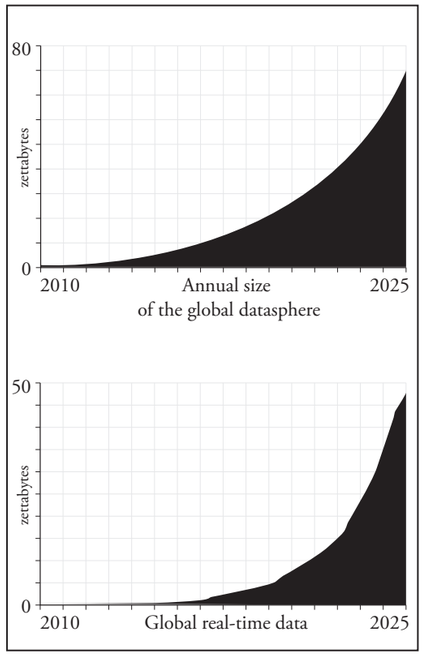
How much does your cloud weigh?



Country / City	Italy, Ferrara
University / School	University of Ferrara / Architecture Department / Sealine Research Center
Academic year	2017/2018
Title of the project	MATERIAL INTERNET. Opportunities in the relationship between data-centers and landscape
Authors	Gregorio Gonella

TECHNICAL DOSSIER

Title of the project	MATERIAL INTERNET. Opportunities in the relationship between data-centers and landscape
Authors	Gregorio Gonella
Title of the course	Master Thesis Laboratory in Landscape Architecture and Infrastructures
Academic year	2017/2018
Teaching Staff	Luca Emanueli, Gianni Lobosco (Supervisors), Massimo Tondello (Co-Supervisor)
Department/Section/Program of belonging	Architecture Department / Sealine Research Centre
University/School	University of Ferrara

Written statement, short description of the project in English, no more than 250 words

Digital Age is approaching a new era: the global datasphere will see a remarkable growth of volume that can only be supported by an analogue expansion of the internet physical infrastructure. By focusing on data storage, the thesis investigates how data centers will change trying to figure out if this process can affect the way they dialogue with the environment and its evolution. The specific case-study concerns the Italian digital agenda for gathering the Public Administration servers in few national data centers. The complexity of the Italian territory makes their right position a challenging matter which has been tackled through the aid of a GIS-based analysis carried out by taking into account environmental risks, logistic and functional criteria. The Po River Delta area has been choose to explore the mutual integration of large-scale infrastructure and environmental processes. By working through a scenario thinking approach, it has been possible to depict three different narratives concerning the Delta future layout: each scenario investigates a different attitude to landscape transformations and the potential role of data centers in the process. Each proposal aims at provocatively understanding how climate change and environmental degradation of the Delta could be faced by the means of a datascape development envisioning data centers as a landform building typology. Going beyond their actual purpose of store, protect and save our pieces of information, data centers, as probably the most powerful expression of the material internet, could finally ground a new type of collaboration between the datasphere and its physical footprints.

For further information
Máster d'Arquitectura del Paisatge -DUOT - UPC

T: + 34 93 401 64 11 / +34 93 552 0842
Contact via email at: biennal.paisatge@upc.edu

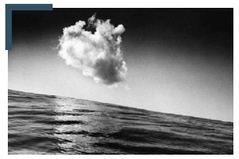
Máster d'Arquitectura del Paisatge -DUOT - UPC
ETSAB- Escola Tècnica Superior
d'Arquitectura de Barcelona
Avenida Diagonal, 649 piso 5
08028 Barcelona-Spain

CLIMATE CHANGE AGAIN

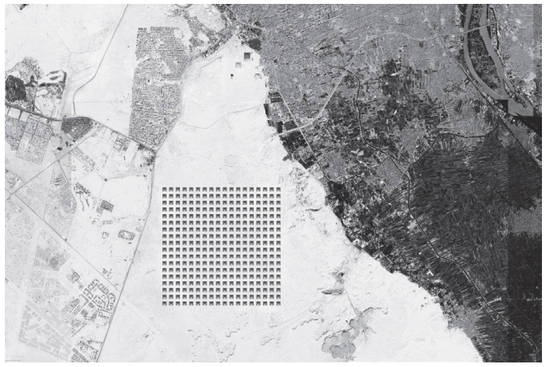
11th International Biennial Landscape Barcelona

