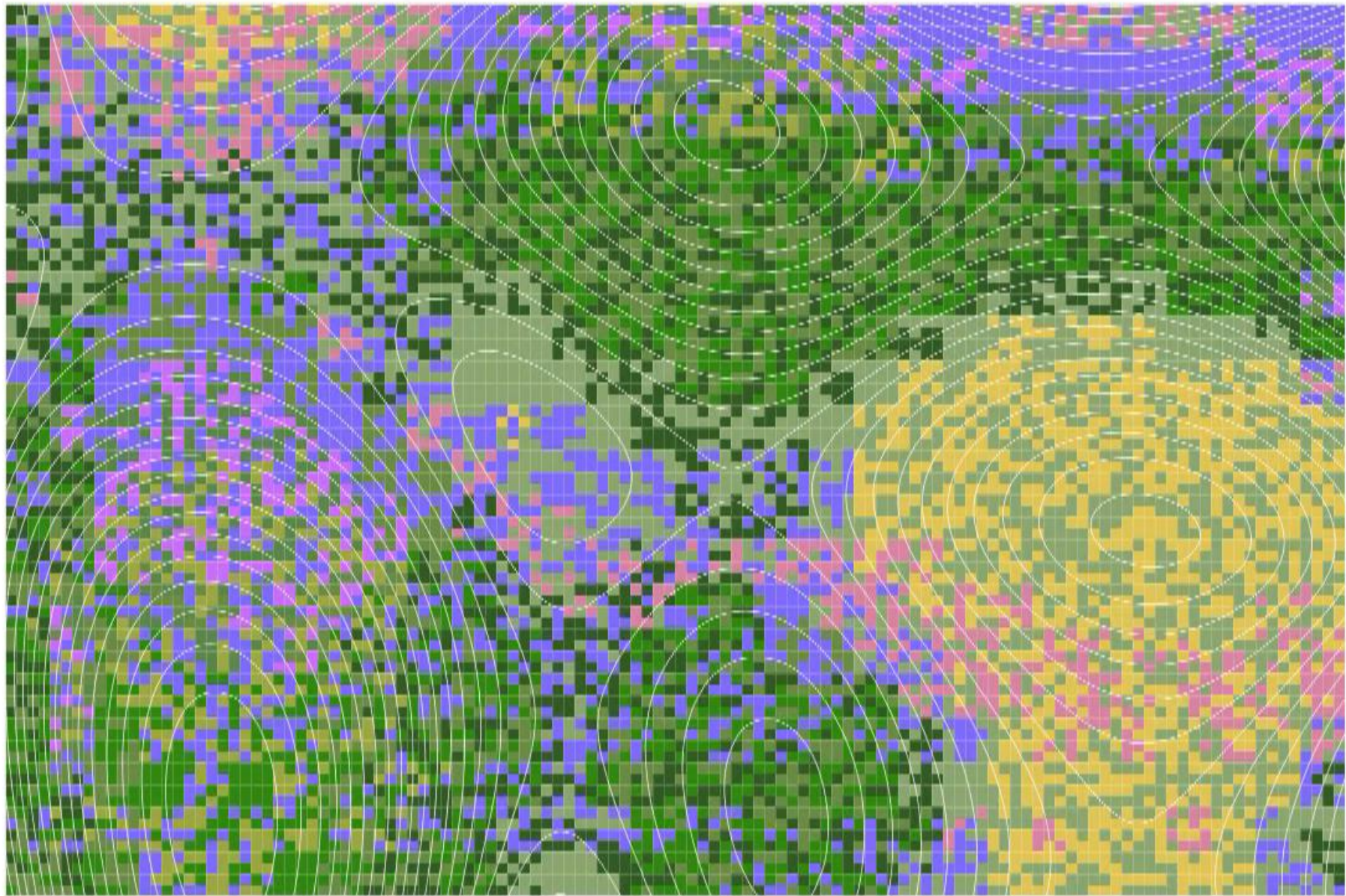
// APPLICATION OF THE RULES

NB 00	NB 07	NB 06
NB 01	CELL	NB 05
NB 02	NB 03	NB 04



// DESIGN PROCESS

// NNB - CA - EXAMPLE



NNB/CA. NATURAL NEIGHBOUR BEHAVIOUR CA. 2019.05

SPECIES INDIVIDUALS

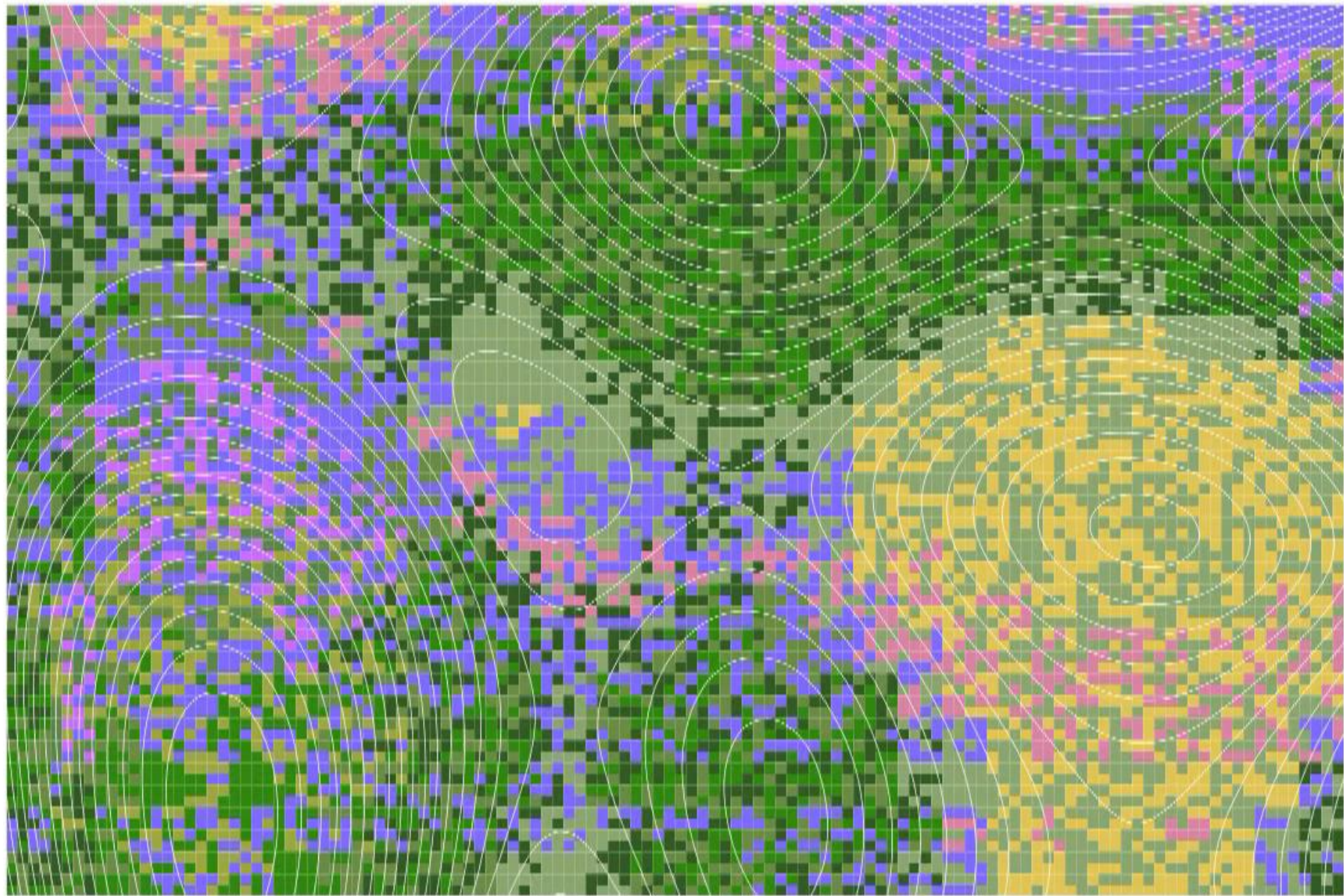
Hesperis matronalis	308
Thymus serpyllifolius	1362
Verbena officinalis	1158
Iris pseudacorus	852
Santolina chamaecrista	375
Lavandula dentata	281
Arbutus unedo	1340
Salvia officinalis	1714
Scirpus holoschoenus	1086
Nerium oleander	464

TOTAL POPULATION :	3400	
GENERATIONS :		
CELL : [00] [40]	EXPOSITION :	5,00
	SLOPE :	2,62
	WALL :	6,36

Thymus serpyllifolius	Thymus serpyllifolius	Thymus serpyllifolius
Health : 3,04	Health : 3,54	Health : 3,54
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,23	Opposition : 0,23	Opposition : 0,23
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00
Scirpus holoschoenus	Thymus serpyllifolius	Thymus serpyllifolius
Health : 4,85	Health : 1,06	Health : 1,06
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,13	Opposition : 0,23	Opposition : 0,23
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00
Scirpus holoschoenus	Scirpus holoschoenus	Thymus serpyllifolius
Health : 4,85	Health : 4,85	Health : 1,06
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,13	Opposition : 0,13	Opposition : 0,23
