# ZERO+
Architecture Design Studio
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Edited by Simone Giostra
with Alberto Lunardi and Giovanni Nardi

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# Introduction

## Give them a tool

*Simone Giostra*

*If you want to teach people a new way of thinking, don't bother to teach them. Instead, give them a tool.*
(Buckminster Fuller)

I discovered CAD software while working on my thesis project over 20 years ago. I had used a sharp pencil to draw a full, 35-board construction set on mylar, a durable plastic substrate that was in vogue at the time among design cognoscenti. Over the course of a reclusive month, I took on retracing every drawing with a mouse, until I had an exact digital copy of the entire set of pencil drawings–and I never went back. My generation was probably the last one to know architecture before the computer–and the first one to enjoy the competitive edge brought by digital tools. Empowered by a very early AutoCad release, I could take on responsibilities, both in the office and on the construction site, that were far beyond the typical duties of a recent graduate.
The so-called digital revolution have empowered each new generation with the tools to design and construct increasingly complex systems since. Interestingly, these new powerful tools are coming to fruition in the midst of an environmental crisis of unprecedented proportions, giving architects the opportunity to play a central role in solving the energy crisis.
Climate change poses an intrinsically multi-scale and cross-disciplinary challenge, one that is difficult to even comprehend, since it unfolds at a slow pace and involves many interrelated scales. Today, digital design tools allow us to detect, measure and visualise the energy forces transforming our environment –forces that were largely invisible to the architect's eye until two decades ago.

The effect of the new digital regime on the profession, however, has been a gradual drifting towards extravagant and often wasteful design propositions. By and large, the flourishing of a new formal vocabulary, enabled by digital tools, rarely translates into buildings that perform better.
With energy efficiency and rational use of resources becoming the overriding concerns in both new construction and retrofits, architects have been gradually marginalised in the design and construction process, as they failed to provide responsible answers to the environmental crisis engulfing the planet. As a result, after more than two decades of environmental policies in place, achievements in energy savings related to the built environment have been disappointingly modest. In fact, most results have been achieved due to factors outside the architectural and the urban design fields, often deploying a plethora of isolated and highly technical solutions.

The projects presented in this book, conducted by students at the Politecnico Graduate School of Architecture in Milan, attempt to recast the on-going debate on sustainability from a pre-eminently architectural position. In most cases, they are the result of individual work in response to a particular site and a environmental challenge chosen by the student. Collectively, they start to identify a specific, measurable relationship between geometry–the traditional domain of the architect–and performance, particularly in the area of energy efficiency and sustainable use of materials in buildings.

Over the past few years, the Zero+ Design Studio has been experimenting with hybrid forms of computational design and traditional form-making, combining various performance analysis with parametric definitions, to inform and support a creative design process. Mapping natural forces shaping the site is often the project's first act, clearly illustrated by the rich, insightful colour-coded maps included in the book. The grain and scale of the architectural structure often reinforce these underlying patterns, as unique and appropriate building components respond to each data point on the map. In many cases, students use rules and algorithms to generate forms, resuming the tradition of form-finding that consumed the best minds of an earlier generation of architects. Some projects supplement a form-finding process with human intuition by creating a feedback loop between analogue and digital domains. Others explore the theoretical limits of a parametric definition to control the shape of a building exclusively based on constrains.

**Each project presented here explores the potential for parametric design to construct this one-to-one relation between environmental forces, building form and energy performance.**

The Studio is predicated on the support of digital consultants, teaching advanced computational skills to students with no previous experience in algorithmic design. Digital simulation tools that predict the environmental performance associated to a particular building form–such as airflow, daylighting and sun radiation levels–are becoming increasingly more accessible and easier to use, providing an intuitive and inexpensive sketch tool to designers. These tools have a profound impact on the way we design buildings and cities, since they provide invaluable support at a very early stage of the design process, when most decisions are made, as opposed to entering the process at a much later stage, when the designer is less willing to accept changes. Also, they come at a much lower cost, since they replace the kind of quantitative advice traditionally offered by specialised engineering firms.

Needless to say, these tools are extremely controversial within more traditional academic environments, where they tend to be relegated to ancillary functions of primary intellectual processes that still promote ideas over tools. Also, they empower a new generation of young designers and disrupt the current teaching model, which is still largely based on the form-making tradition of the Ecole de Beaux Arts. Outside the school, they are set to transform professional practices as well, as fresh graduate students experiment with new forms of collaboration that bypass the traditional apprenticeship model–a source of cheap labour on which the success of most corporate firms is predicated.

In this context, the support of the school's leadership has been instrumental to the realisation and sustainment of a new studio culture in emergent technologies and computational design at the Politecnico. Students' enthusiasm, however, is the true engine for the impending revolution.

## Landscape Narrative: A New Methodology

*Hope Strode*

—

The field of landscape offers complementary working methods to the allied professions that are necessary when facing climate change, rapid urban expansion, resource scarcity, and diminishing biodiversity. It mediates diverse scales and serves as a link between the site and its broader urban, regional and territorial context. Additionally, and perhaps most importantly, the landscape approach provides working and representational methods that take into account the dynamics and flows of the immediate and larger context.

The complexity of contemporary urban and environmental challenges necessitates a fundamental shift in how we design and construct the built environment. Conventional architectural design methods, while generally embracing the concept of 'sustainability,' have proven to be largely ill-equipped for responding to the complexity of problems facing the designer today. In part this is an issue of scale: the architectural object itself is relatively limited in its ability to address broader urban relationships, resource flows or ecological systems[1]. But it is also a failure in working method among the design professions that continue to operate in siloed disciplines favouring a top-down, form-based approach to one that is collaborative, open-ended and dynamic in both space and time[2].

**Sustainability techniques in architecture tend to be mere add-ons to established building forms that increase performance but rarely impact the formal notion of the object or extend their reach beyond the site confines.**

This is not for lack of theoretical thinking around the requisite of cross-disciplinary and collaborative working methods – 'sustainable architecture', 'landscape urbanism,' ecological urbanism' all suggest disciplinary hybrids that challenge customary boundaries and open new operative possibilities – yet in practice the overlap often remains defined by traditional professional hierarchies and working relationships. Urbanists and planners define the site boundaries, architects design the building form, engineers optimize efficiency and landscape architects provide a decorative green veil on and around the building. The result is conventional buildings espousing sustainable features.



**Context: Ecological Thinking**

"Ecology" as a framework from which we design is an essential component of landscape architecture today. Our understanding of it is not confined to "natural" or "environmental" contexts[3]. Rather it refers to the complexity of agents acting in any environment and their unique interactions. These agents are biotic and abiotic, urban and natural, human and non-human and they produce incremental changes on the broader system over time. For centuries western culture considered nature to be outside of and therefore separate from the city. It was sacred, foreboding, pristine, pure, wild – something that lived independent from and was threatened by the influence of humanity. The city, on the other hand, was the realm of man and technology; it was a canker creeping out into primeval nature. Today we can no longer make this distinction.

**As urban areas expand and population growth strains our remaining resources, we are forced to acknowledge humans and their constructions as an active participant in the natural environment.**

The architectural design studio Zero Plus, coordinated by Professor Simone Giostra, asks students to design housing that goes beyond the building envelope to include systems of food, energy and waste (i.e. the FEWs). This programmatic precept anchors the design studio in the cross-disciplinary, where landscape is a fundamental component. The FEWs, themselves dynamic and operating in relation to one another (and the human users), place the building and its inhabitants within the ever-changing system of the landscape. Furthermore, the students were asked to choose a disturbed site upon which to intervene. Each site had an existing context – social, geological, ecological, urban, climatic, and political – which became the structuring element for their projects. The food, energy and waste systems, therefore, were intimately tied to the context – or "ecology" – of the site.

**Layers and Time: Representing Flows**

Starting from this ecological framework, project sites are mapped in the McHargian tradition[4] – separating layers of geology, hydrology, plant communities, topography, solar exposure, urban development, infrastructure, pollution and contamination – and overlapping them to reveal a new site reading. The mapping itself becomes the first critical exercise in the design process. As James Corner puts it in the seminal essay The Agency of Mapping:

> *As a creative practice, mapping precipitates its most productive effects through a finding that is also a founding; its agency lies in neither reproduction nor imposition but rather in uncovering realities previously unseen or unimagined, even across seemingly exhausted grounds.*[5]

More than a simple cut-and-paste of data already available, each layer is drawn to represent a particular intention of the designer. The maps are closely edited for content and clarity; too much information does not allow for a clear reading of the design strategy, while too little information renders the map useless.

Topography is often the starting point for analysis, the ground being the base on which everything else acts. It is also relatively static – let us leave the process of erosion and sedimentation, shifting tectonic plates, lava flows and surface mining for further discussion – until it is activated by dynamic systems such as weather patterns and hydro-

# Methodology

logical flows. The intensity of solar exposure, for example, varies significantly across a terrain and becomes an important indicator of where and how to build when considering factors of food and energy production. Flows of wind and water, for example, respond predictably to topography: water flows down hill and accumulates in lowest points, and wind speed is increased as it moves over or around objects in its path. But these flows are not constant; we have to read them as averages, highs and lows, which change throughout the day, across the seasons and over the decades.

It becomes clear that it is not sufficient to represent many of these layers at a fixed point in time. Some layers are relatively stable – geological conditions, for example, would show little change when represented over the course of 100 years. However, a time-based mapping of infrastructure, urban footprint, settlement patterns, contamination or hydrological flows, would uncover great changes over a century. For example, rivers and deltas are mapped over time to understand and demonstrate their unique morphologies. Water flow and accumulation could suggest how contamination might travel and settle across a site. In mapping these changes we not only identify site-specific patterns relative to flows, but they often reveal discontinuities. These interruptions can be anthropogenic – the construction of a dam or the decommissioning of a polluting factory – or they may be natural, such as a major flood or storm. Interestingly, patterns are not recovered after an event; rather, they are rearranged with a new logic and set of dynamics.

Time-based representation of the landscape not only provides and understanding of the existing conditions and patterns, but allows for projective simulations of how the system might respond in the future.
Climate change and its effects necessitate adaptability, resilience, and flexibility. The built environment's failure to be resilient in the face of recent natural disasters makes it clear that the conventional, static approach to landscape, infrastructure and urban development cannot respond adequately to the changing environmental conditions and demands. Furthermore, the cost and time required for landscape interventions at this scale require a long-range phased intervention.

**Here the designer engages directly with designing pointed interventions that activate processes and allow them to develop over time.**

"The author's hand is not always so apparent," as Bradley Cantrell puts it, "It's based on catalyzing events as opposed to formalizing the results."[6] These processes are neither linear nor mechanistic. They feed back on themselves cyclically, resembling ecological systems, which are not self-contained; they are part of greater social, urban and biotic systems that operate across a range of scales.

**The Landscape Palimpsest**
The overlapping of the landscape layers, both static and dynamic, frame the project narrative and becomes the basis of the site selection and design intervention. Often as few as three layers are enough to reveal the unique complexities of the site and focus the additional project research. The layering of the landscape, therefore, becomes a political and creative act.[7] What then can we learn from these layers? How might the designer intervene (or not intervene) to heighten, reinforce or take advantage of existing patterns? Could a project support or improve an existing environmental system through the architectural intervention?

Landscape architects have long use the palimpsest as a metaphor for the richness of the layers embodied in a landscape. Defined by Anita Berritzbeitia as "a series of layers that accumulate on a site over time, that are of different origins – geologic, social, productive – and that leave traces behind," the palimpsest is a "testament of the passage of time and to ongoing cultural processes on the landscape."[8] These layers make visible the complexity and the continuous dynamic processes that act across the landscape.

When we overlap landscape layers we prepare to write a new narrative on the site; one that contains traces and elements of what was already there while envisioning entirely new possibilities. Here and there we will read the hand of the designer, mostly it is the traces of the flows - social, economic, ecological and cultural – that will remain.

**The palimpsest is not nostalgic, though it does not deny the intrinsic elements of the past; rather it waits to be constantly re-written.**

Notes:
1. See Mohsen Mostafavi "Why Ecological Urbanism? Why Now?" in Mohsen Mostafavi and Gareth Doherty, *Ecological Urbanism* (Baden, Switzerland: Lars Müller Publishers, 2010), 26.
2. See James Corner, "Terra Fluxus," in Charles Waldheim, ed., *The Landscape Urbanism Reader* (New York: Princeton Architectural Press, 2006), 23-28.
3. See James Corner, "Ecology and Landscape as Agents of Creativity," in George F. Thompson and Frederick R. Steiner, eds., *Ecological Design and Planning* (New York: John Wiley & Sons, 1997), 80-108.
4. See Ian McHarg, *Design with Nature*, (Garden City, New York: Published for the American Museum of Natural History by the Natural History Press, 1969).
5. James Corner, "The Agency of Mapping, Speculation Critique and Invention," in Denis Cosgrove, ed. *Mappings* (London: Reaktion Books, 1999), 188.
6. See interview with Bradley Cantrell, in Kristina Hill, "Ecology on Autopilot," *Landscape Architecture Magazine*, vol. 107, no. 6 (June 2017), 110.
7. James Corner, "The Agency of Mapping, Speculation Critique and Invention," in Denis Cosgrove, ed. *Mappings* (London: Reaktion Books, 1999).
8. See Anita Berritzbeitia's essay "On Palimpsest" in George Hargraves, Landscape Alchemy: The Work of Hargreaves, (Pt. Reyes Station, California: ORO Editions, 2009).