Barcelona September 2020

SCHOOL PRIZE

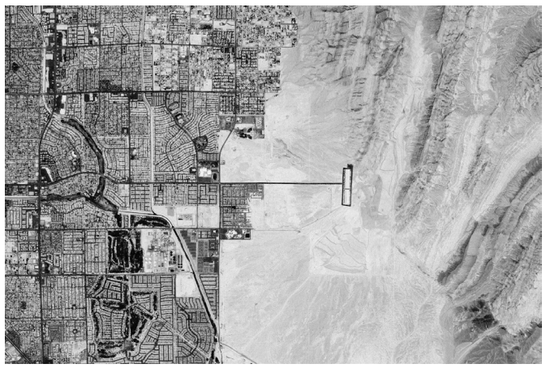


The widespread idea of an ethereal, boundless, intangible Internet finds its deepest roots in its origin: born as a military and research structure, and only later opened to the public. The large economy that today the Internet supports leads the subjects involved to make it less flashy and plan it away from the spotlight. Like other infrastructures, it is deeply linked to the territory, to the seas under which it passes, to the land on which it sinks. An internet flying in the sky is the most distant image from reality there may be. Instead, it assumes on geography the scale of the sublime, its units of measure rise to the stars as if countless numbers of zeros appears on a calculator, as if we saw billions of lines of code written in secret languages slipping under the ground we walk.



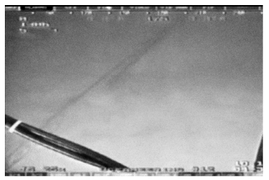
Scale

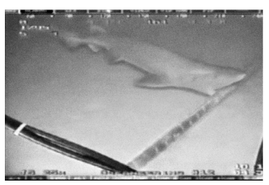
Forecasts indicate that by 2025 humanity will have produced 163 zettabytes of data. Images show 44 zettabytes stored in hard disk of 1 terabyte and stacked on top of each other: the physical space of hard disks only would produce 300 pyramids larger than the pyramid of Cheops in Giza, Egypt.

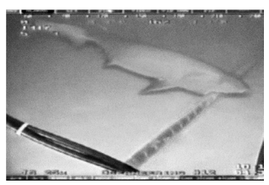


Energy

In 2017, it was estimated that the internet industry alone used 8% of the world's electricity. On the left, a Las Vegas data-center compared with the number of houses which use the same electricity; on the right, Mark Zuckerberg attending with his Oculus Rift a nuclear test in Enewetak Atoll, during 1951.

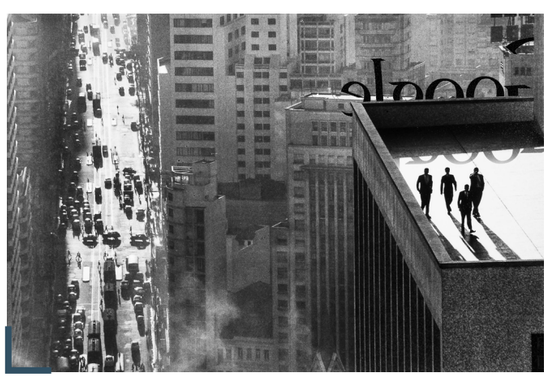






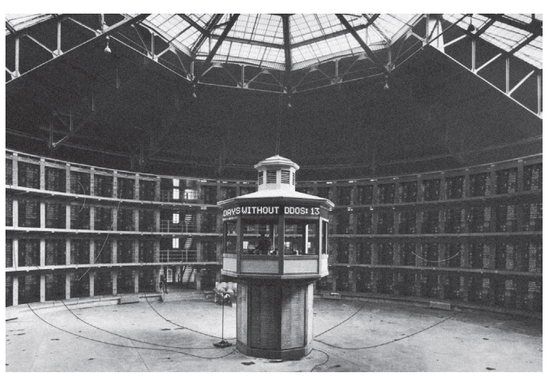
Geopolitics

Costs of internet blackouts demonstrate the importance of choosing the right location of physical infrastructures. On the left, a shark, attracted by magnetic fields, bites a fiber optic cable; on the right, the famous Apple Store in New York in the middle of a protest in Tahrir Square, Cairo, during the Arab spring.



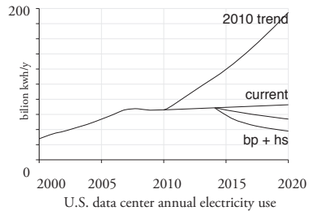
Security

Less than 1% of Google's employers has ever set foot in one of their own data-centers. On the left, a photo taken in 1960 by René Burri in Sao Paulo of mysterious negotiations over a Google building; on the right, a Cuban pan-optic prison transformed into a data-center of maximum security.



The next big thing(?)