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00

// DESIGN PROCESS

// NNB - CA - EXAMPLE



NNB//CA. NATURAL NEIGHBOUR BEHAVIOUR CA. 2019.05

SPECIES INDIVIDUALS

 <i>Homiumus</i>	262
 <i>Urtica</i>	1417
 <i>Viburnum</i>	1148
 <i>Iris</i>	819
 <i>Scirpus</i>	1822
 <i>Salvia</i>	238
 <i>Arbutus</i>	1185
 <i>Salvia</i>	1764
 <i>Scirpus</i>	1822
 <i>Nardum</i>	482

TOTAL INDIVIDUALS : 2400
GENERATIONS :

CELL : [00][10]	EXPOSITION :	5,30
	SLOPE :	2,62
	WALL :	8,30

<i>Scirpus holoschoenus</i>	<i>Scirpus holoschoenus</i>	<i>Scirpus holoschoenus</i>
Health : 5,17	Health : 4,58	Health : 4,58
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,28	Opposition : 0,28	Opposition : 0,28
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00
<i>Scirpus holoschoenus</i>	<i>Scirpus holoschoenus</i>	<i>Urtica helix</i>
Health : 4,85	Health : 4,35	Health : 1,56
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,28	Opposition : 0,28	Opposition : 0,47
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00
<i>Salvia officinalis</i>	<i>Urtica helix</i>	<i>Salvia officinalis</i>
Health : 1,79	Health : 1,96	Health : 1,51
Strength : 0,00	Strength : 0,00	Strength : 0,00
Opposition : 0,17	Opposition : 0,47	Opposition : 0,17
Evaluation : 0,00	Evaluation : 0,00	Evaluation : 0,00

THANK YOU!!!