# Digital Tinkering: Experiments in Energy Form-finding

*Simone Giostra*

Tools

After nearly 3 decades since their first appearance in architectural practice, digital design tools are increasingly pervasive in nearly every aspect of the profession and throughout the building life cycle, from project development to construction administration to demolition and recycling. While an integrated approach to building information management is becoming the key to winning projects, the creative attitude of an earlier generation of computational designers is fast replaced by new tools and protocols geared toward achieving efficiency targets and boosting profitability.

The studio takes on a different path toward our shared digital future–one that tries to address the environmental challenge while fostering creative freedom.

**Gateway to another world**

A claim frequently heard from older colleagues, both at school and in the profession, is that new forms of digital practice–that is, using a machine in the artistic process–stifles creativity and generates anonymous architecture.

In fact, the problem of design is not, and it never was, one of creativity–of enabling the mind to formulate new formal constructs, that is, of 'coming up' with ideas–but quite the opposite:

**The creative process desperately needs parameters, limitations, some kind of intellectual friction in order to operate.**

Unchecked, the mind is capable of conceiving the wildest shapes, none of which would actually turn into architecture. The first set of limitations comes in the form of a tool enabling thoughts to take shape in some intelligible way. Ideally, a useful design tool would limit the range of expression to only that which can be eventually built. If the tool is too restrictive, you will end up with conservative or conventional design; conversely, if the tool is too loose or unresponsive, you will end up with wild propositions that cannot be built. If architectural drawings are the anticipation of the act of building, then tools are the guardians of the act of anticipating, deciding which line/form/structure has a right to exist in a drawing.

Many older modelling and visualization tools, such as 3ds Max and Cinema 4D, knew no boundaries, since they were created by the film animation industry precisely to 'unbound' the imagination of the designers and to create an imaginary world that needed to exist only on screen: "your gateway to another world" is the promise by a leading developer of 3D software. The evolution of graphic interfaces only meant an increasingly smother transfer mind-mouse-screen that effectively eliminated many, if not all, limits to creating free forms–making the results largely irrelevant to the purpose of building.

The fact that an early generation of architects were being introduced en masse to these tools in the mid-1990s by elite architecture programs at Columbia University in New York, SCI-Arc in Los Angeles or the AA in London, speaks to the opportunistic, disingenuous relationship between architecture and the graphic software industry. By and large, this first generation of 'digital' designers were responsible for stretching, once again, the boundaries of what was considered architecture–and for raising much of the opposition to the so-called 'blob architecture' that is still felt in academic circles today, along with a lingering suspicion toward any new digital tool since.

**From the command line**

Digital design, however, has many strands. At the opposite end of the spectrum, early CAD tools offered a great deal of resistance in the form of a reduced number of operations, none of which included unforeseen or unimaginable results. A 'command line' implies a master able and willing to spell out orders: here every shape is the result of explicit instructions given in a specific sequence, using a mediating protocol that requires training and some ability. Similar to the visualisation tools discussed earlier, CAD software was developed for the engineering industry, not architecture, and presented its own kind of limitations. For one, it forced the designer to a level of precision that finds no application in architecture, particularly in the early stages of the project. Also, it did not allow for any tolerance, since it demanded that each line should be placed in Euclidean space without ambiguity or hesitation, with the snap function marshalling any wandering line to its designated place. Incidentally, Building Information Modelling (BIM) software belongs to this second lineage of digital design tools.

An intelligent 3D model-based software that involves functional and relational characteristics, BIM represents a more pragmatic and conservative response by the industry to the same disruptive forces transforming all levels of design. In fact, BIM tools are designed to enhance productivity and ultimately profitability–one major player in the market incites architects to "use BIM architectural design software to win more work and retain clients"–at the expense of innovative and risk-taking approaches to design. Contrary to a generalised perception that BIM software should empower the architect and foster design innovation, I am convinced that it will regiment the creative process in favour of delivering normalised, predictable (and profitable) results.

Interestingly, BIM software represents the antithesis to the experimental processes pioneered by early digital artists and the hacker culture that infiltrated many artistic fields over the past 40 years–first electronic music, then video art, interactive design and gaming–and slowly percolated into more traditional design fields such as architecture, with the introduction of graphical algorithm editors like Grasshopper and Processing.

**The projects presented here bring back the spirit of this early experimental phase, when algorithms were used to propel as much as disrupt the traditional design practice.**

**Generative tools**

Because of its disruptive potential, a conservative majority still perceives the digital practice in opposition to analogue modes of design, such as hand drawing or model making–a futile distinction at best, serving the entrenched

interests of an older generation. And it's not merely a fight for self-preservation. Some of the most exciting digital tools making their way in the profession are generative in nature, that is, they open up design opportunities that become apparent only to those who practice. As with any other craft, there is no verbal substitute for a digital practice. Most decision makers, in our schools as well as in most traditional industries, simply lack the digital skills to appreciate first-hand the generative potential of these tools.
For centuries, architects have been using scale models to predict the performance of buildings by applying materials and techniques that replicated actual constraints. Physical models, however, cannot test a design solution for structural integrity, as commonly accepted before the discovery of the so-called square/cube law by Galileo in 1638. Interestingly, for over 300 years from the first publication of the 'Two New Sciences', we did not have a reliable analogue method to test structural integrity of buildings in the early phases of design. This is particularly striking if we consider, as Reyner Banham noted, that the history of architecture up until the end of the 20th century is largely an history of space-enclosing structures.[1]

**Remarkably, intuitive computer simulation tools provide designers with the unprecedented ability to test early design concepts for structural integrity and energy performance, effectively overcoming a centuries-old limitation.**

And there is more: the introduction of accessible parametric tools, such as Grasshopper a decade ago, allows to use rules and algorithms to generate forms, resuming the tradition of form-finding that consumed the best minds of an earlier generation of architects–including Frei Otto's experiments with lightweight structures and Gaudi's analogue force models.
Rather than a fictitious opposition between digital and analogue models, then, what's really a stake is a dramatic shift in recent years from form-making to form-finding.

Today, energy considerations are supplanting structural integrity as the main parameter in designing a building. Thanks to advances in computer technology, we are the first generation of architects with the tools to simulate relevant energy indicators from the very early design concept, using inexpensive applications run on our laptops. Of particular interest are tools that produce graphic output in the form of 2D- and 3D-color-coded diagrams, in some case projected directly onto the space being evaluated. I am convinced that the defining challenge for our generation is to do for energy what Frei Otto and Gaudi did for structure: shaping buildings using energy-related constraints–in other words, energy form-finding.

**Invisible forces**
The problem with parametric design tools is that they require explicit instructions to operate; in other words: they only execute orders. As any architect working on a design problem knows well, much of the creative process in architecture is based on what Malcom McCullough calls 'intrinsic information', that is, information that is embedded in the ambient and come to fruition less through focused attention than by situational awareness.
Creative work does not always involve deliberate thought; a skilful practice, tools as props, habituation–all play a cognitive role in 'coming up' with ideas. As he puts it, "A great deal of knowledge is inarticulable, especially when in use. In music, sports, or many other expertise, you can do things you cannot explain".[2]

While digital tools should not replace the architect's mind in formulating a design concept, they can be very helpful when dealing with information that does not fall within the visible spectrum. In one of his seminal writings, Buckminster Fuller famously declared: "[…] Forms are inherently visible and no longer can 'form follow functions', because the significant functions are invisible".[3] He was referring to natural forces, as well as to material properties that are not detectable by senses or experience, since they result from manipulation at the molecular level that are invisible to the naked eye–yet have a great impact on the built form. Environmental analysis tools can provide critical insights into these invisible functions by widening the architect's gaze in areas of knowledge outside the spectrum of visible light.

There are obvious advantages in giving form to these invisible forces, as they play an increasingly larger role in the built environment. Architects typically resort to highly technical solutions for compliance with ever stricter energy codes–'green gadgets' that come in the form of sophisticated mechanical systems, super-insulation materials or expensive glass treatments–so that they don't have to question a consolidated formal language. Conversely, formal solutions that directly address these invisible forces at a structural level can dramatically improve the performance of buildings by reducing heating and cooling loads, fostering daylighting and natural ventilation, and generally lowering energy demand.

Additionally, a building form that is the result of a form-finding process can manifest information regarding the ambient–prevailing wind direction, solar radiation levels, air flow or pedestrian traffic–in ways that are intuitive and do not require mediation. A classic example of the architect's disconnected design approach to the new energy imperative are the many digital displays showing the amount of energy being produced by solar panels that are hidden away on the roof of buildings. This is particularly relevant in an age of mediated information: as we increasingly rely on screens, large and small, to retrieve useful information on our environment, embedding information in the persistent structure of buildings can have positive effect in learning to navigate our world without depending on a smartphone.

**Beauty and survival**
This bring us to a final question regarding the use of form-finding strategies and related computational systems predicting the behaviour of buildings. We understand that a form resulting from relevant forces might cope well with these same forces, so that if a building envelope is shaped based on solar radiation levels, for instance, it has a larger potential for energy generation than a building shaped after a crumpled paper bag. But how prominent should the energy radiation potential be among the many factors–such as program, context, budget, historic references or quality of interior space–contributing to the design of a building? The answer depends on the stage of human development in which you find yourself operating.

Cultural values govern the relationship between nature and human actions–a sort of protocol of engagement with our natural environment designed to improve the human specie's competitive advantage and, ultimately, chances of survival. Even abstract notions such as 'beauty', according to Denis Dutton, might be evolutionary determined, so that we consider beautiful that which enhance the survival of the human genes.[4]

**By necessity, then, design criteria must be an evolving concept, as our collective success is continuously challenged by changing environmental conditions.**

In his book *Collapse*, Jared Diamond argues that with changing environmental conditions, societies face the challenge of identifying which cultural value can be sustained and which one is no longer appropriate to the new set of conditions.[5] For instance, he writes about the choice of Greenland Norse to stick to Christian identity values—refusing to adopt habits and techniques from the indigenous Inuit that were much better adapted to the environment, because deemed culturally inferior—as the main cause of their extinction. Interestingly, he describes how societies on the verge of environmental collapse, such as the Rapa Nui civilisation, stubbornly clings to—and sometime even intensify—the very same practices that are the root cause of their demise. Erecting large ceremonial statues on Easter Island turned into an unsustainable practice toward the end of the 17th century, as it required a disproportionate amount of timber and human labour to sustain, in a context where sources of both trees and proteins were depleted. Interestingly, statues became increasingly larger and more complex, therefore demanding more resources, precisely when resources became more scarce.

Confronted with the progressive depletion of resources and declining quality of our natural environment, we continue erecting monuments to our minor gods.

**In the eye of future generations, the irresponsible use of resources to serve the extravagant formalism of some of today's most prominent architecture will bring to mind the excesses of a collapsing civilisation.**

**And if history is any indication, cultural conservatism is not what will get us back on track. On the contrary, I believe that this is a time for vigorous experimentation and some serious debate on what we collectively can and cannot afford.**

Notes:

1. Banham, R. (1984). *The architecture of the well-tempered environment*. Chicago, IL: University of Chicago Press.
2. McCullough, M. (2013). *Ambient Commons: Attention in the Age of Embodied Information*. Cambridge MA: MIT Press.
3. Fuller, B. R., & In Snyder, J. (2010). *Ideas and integrities: A spontaneous autobiographical disclosure*. Baden, Switzerland: Lars Müller Publishers.
4. Dutton, D. (2010). *The art instinct: Beauty, pleasure, & human evolution*. New York, NY: Bloomsbury Press.
5. Diamond, J. (2005). *Collapse: How societies choose to fail or succeed*. New York, NY: Penguin Books.

# Syllabus

## The House of the FEW

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ZERO+ looks at the transformation of dwelling in the context of climate change and as a result of the new imperatives of the European Challenge 20/20/20: reducing greenhouse gases by 20%, increasing energy efficiency by 20% and reaching 20% of renewable energy by 2020.

The establishment of the City, from its very inception, is the result of a fundamental separation between places of consumption – located within the city limits – and places of production, where enough surpluses of raw materials and food are created to support city development.
The dislocation of production activities has only increased since the industrial revolution: over the past 150 years, the massive loss of natural land to the combined effect of relentless expansion of urban areas, modern infrastructures and extraction of natural resources resulted in a drastic reduction of biodiversity, air and water pollution, and the depletion of natural resources.
As advanced societies become increasingly dependent on the mass production of industrialized agriculture and vast mining operations, the places of production and extraction are being gradually relocated in remote areas of the planet, often outside the control of environmental agencies, away from public scrutiny, and removed from the collective consciousness.

**The studio challenges students to rethink existing living models by integrating Farming, Energy production and Waste management systems (FEWs) to the house of the 21st century.**

**Morphology**: Over the next few years, all new construction will have to be nearly Zero Energy Building (Directive 2010/31/EU); however, because of the specific scales of energy production, the traditional size of building lots in the city is not sufficiently large to achieve the Zero Energy mandate. Similarly, current levels of food production and waste processing practices cannot sustain population densities of contemporary cities like Milan without devastating consequences for the environment. In short, the new energy paradigm calls into question the very premise of the city – that is, its high density.
While there is general consensus that cities are indeed a good thing - "our greatest invention", according to Edward Glaeser in The Triumph of the City - we need to find ways of offsetting some of the environmental costs of maintaining today's megalopolises by bringing production and management of energy, food and waste back into the fabric of the city. Accordingly, the studio will promote entirely new strategies of subdividing urban land and using public space in order to reduce environmental degradation and to attain true energy independence.