LATENCY ISSUES

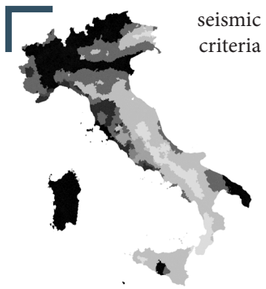


Gangnam Era & Hyperscale Shift

On December 21, 2012 the video "Gangnam Style" is the first to break the barrier of one billion views on YouTube. The event is a marker of Internet's evolution: streaming services take over in the entertainment panorama, and imply a drastic growth of data highly sensitive to latency. The contents need to be positioned close to the final user paving the road to development of edge data centers, smaller than classic ones and located near cities to ensure efficiency to services like Netflix or Spotify.
A study funded by the US Government shows us how the annual use of electricity in the U.S. would have grown dramatically if data centers had maintained the levels of 2010. Instead this curve has almost flattened thanks to good practices and the large use of renewable energy in the sector, but graph also shows how this curve could be even pulled down in a hyperscale shift scenario. It would mean gathering all the small data centers scattered across the territory into a few large structures: a similar operation would lead to savings of billions of kWh/year.

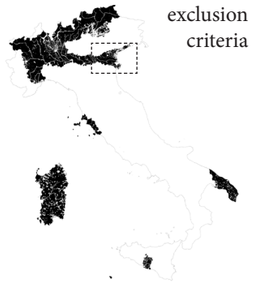
Split

Several factors leads to a splitting of the Internet infrastructure. On one hand, as showed above for a beach in the Adriatic, micro data centers will approach the critical-crowded areas already equipped with repeater. On the other hand, more and more large data centers will be built, no longer related with highly latency-sensitive data. As a result, minor data centers, as the one below captured by Luigi Ghirri, will be abandoned.

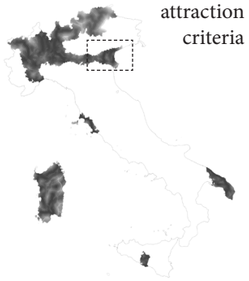


seismic criteria

In 2017, Italy approved a plan to improve the digital security of Public Administration systems. The most rational solution for the PA is the construction of few large data centers across the country to substitute the constellation of servers spread out among different spots. In order to find their more suitable location, the thesis has developed a GIS analysis based on the criteria used for radioactive waste disposal. Once all the areas with a seismic risk have been subtracted from the national territory, the remaining zones have been processed by additional exclusion (flood risk, landslide and avalanche risk, high land-value) and attraction (proximity to internet backbones and to the electric networks) criteria.
By just slavishly following risk reduction and logistic criteria, a sort of no man's landscape seems to arise. But, are there any alternatives?