**Typology**: While environmental measures are drastically transforming our cities, architects have struggled to find their own voice: by and large, issues of technical feasibility, efficiency and cost reduction alone have been driving the discourse on sustainability and the implementation of the new energy policies to date. The Studio explores the architectural implications of combining am existing typology –single or multi-family housing – with one or more FEWs components.

**Hybrid forms of aggregation and synergistic opportunities will emerge from the logic of the FEWs, promoting novel adjacencies, circulation patterns and spatial configurations–and ultimately generating new forms of living.**

**Technology**: The scale of the individual component, particularly within the envelope of the building, offers perhaps the most productive opportunities for implementing environmentally friendly strategies in architecture. The skin of buildings is in direct contact with the surrounding environment, exposed to the forces of nature, and best positioned to harness wind and solar energy, reduce heat loss and condensation, foster daylighting and natural ventilation, and generally promote an efficient and healthy relationship between the building's inside and the outside. Within the time limits of the semester and in the context of a 2nd year master class, the studio will introduce the students to a range of environmental strategies at the scale of individual living units, using the extensive documentation on recent Solar Decathlon events as point of departure.

**Language**: Historically, technological developments find their first applications in architecture in two seemingly opposite – and often simultaneous - forms: in the first model, the new technical component is hidden within a pre-existing architectural framework, which remain substantially unchanged. In the second model, technology is embraced in its naked form, unmediated by any pre-existing cultural protocol, and celebrated in all its ugliness – for all original forms are ugly by default – as a beacon of modernity. Similarly, in today's architecture the new environmental technologies used for energy production, farming, composting and recycling are being pushed to the forefront and celebrated as icons of modernity or, alternatively, hidden in basements and attics, in underground facilities and secluded areas outside the city. In either case, they still lack a language.

The program explores the spatial, programmatic, and formal potentials of the FEWs, using industrial processes of production and disposal of food, energy and waste to propel the next architectural revolution.

# Here

**01**
**PROJECT-Y**
Elina Akiozoglou
Iro Karountzou

**02**
**ARCA**
Arin Alia

**03**
**ZERO ENERGY WALL**
Massimo D'Alessio

**04**
**W-TANK HOUSE**
Luca Breseghello

**05**
**WATERWAYS**
Nadia Safronova

**06**
**WATER DISTRICT**
Ilaria Calamita

**07**
**FE(W)² PROJECT**
Mariela Tsopanova

**08**
**DUG HABITAT**
Anna Otlik

**09**
**LIVING THE GROUND**
Davy Campana

**10**
**VORTEX**
Giovanni Trogu

**11**
**MYCELIUM GREENHOUSE**
Huyen Chu Ngoc

**12**
**ELYSIUM**
Matteo Bulgarelli
Chiara Robuschi

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Susanna Vissani

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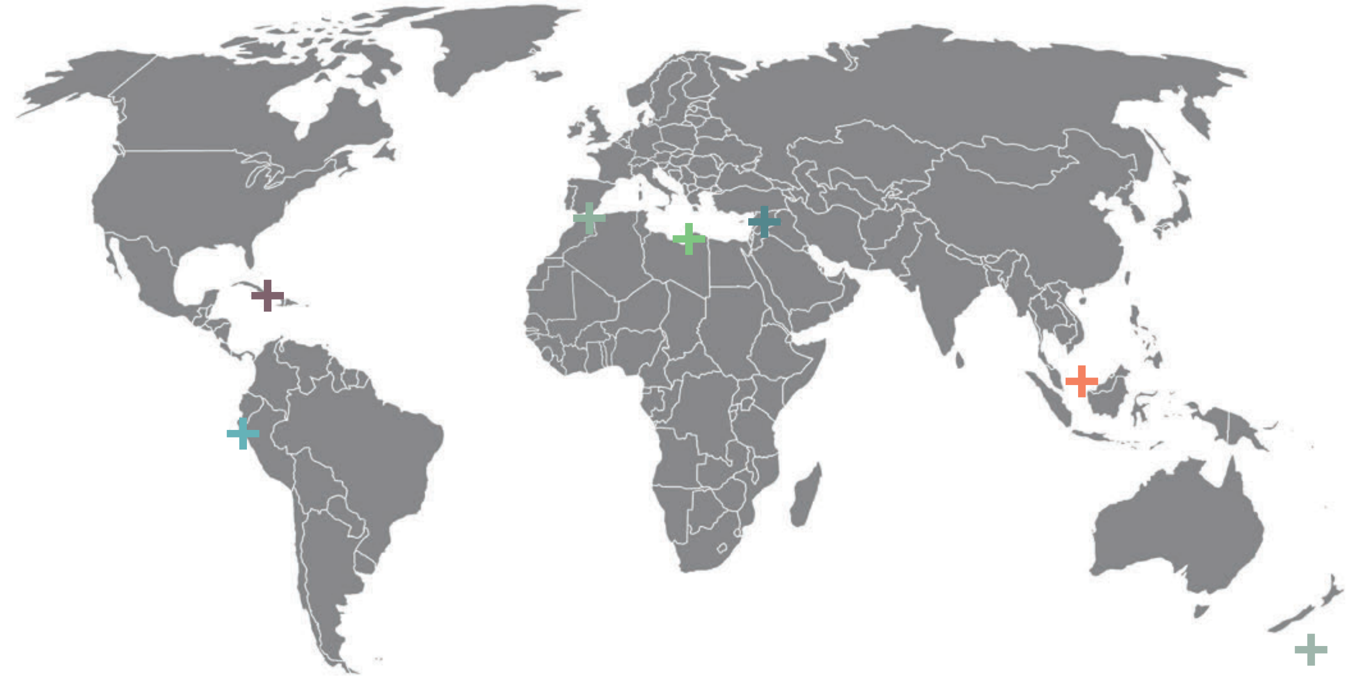
**INTER-EVOLUTIVE DISTRICT**
Giovanni Nardi





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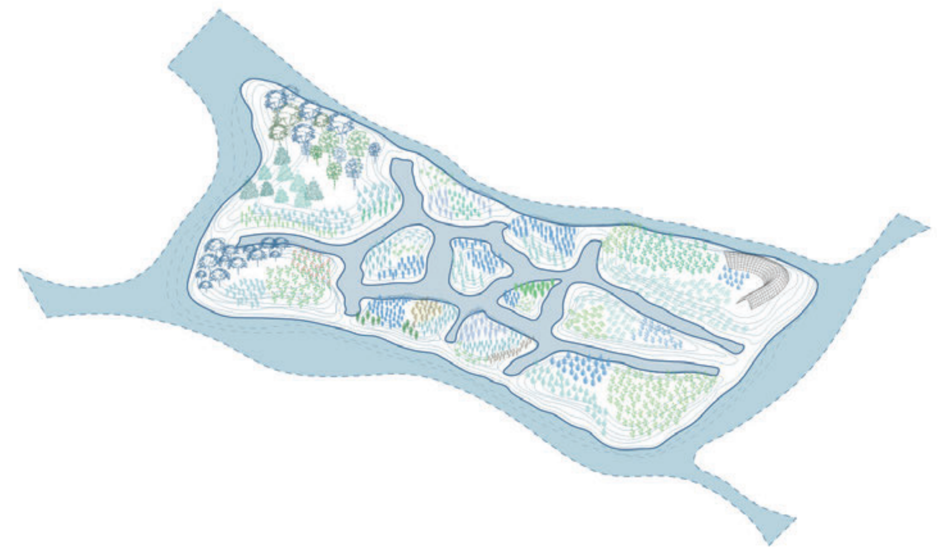
## SALT SPRAWL
Lake Urmia, Iran

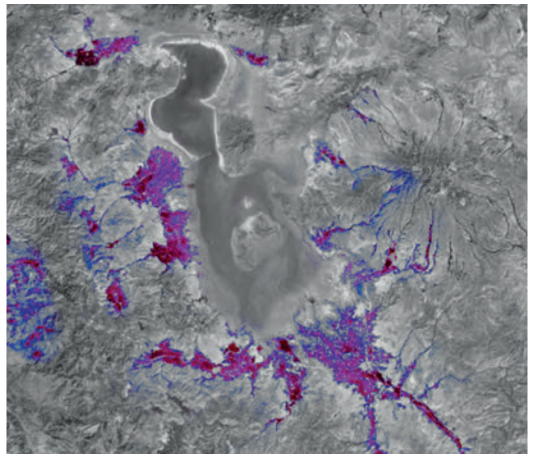
Salt Sprawl shows alternative ways of thinking, designing and manufacturing architecture. It sees the building and the landscape as living organisms which are the result of energies they are surrounded by and that work with them.
The project is located in the biggest saline lake of the world, Lake Urmia (Iran), which is characterized by arid climate and a wide difference between day-time and night-time temperature.
Surface flow and direct rainfall are the main water sources of the lake, but as a result of increasing temperatures and human activities, the surface of the lake has been decreasing by 80% in the last 15 years. Environmental resources (sun, water and salt) are the foundations of the project. Starting from the consequences of water scarcity, natural evaporation and salt deposit, the aim is to re-establish a balance between architecture and environment. The ecosystem approach tends to reduce the amount of water used for agriculture by shaping the soil and by ensuring natural drainage. Furthermore, the FEW strategy connects architecture and environment: each parcel provides a system of salt/desalinated water canals which restores the water cycle and different agriculture typologies which follow soil salinity. In this process, the building acts as a filter which uses the leftover of the evaporation process - salt - both as renewable energy source and as a construction material.
The building prototype is inspired by two basic concepts: form follows energy and a passive climate structure. The envelope follows the solar radiation analysis and results in a paraboloidal shape in section and in elevation, which is designed to maximize/minimize sun energy collection. Considering sun path, the wall thickness changes along the section in order to absorb solar radiation along the day and release it during the night.
The house is made of a timber structure and prefabricated salt panels which improve the conditions of inhabitation; salt porosity and reflectance, in fact, work with the differences of temperature outside and with the solar shape of the building improving internal comfort conditions.

*Mara Fraticelli*

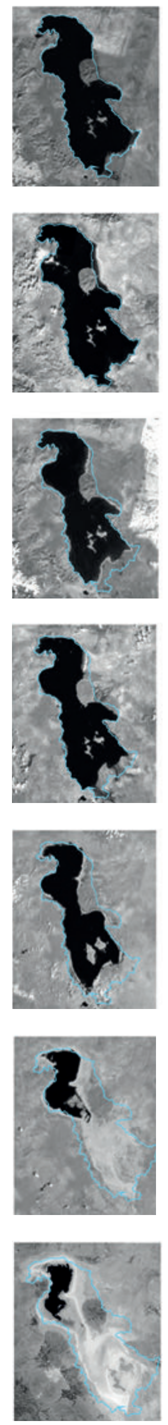


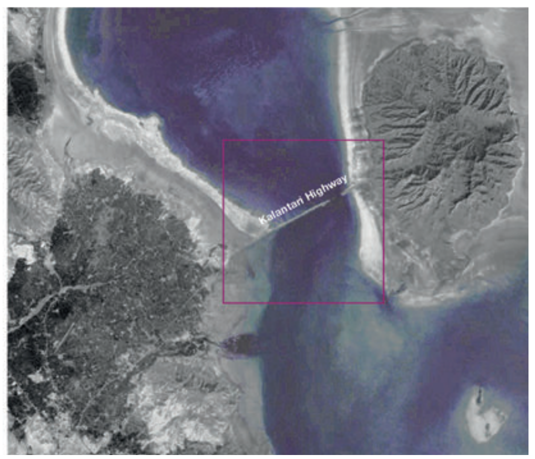


Lake Urmia is the largest permanent hypersaline lake in the world and was designed a UNESCO Biosphere Reserve in 1976. The lake is an important habitat for many species of reptiles, amphibians, mammals and migrant birds. The surface area has been estimated around 6100 km2, but since 1995 it has generally been declining and was estimated from satellite data to be only 2366 km2 in August of 2011.

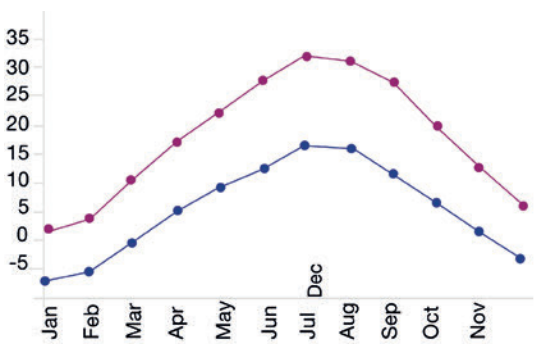


**Water management**
The watershed of the lake is an important agricultural region with a population of around 6.4 million people; an estimated 76 million people live within a radius of 500 km. As a result, the lake's water level has dropped by as much as 9 meters over the last two decades.





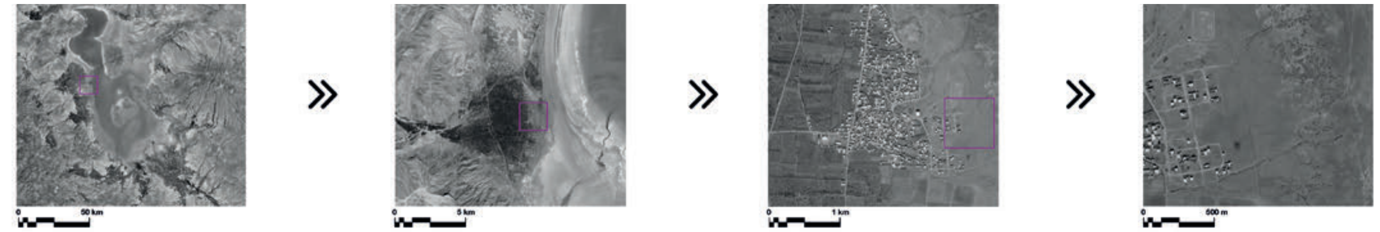

**Damn construction**
The the dyke-type "Kalantari" highway connects the two major cities across the lake and bisects the lake into northern and southern part. As a consequence, natural water circulation, sedimentation pattern and evaporation rates have been significantly altered and high levels of heavy metal contaminants have been introduced to the lake environment

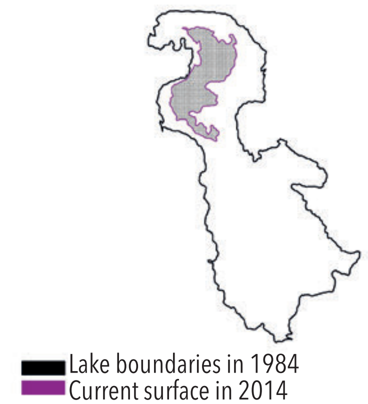



**Increased temperature**
The average annual temperature increased of 7° from 2000 to 2011. The annual rainfall within the basin from 1967 to 2006 was 235 mm, with variation between about 440 mm in 1968 to less than 150 mm in 2000. The arid to semi-arid climate of the basin means that agriculture is largely dependent on irrigation.

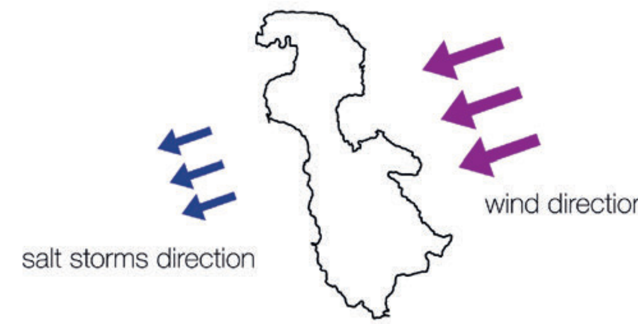






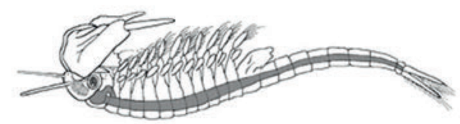



As lake levels decline, the exposed lake bed is left with a covering of salts, primarily sodium chloride, making a great salty desert on much of the 400 Km2 of lost surface area.




The concentration of salt in the lake passed from 200 g/L to 300 g/L with a red negative impact on growth rate, reproduction and mortality of phytoplancton and algae colonies.

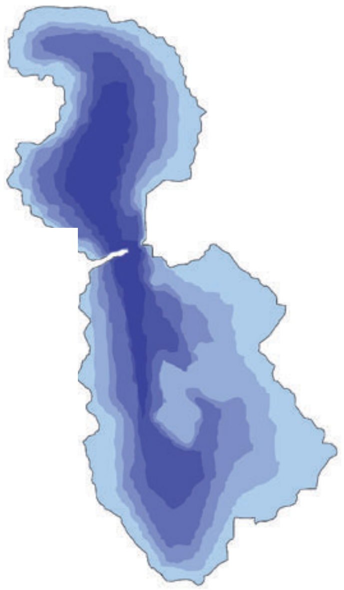
Exposed to wind erosion, the salt desert generates 'salt storms' with serious impacts on local agriculture as well as regional health causing respiratory illness, eye problems and throat cancer in the worst cases



The high salinity has caused a severe decline in biodiversity (both species richness and biomass).The endemic Artemia Uromiyehna populations that live in a salinity level of 240 g/L have stopped hatching, except at the mouths of incoming streams where salinities are lower.

As a result, species that feed on brine shrimp have declined dramatically and migratory waterbirds have abandoned the area.

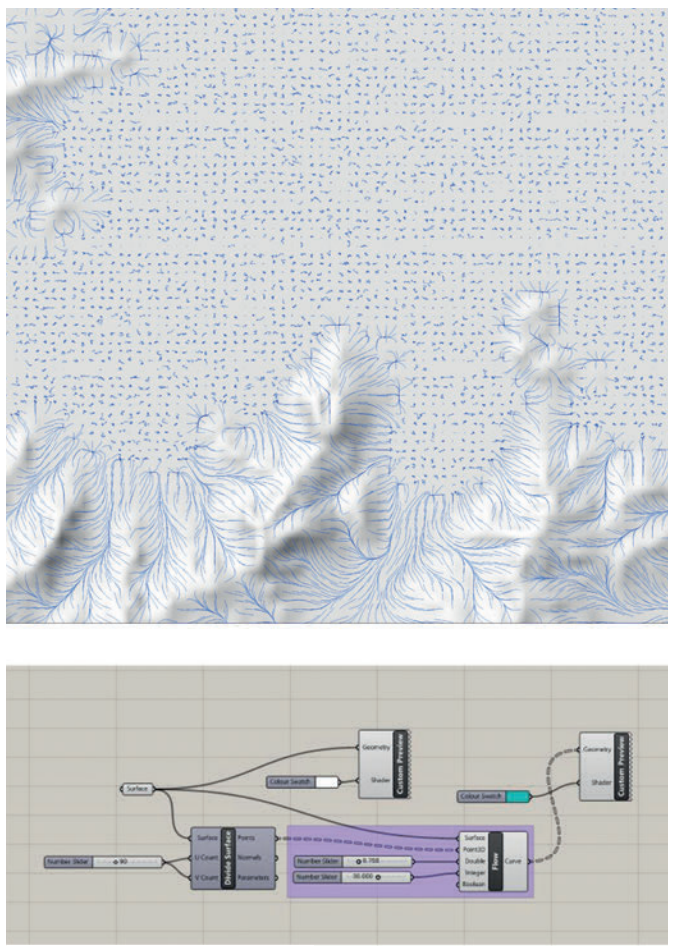
### Water level



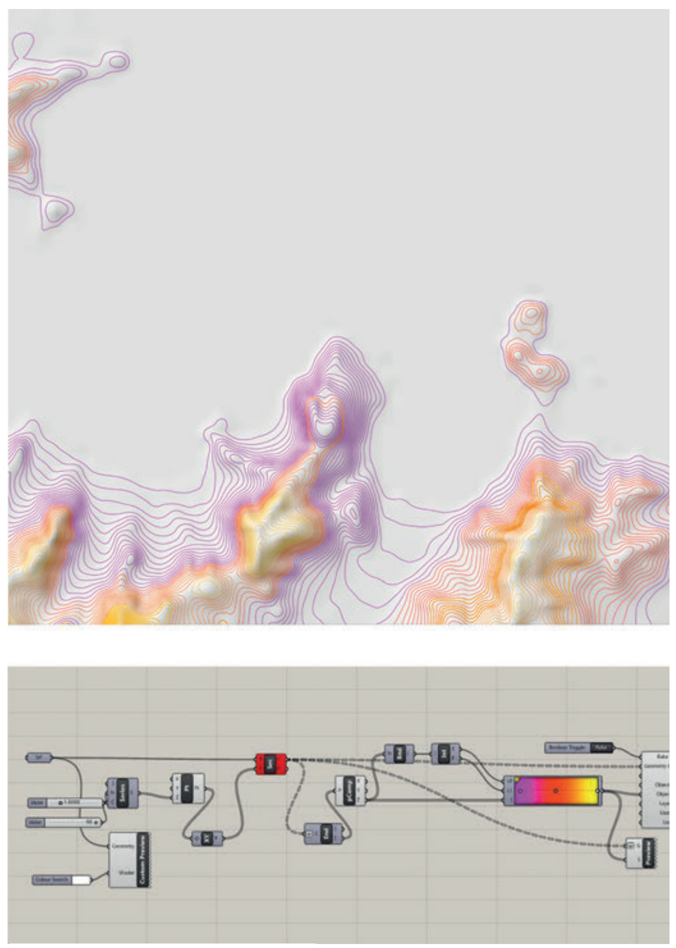

Variability of the lake prior to the early 1960s does not appear to have been widely studied, however, a generalized plot of lake levels dating back to the early 1900s shows one brief period in 1937 where deepest point of the lake was 7 mt under the surface level.

### Summer average temperature


Decreasing the lake's surface area leads to expansion of salt planes with high albedo and affects the thermal balance of the atmosphere above the lake.



Water flow simulation

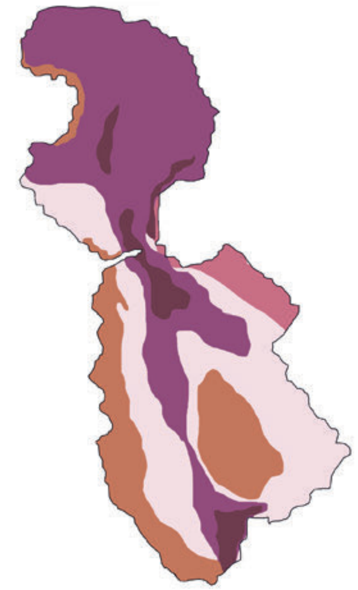


Contour lines

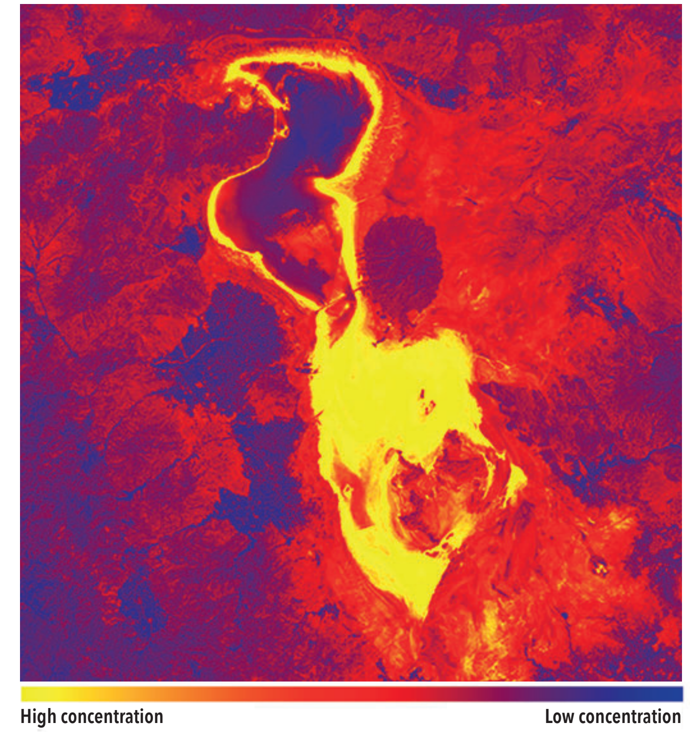


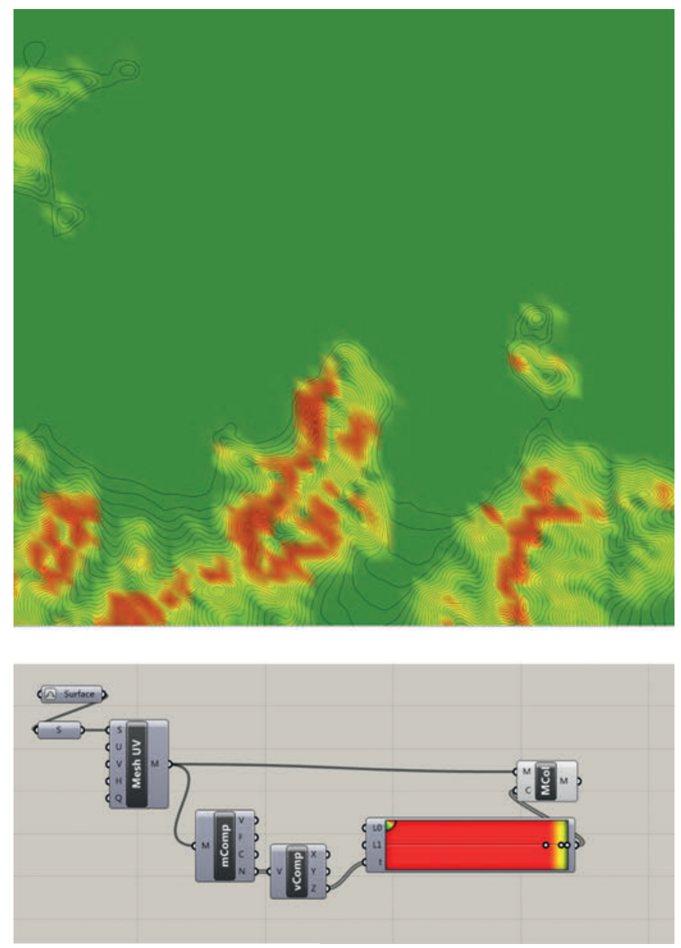


### Salinity

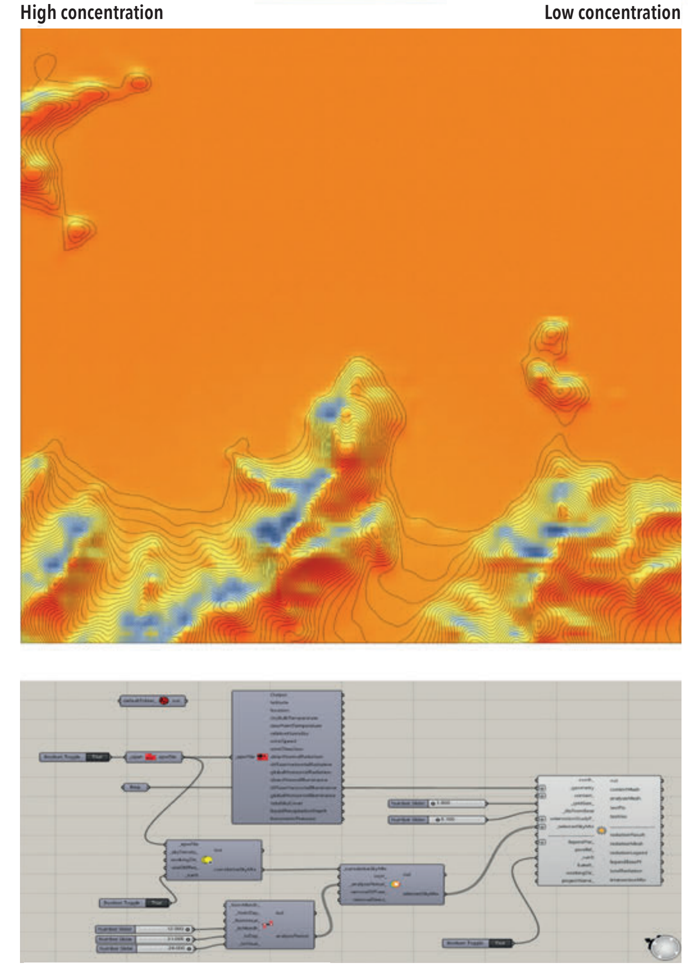



As the lake retreats from its original shoreline it leaves a layer of salt (primarily sodium chloride) which leaves the land unusable for agriculture and threatens to unleash damaging storms of wind-blown salt on the surrounding area.