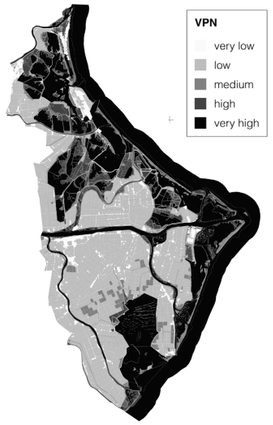


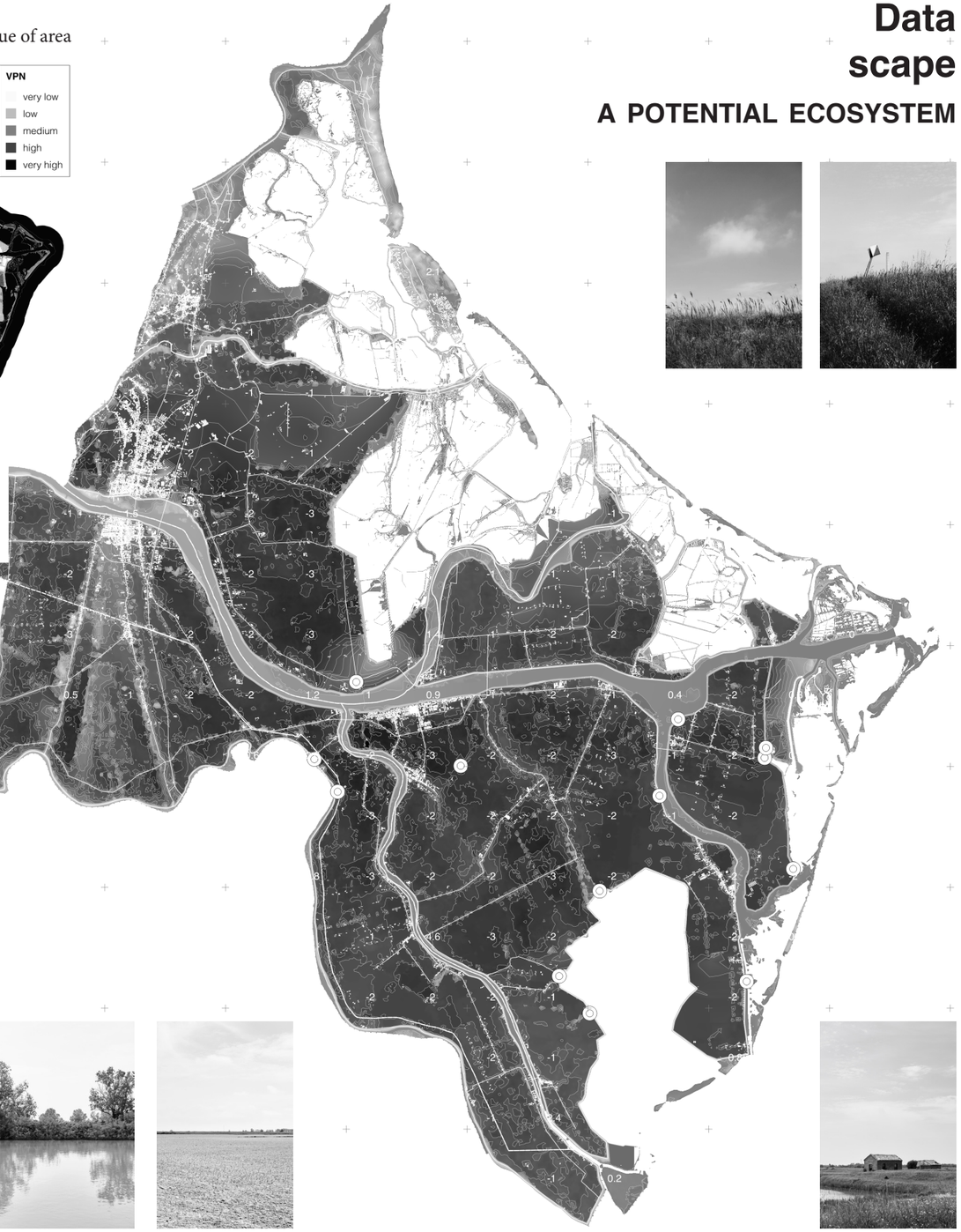
exclusion criteria



attraction criteria

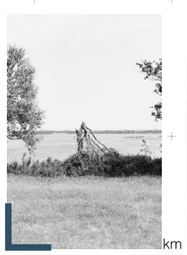
Potential Natural Value of area





Data scape

A POTENTIAL ECOSYSTEM



km

Versus another gray box

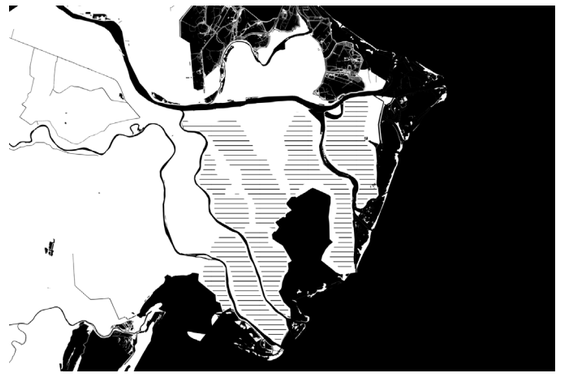
The north-east was chosen as a case-study macro area. The analysis shows the most attractive areas according to the criteria applied: Mestre, a part of the Euganean hills comprising the Monte Venda, the flatland below Rovigo, and the Adriatic coast up to Porto Viro. Checking these areas, it is clear that a totally scientific approach cannot be enough to tackle the topic concerning the possible relationships between the landscape and the infrastructures. The images above show as the data center would end up confusing itself among the other factories and industrial structures already spread through the territory or, as in the case of the reuse of the former Nato base in the Monte Venda, completely prevent a dialogue with the landscape.

The Po Delta option

The data center is a large-scale entity not only because of its square meters extension, but also because of its capacity to affect the surrounding territory, from energetic to urban issues. In such perspective, the collaboration between data and landscape is not a problem that can be solved or not, but the foundation of a design approach: addressed to built new ecosystems and to drive their evolutions. Respecting the criteria of the previous analysis, but moving in apparently less-appealing localisation gradients, the proposal of a data center is investigated within the Po Delta area, aiming at provocatively understanding how climate change and environmental degradation could be tackled through the means of a datascape development.