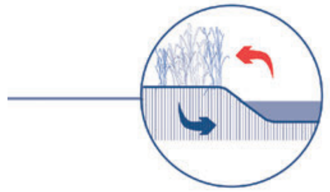


Slope gradient

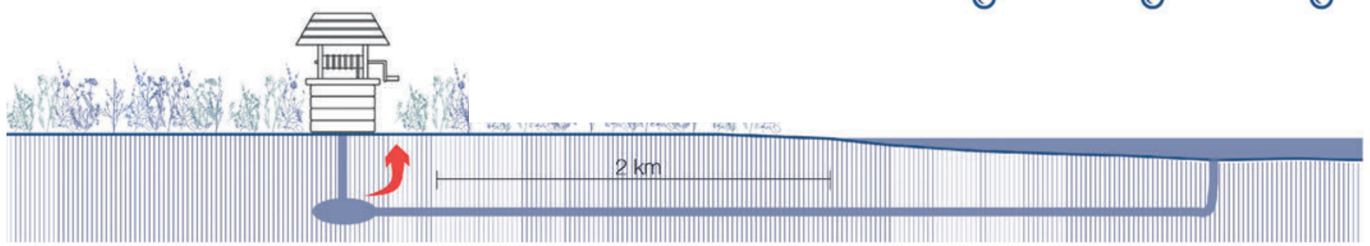


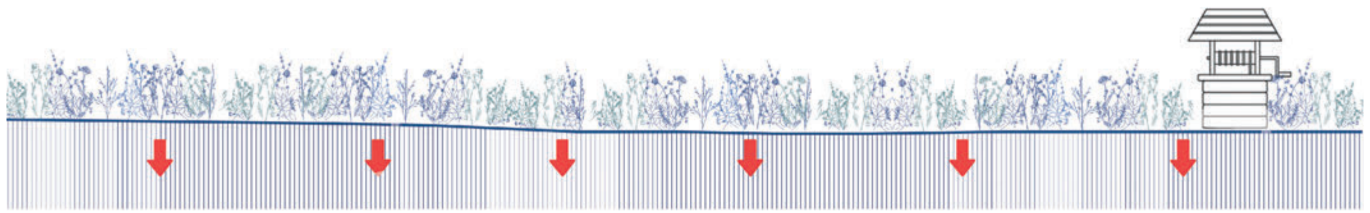
Annual solar radiation

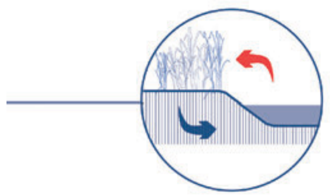


**"Ecosystem approach"**
The 'ecosystem approach' is a strategy for the integrated management of land and living resources that promotes conservation and sustainable use in an equitable way.

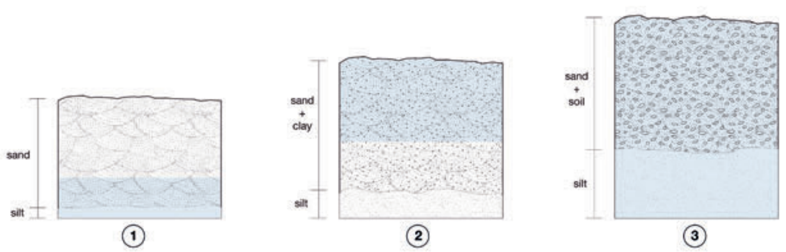
**Agricolture-based economy / Cultivation of:**

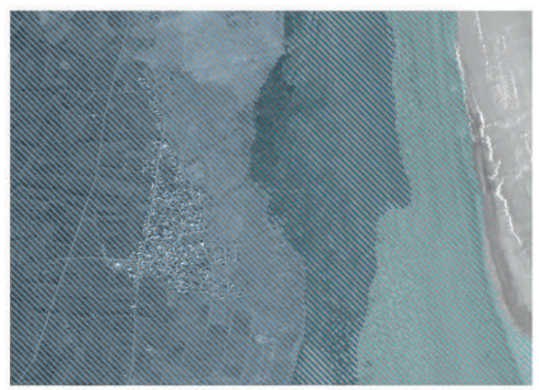





**Different soil stratifications for different agriculture typologies** / One of the main problem of the agricultural fields around the Urmia Lake is their soil composition - mainly sandy soil - that absorbs water very quickly and leaves the surface semi-dry. Furthermore, the typologies of plants cultivated should consider both the soil stratification (that means the way of draining water) and the salinity concentration of the soil itself. Because the provinces that surround the lake have an economy based on agriculture, it is important to find the right dimension of each lot in order to produce enough food and sell it.



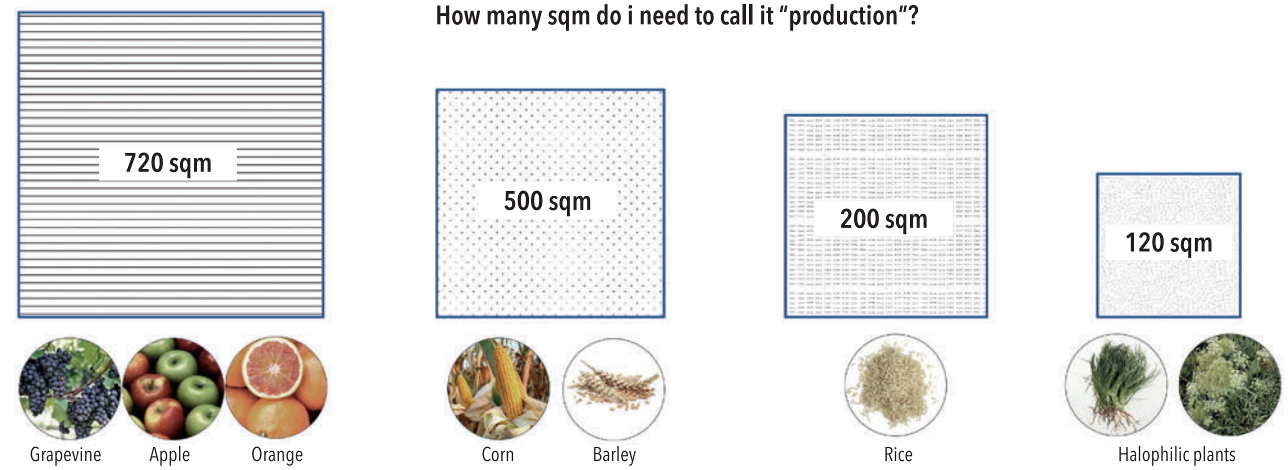



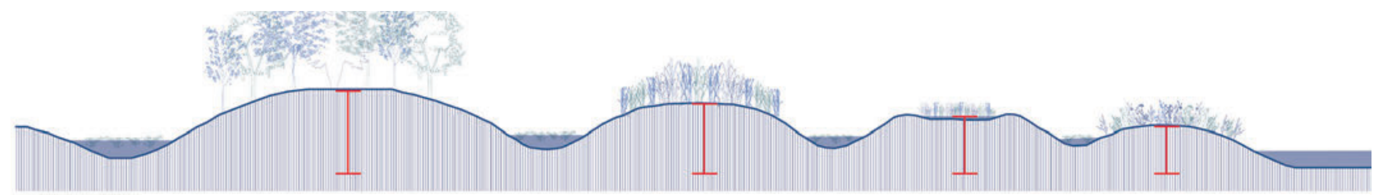
**Type 1** low salinity **Type 2** medium salinity **Type 3** high salinity





**How many sqm do i need to call it "production"?**



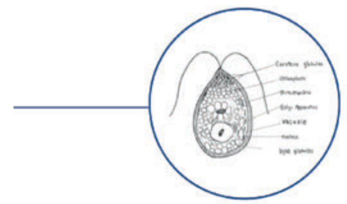



**Soil type 3** 2,00 m above lake level

**Soil type 2** 1,00 m above lake level

**Soil type 2** 0,60 m above lake level

**Soil type 1** 0,30 m above lake level

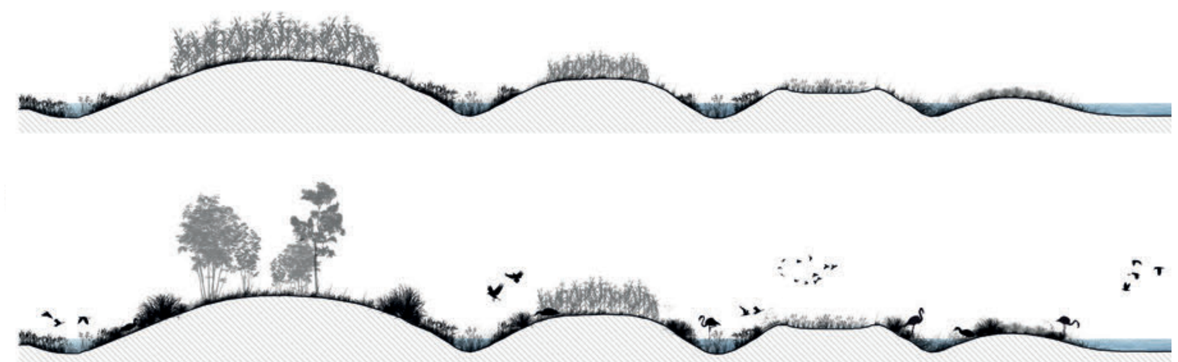


**Dunaliella algae** / Dunaliella is a genus of the algae family of Dunaliellaceae. It is the only natural species that grows in the Dead Sea because of its capability to resist high level of water salinity.

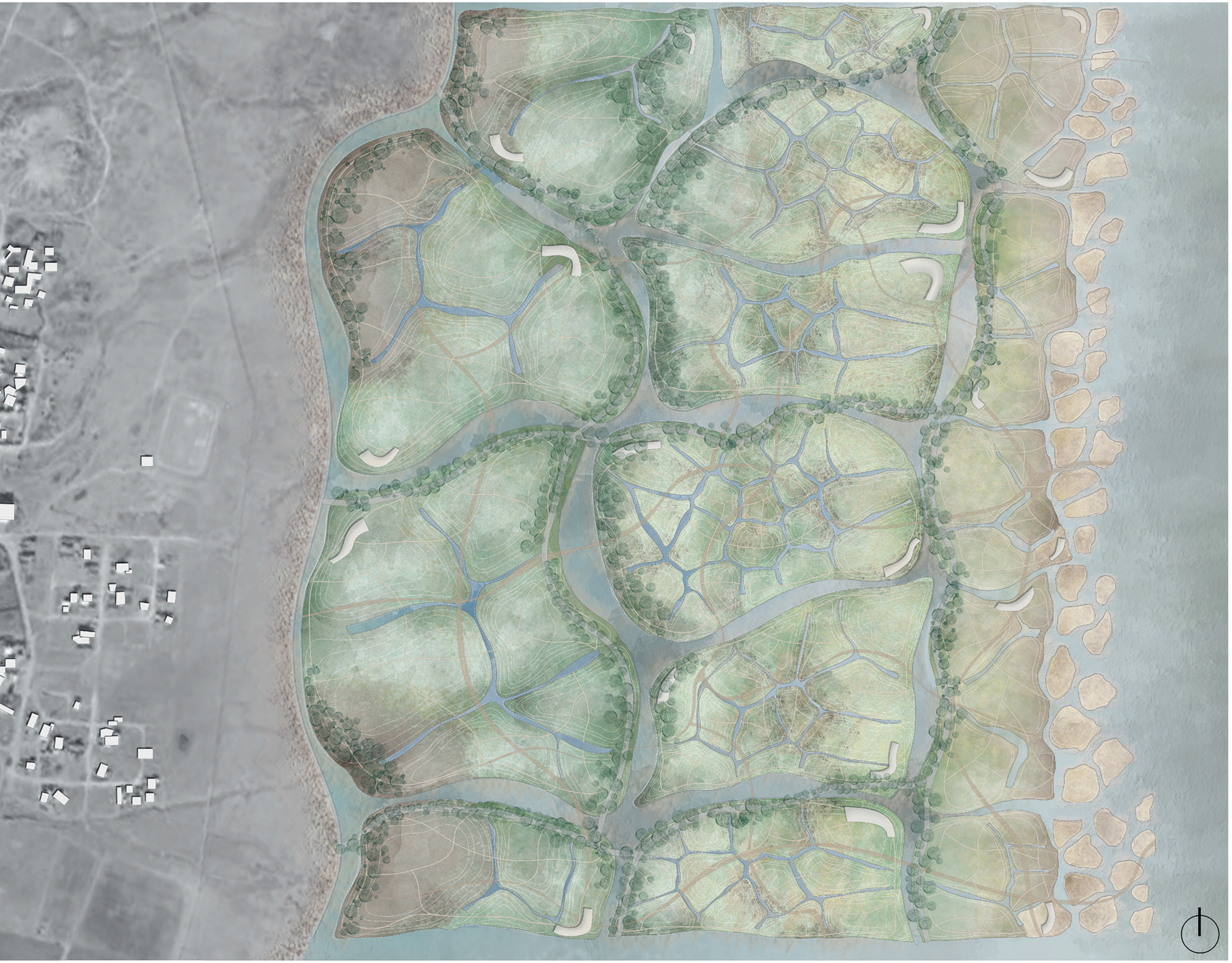
1
Algae insertion

2
System development (50 years)

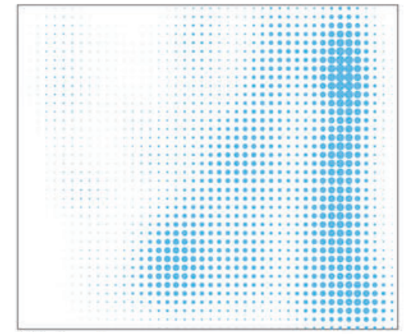
3
Wetland (100 years)



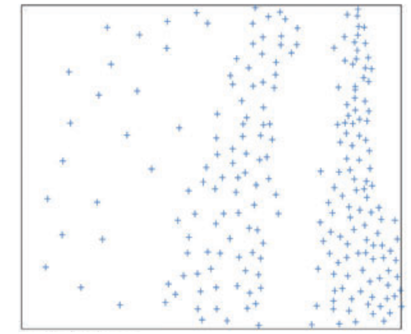
/ SALT SPRAWL / Site proposal



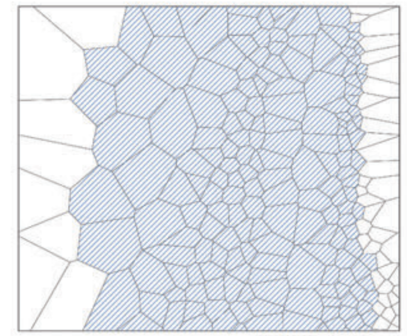
Masterplan



Salt typology

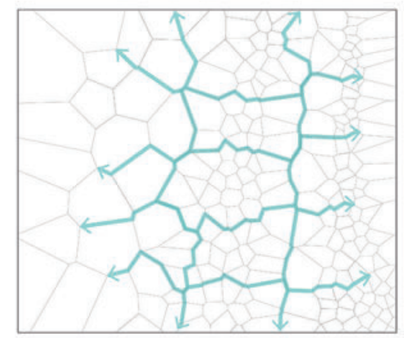


Point derivation

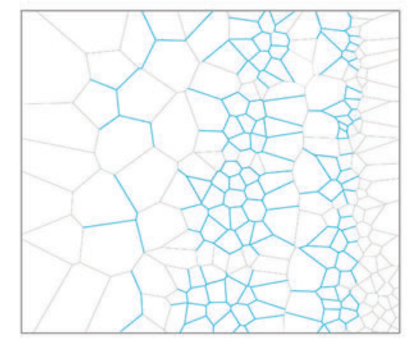


Voronoi tessellation

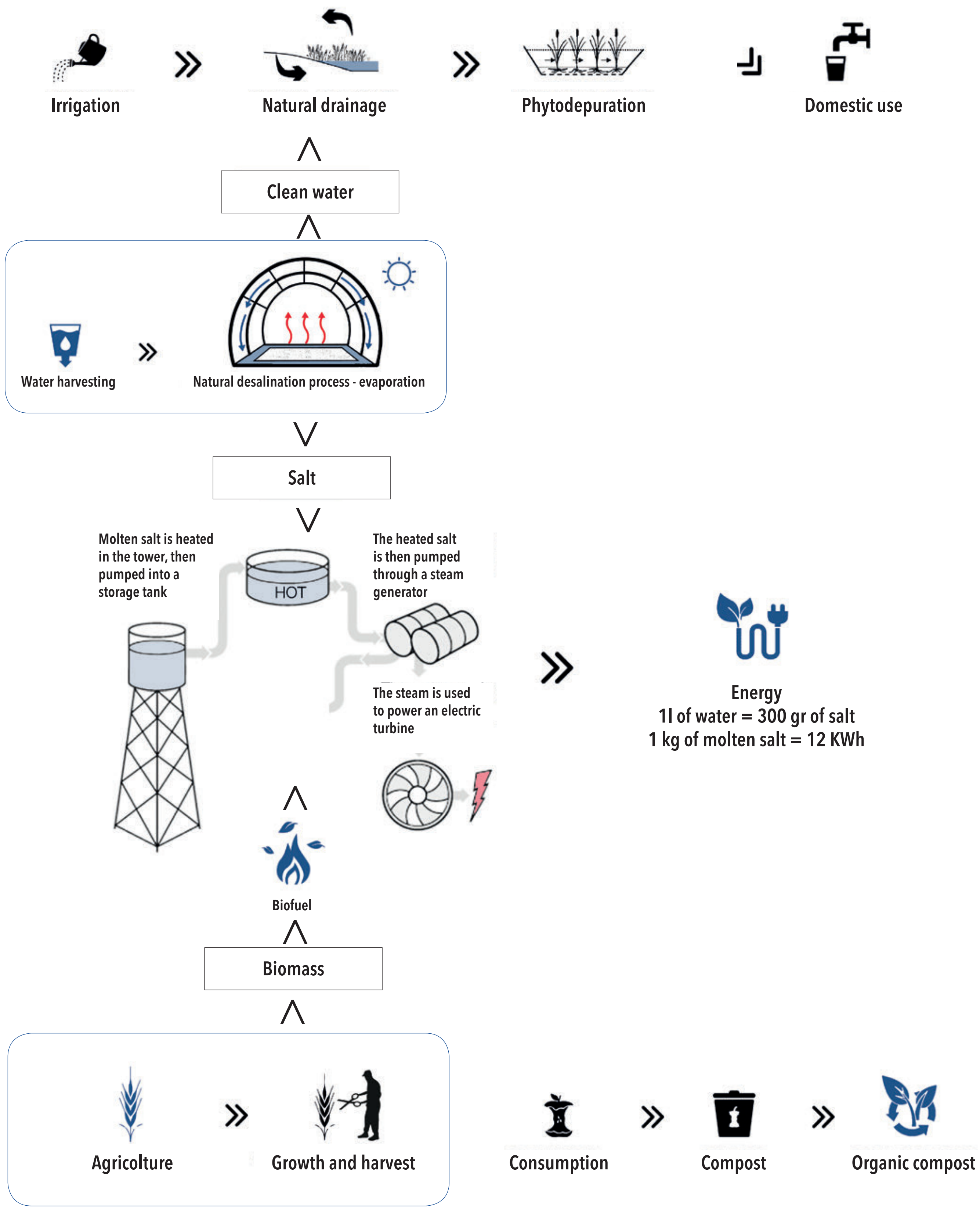
Parcel subdivision



Salt water canals



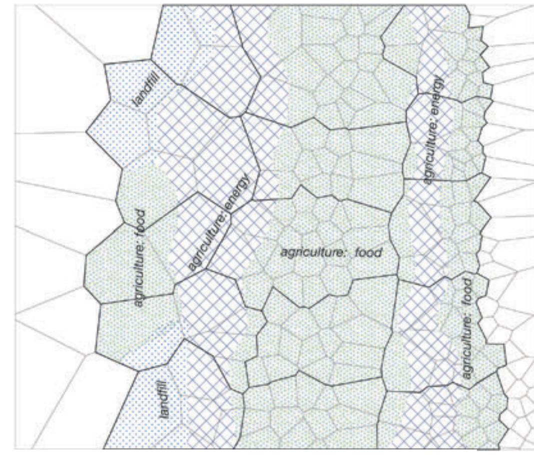
Desalinated water canals



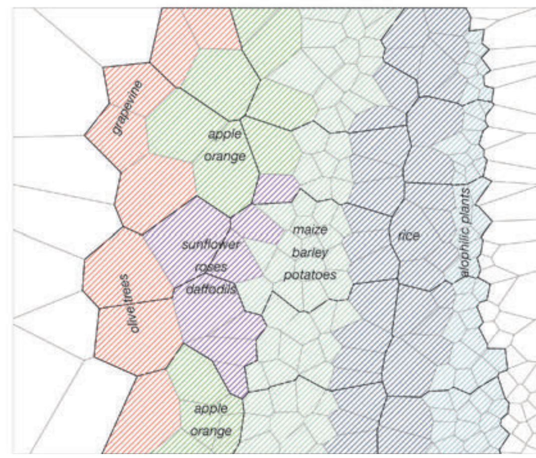

FEW'S strategies





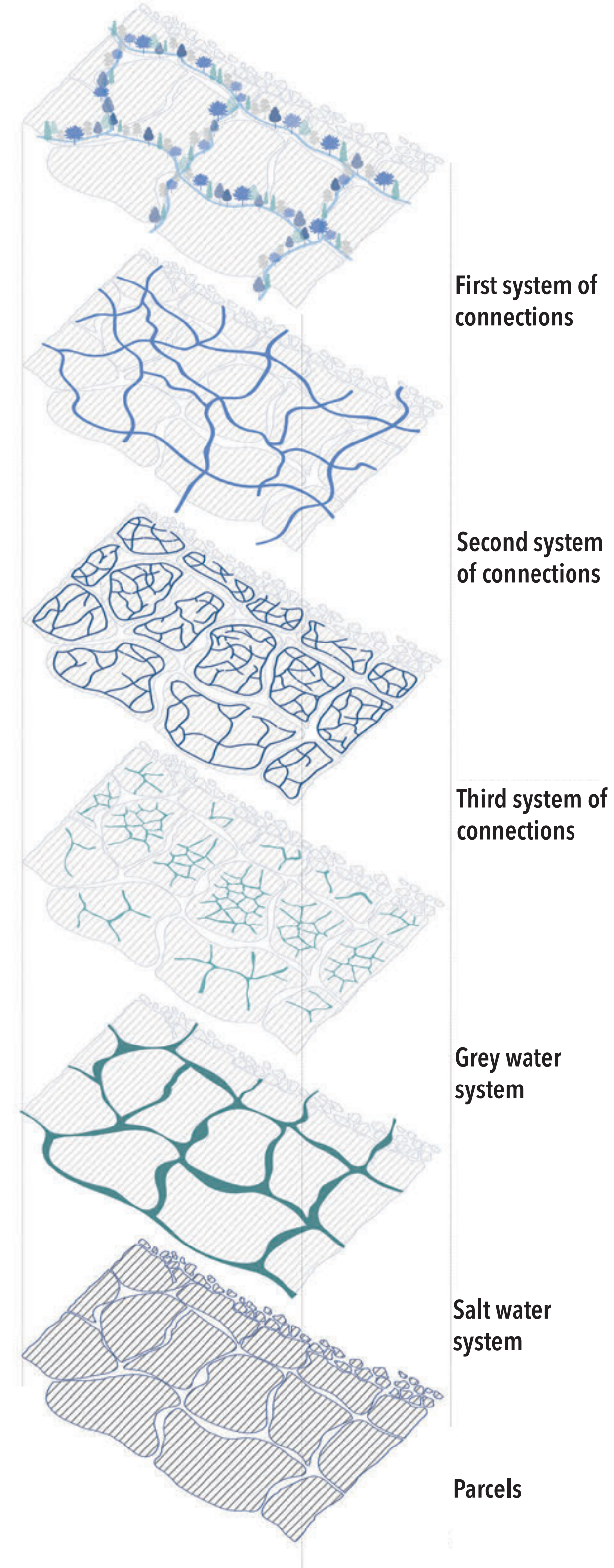



FEW's interaction




Agriculture typologies

- Food production self-sufficiency
- Energy production
- Reuse of waste
- Water recycle
- Micro-economy based on agriculture



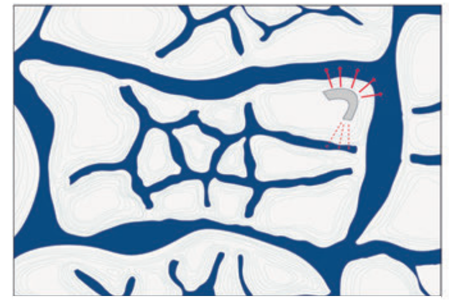

Hierarchy of the system

**Parcel strategy**
Each parcel is designed according to the FEW's program, providing a continuous interaction between the building and the environment.
The presence of a big portion of agriculture and the water canals provide the right amount of food, energy and waste for a singular family. The network of paths crosses the parcel and, at the same time, subdivides it into small parts - each of them with different function such as food cultivation, landfill, biomass, ecc...
The building is displayed at the edge of the parcel, directly connected to the water canals in order to guarantee the water cycle and salt extraction.
The portion of the building dedicated to the evaporator faces a north-south orientation so that it guarantees the maximum amount of surface covered by solar radiation and it guarantees a continuous evaporation. On the contrary, the portion dedicated to housing follows a east-west orientation so that it avoids direct solar radiation during the day.