Strategic flooding

The Delta of the Po River covers 18.000 hectares occupied by lagoons, fishing diked valleys and wetlands. Such system is highly unstable, vulnerable to intense dynamics (coastal erosion, subsidence, saltwater intrusion, etc.) affecting both its ecological value and the human activities. The infrastructural effort to freeze its evolution is no longer maintainable and increasingly less efficient, given the site dimension and complexity. A selective retreat could be a radical solution to better manage the investments and maximize the efforts on some specific settings, deliberately omitting others. The proposed flooding strategy for the Po delta aims at integrating climate changes into a long-term sustainable scenario. Such hypothesis explores a retreat strategy, selecting areas to be flooded or further protect, in order to reach a new balance.



Power conversion

The programmatic flooding of the Po Delta would drastically reduce the need for the dewatering pumps which are now spread across the area and that are capable of raising one billion cubic meters of water per year. In this scenario they could be converted in devices for the water cooling system of the data center keeping almost the same consumption of electric power, around 10 MW per year. The same interaction with existing infrastructures would be realized by the reuse of the electricity network originated by the now dismissed thermal power plant in Porto Tolle.

DeepMind control

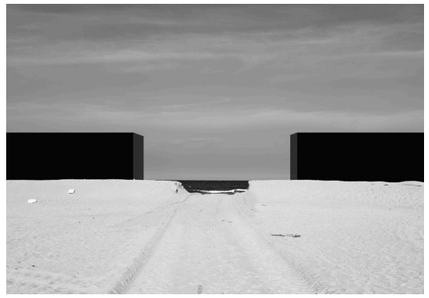
DeepMind artificial intelligence applied to cooling systems of Google data centers has increased energy efficiency of 40%, saving millions of dollars. The graph below shows the trend of the energy efficiency factor: when the AI is activated the system is very close to the limit of perfect efficiency. The AI uses learning systems based on local environmental data processed in real time. Data collection requires a large number of sensors, which in the Po Delta environment can be used for monitoring a such sensitive area.

Landform scenarios

IRRIGATING THE SITE WITH POTENTIAL

There is a famous story about the Casa Malaparte in Capri: Malaparte recounts how Ewin Rommel visited the house in 1942; he asked the writer if he had bought his house ready-made or designed it himself. Pointing toward the sea, Malaparte replied that the house had been there, but he had designed the landscape.

The paradoxical nature of datacenters: a building designed to enclose itself from the space outside but capable of changing it in a drastic way; a technology meant to survive to geological eras in a fast-changing technology time; an infrastructure that intentionally denies the existence of space and time. This is wahy we approach to datacenters as a landform building typology: the project must breed with landscape architecture to reveal a design that not only explores the potential of the site, but gives a contribution to its future.



Scenario thinking

The alternative scenarios focus on the role of data centers in addressing different attitudes at long-term landscape changing connected with the flooding strategy. Each scenario figures out the development of a first data center estimated in 100.000 square meters extension with a peak power of 10 MW, then a subsequent urbanization of additional data centers around it. The variables taken into account concern three main topic depending on the interaction between buildings and the environment: power supply and heat dissipation systems; the need for security buffer-zones around data centers; the development of molluscs farming which constitutes the founding economy of the area.

Exploit the change

By expanding the Scardovari lagoon through the dismantlement of existing dams, the flooding operations allow to increase the molluscs farming area and to create a security buffer-zone for the placement of data centers (image below). The additional water volume - corresponding to +137.5% - is used for heat dissipation also due to the possible reconversion of dewatering pumps in cooling systems. Besides, molluscs farming seasonal production is extended over the winter months thanks to the general increase the lagoon temperature. The two above images show the transition from the present almost unproductive agricultural landscape to a future more fertile waterscape.

Freeze the change

The scenario explores the role of data centers as a sort of topological device capable of integrating and strengthen the existing defence system of the Po Delta. Since this type of buildings are free from the functional limits imposed by the human presence, it can be possible to figure out a way of exploiting their scale and introversion for protecting the coast from erosion and sea level rise. As the image below shows, data centers are linearly disposed as a damn in order to artificially preserve the lagoon ecosystem balancing the expensive ambition of freezing the landscape evolution with the necessity of finding a proper location for these profitable, massive and enigmatic infrastructures (images above).

Emphasize the change

As shown in the image below, data centers are strategically located among the most sensitive areas in term of salt intrusion and subsidence. Flooding operations are managed by a system of autonomous pools of different size, salinity and water temperature which provide heat dissipation and a large number of different habitats for wildlife and molluscs farming fields (images above). This configuration, together with the environmental sensors of the data centers' DeepMind control, allows to develop an experimental landscape where to test different ecological conditions aimed at becoming the matrix for the progressive re-organization of biotic and abiotic interactions in the area.