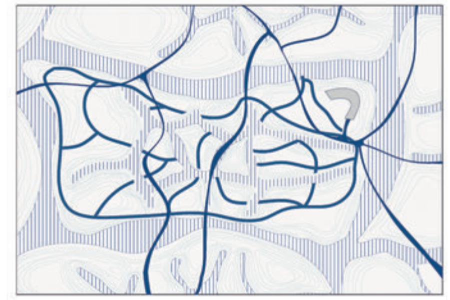
Parcel design



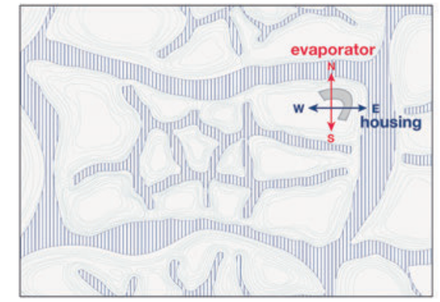
/ SALT SPRAWL / Parcel development



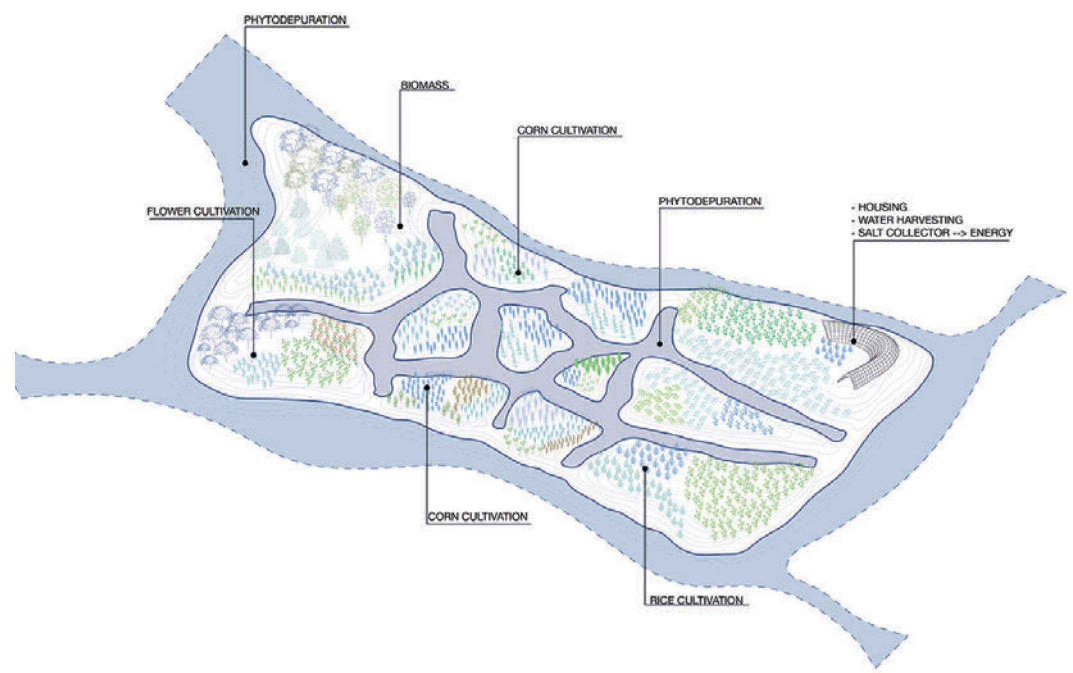
Function: direct connection to water canals

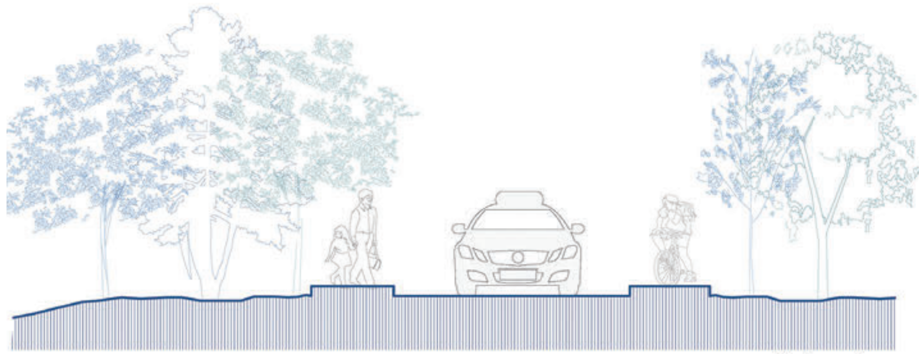


Landscape: integration with path network



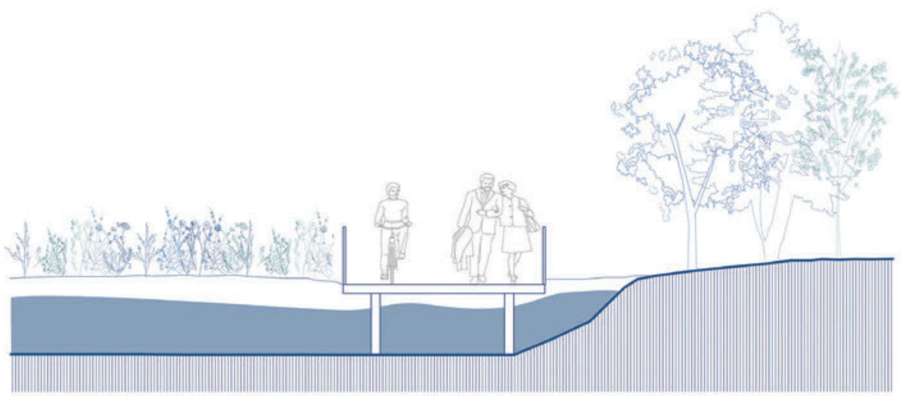

Program: N-S and E-W orientation





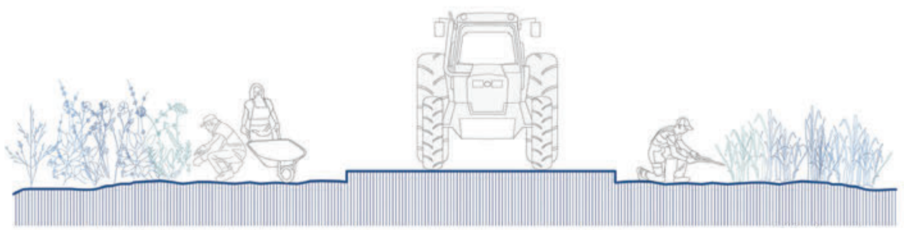
First system

The first system of connection consists of 4 mt wide roads, lied with pedestrian paths and trees. This system is the continuation of the existing urban street network and crosses the site according to the idea of 'cardo' and 'decumano', dividing it into eight sectors strictly connected.



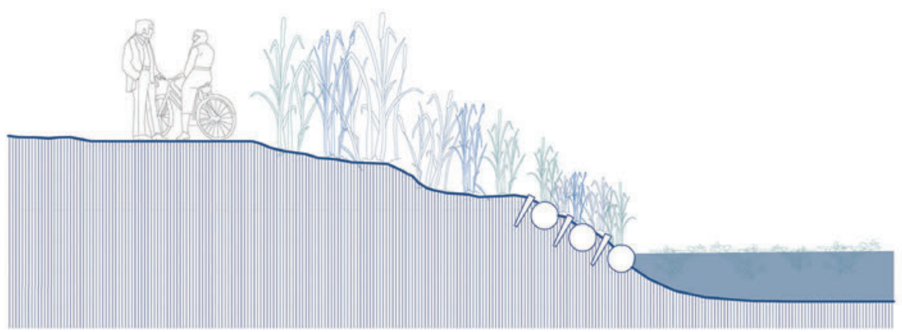
Second system

The second system is for pedestrians only and it is more linked to the experience of the place rather than the function of connection itself. It's an organic and fluid network elevated above the ground that connects all the buildings. Sometimes it becomes a pier on the water canals, sometimes a runway through trees or through agricultural fields.



Third system

Since most of the land is dedicated to agriculture, it is important to provide a network of streets reserved for the passage of tractors and other means. The third system crosses and cuts the parcel, dividing it into smaller parts, each of them dedicated to a different typology of agriculture.

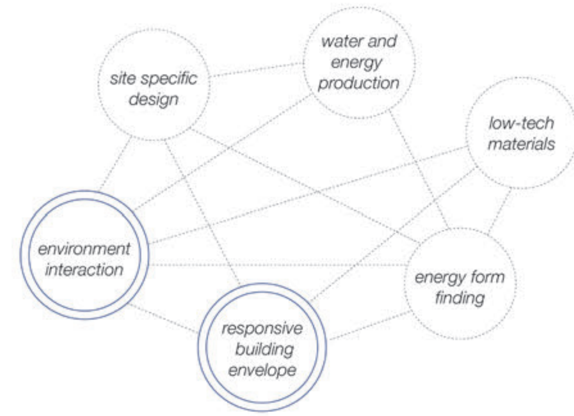


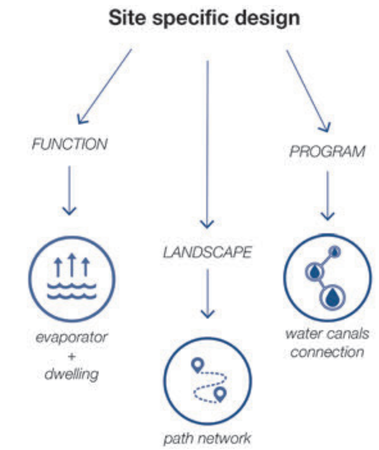
Water canals - Phytodepuration system

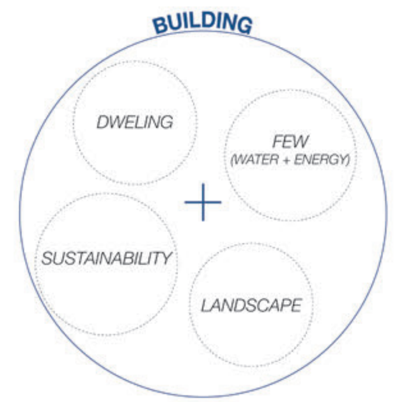
According to the strategies of the project, water management and reuse is important for the success of the project. Thanks to the natural slope, water is drained from agricultural fields to the water canals; then, it is depurated thanks to the alge from chemical agents usually used in agriculture and purified water is pumped and stored into tanks in order to re-start the process.



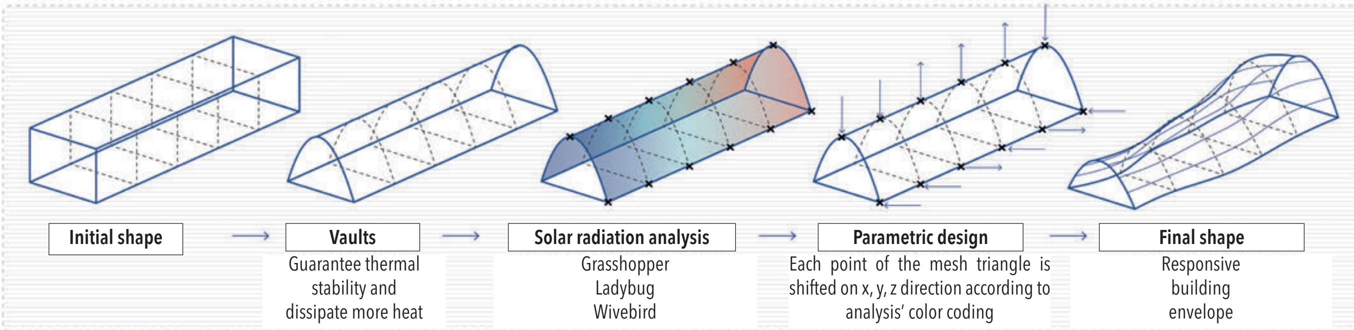




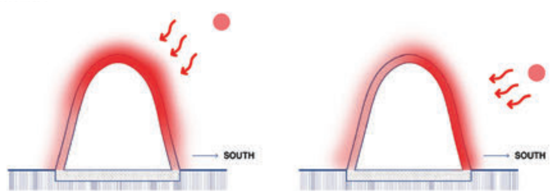




External view



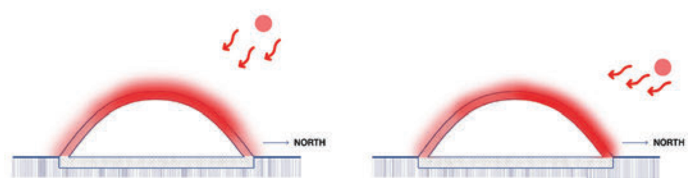

Conceptual diagram of form finding

**Height**



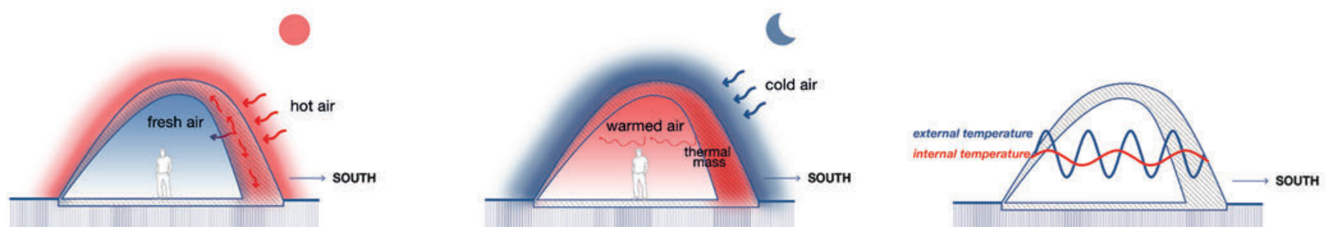

Summer Winter

**Width**

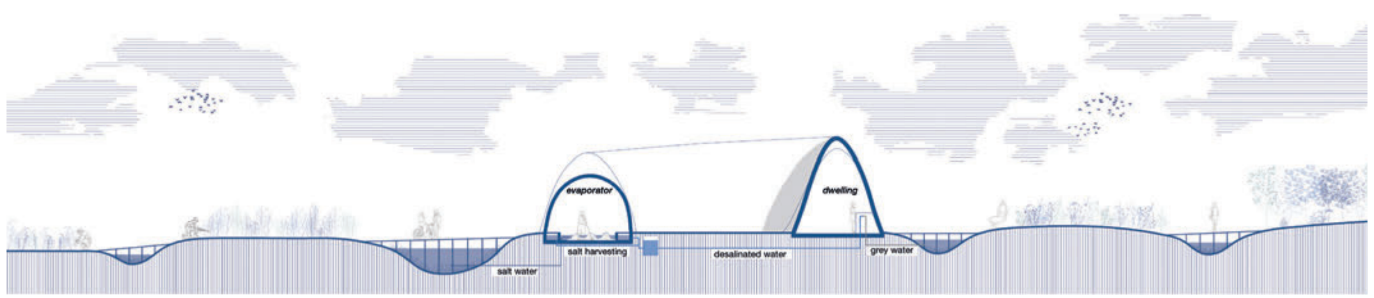



Summer Winter

**Wall thickness**



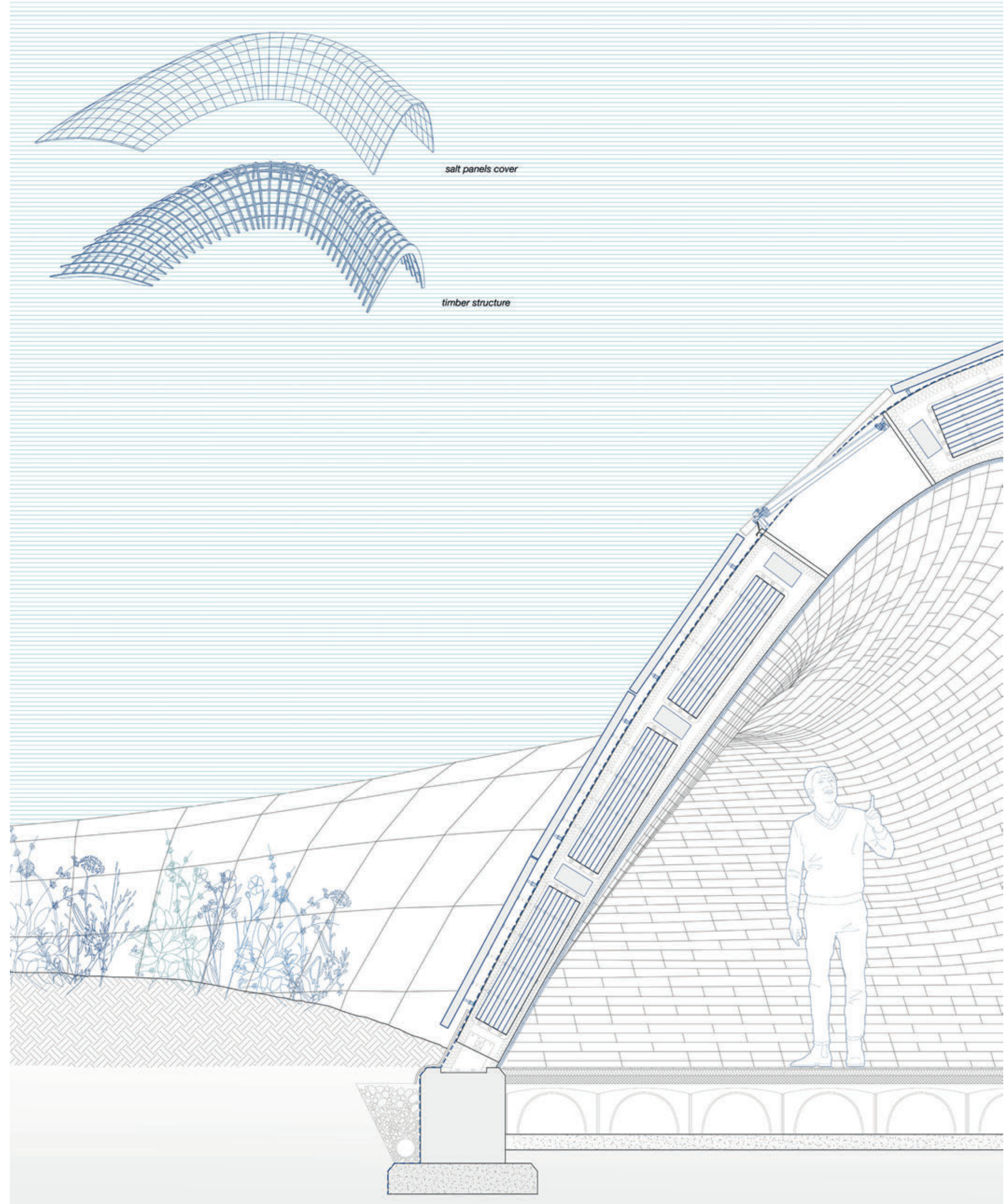

Day Night Daily temperature




Section

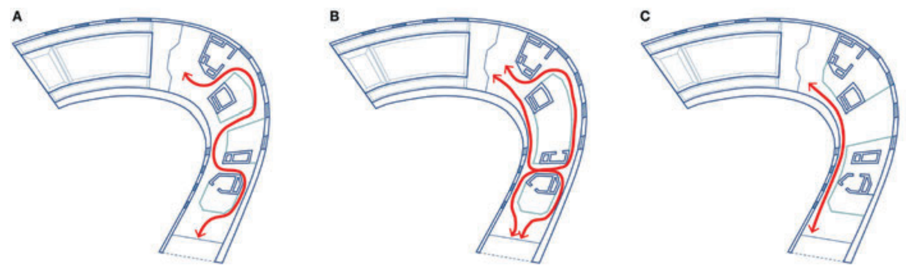


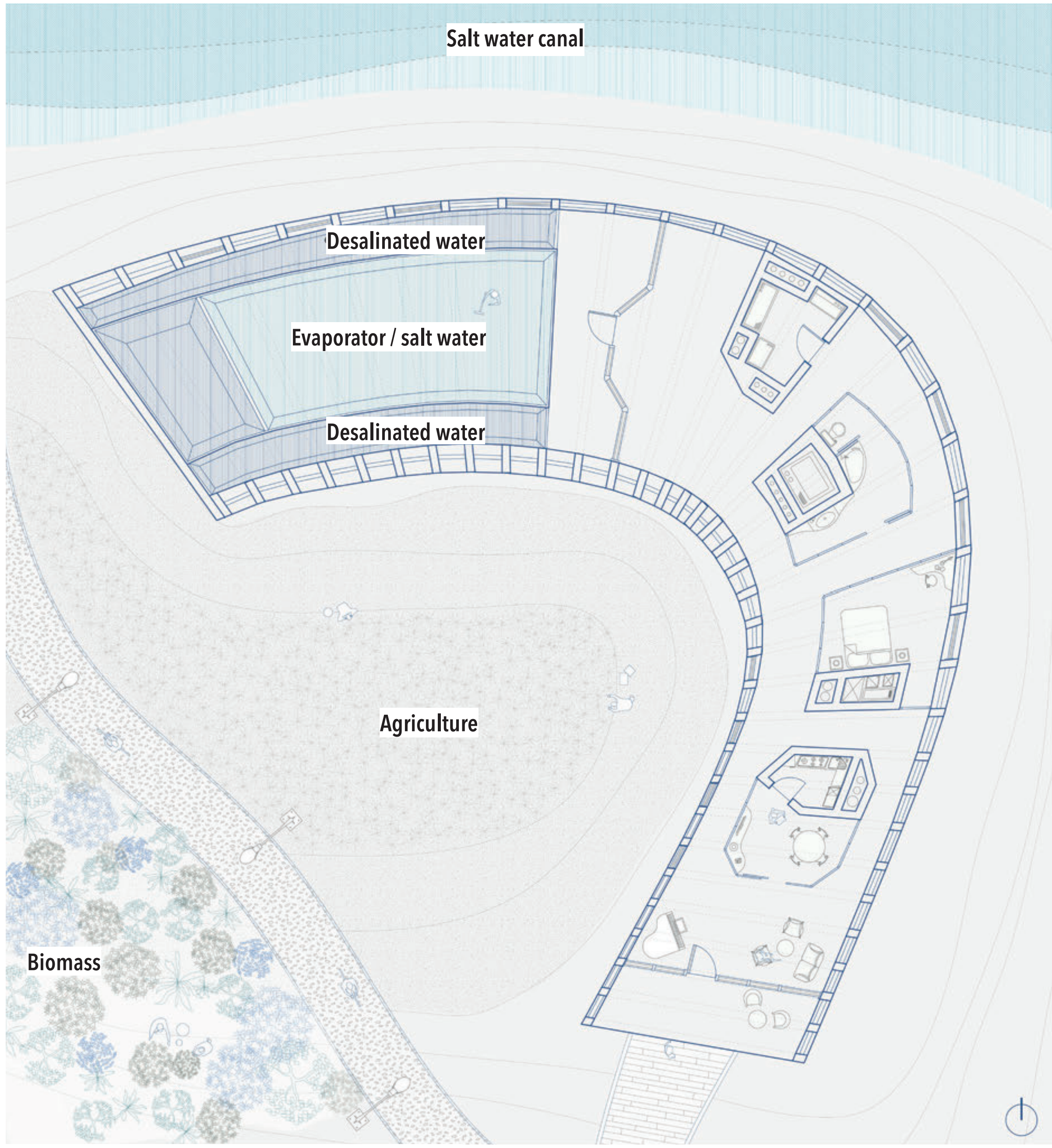





Detailed section

**Interior design strategy**
The different thicknesses of the walls provide a stabilization f the temperature inside the building, avoiding the concentration if heat/ cold in some areas. With this system, the building works as a whole structure, a unique room. The optimal solution consists of fixed walls containing services and sliding panels, in order to create a space that is both flexible and livable.



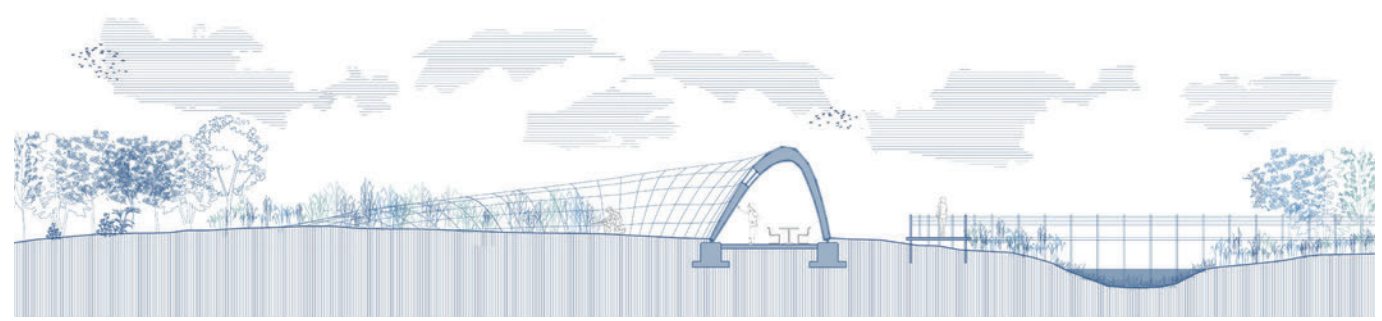




Plan



/ SALT SPRAWL / Architectural drawings

Section A-A'



Section B-B'

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Simone Giostra is an architect, writer and professor of architecture at the Pratt Institute in New York and at the Graduate School of Archietcture at the Politecnico in Milan. He is the founding partner of SGPA, a full service firm based in New York. Mr. Giostra has lectured extensively in Europe and the US and his work was published in several books and journals.


## Hope Strode
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Hope Strode is a practicing landscape architect and architect. In 2014 she co-founded Atelier de Molfetta Strode, a landscape architecture firm with offices in Milan and Lugano. Prior to establishing her firm, she practiced professionally in the United States, Canada and Europe. She is currently an Adjunct Professor at the Graduate School of Architecture at the Politecnico in Milan.


## Giovanni Nardi
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Giovanni Nardi was born in Venice in 1988 and moved to Milan in 2007 to join Environmental Architecture at Politecnico. After graduation, he studied photography at the Italian Institute of Milan, specializing in architecture photography. During his Master course in Architecture, he studied with Professor Giostra and served as co-editor for the 2016/17 yearbook.


## Alberto Lunardi
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Alberto Lunardi was born on 20 June 1992 in Treviso and studied architecture at the "Istituto Universitario di Architettura di Venezia, IUAV". After graduating in 2011, he moved to Milan to enrol in the international master degree in Architecture at Politecnico di Milano, where he attended the Architectural Design Studio 2 and was selected to co-edit the 2016/17 yearbook .




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