Carbon-Aware Spatio-Temporal Workload Shifting in Edge–Cloud Environments: A Review and Novel Algorithm

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HERBARIUM 2.0

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ABSTRACT
Nowadays, both public administrations and private institutions account neglected areas, brown-fields and abandoned buildings as a factor of major urban degradation, often looking for temporary solutions and low-budget ideas as an answer to very problematic issues. But in many cases, these re-generation actions are long-term processes, requiring big investments and granting no certain outcomes. Nevertheless, such abandoned areas –colonized by a sort of "second-hand nature"– are often fundamental oasis of biodiversity; if intended as a network, they represent a concealed green infrastructure spread out across the whole urban landscape and it is as such they should be conceived and designed. Herbarium 2.0 aims at inspiring new strategies in order to trigger effective changes in such contexts, starting from a tool that introduces an alternative taxonomy for plants and green-devices. Herbarium 2.0 is a collection of sample species, catalogued according to specific features and pragmatic implications. The strategy adopted by many plants to spontaneously grow and develop in particular environmental conditions is firstly analysed in order to identify their best use and to address specific tasks. Plants are capable of drastically decrease the quantity of metals in the atmosphere, capturing CO2 and other greenhouse gases and fixing them through photosynthesis. Some of them bring nourishment to depleted soils, cleaning contaminated lands and accumulating earth in ruined and rocky areas, growing and spreading across asphalt and concrete. Under this perspective, it is not important whether these species are autochthonous or allochthonous, overriding or invasive, but rather the extent to which they respond to environmental needs and to the landscape project's targets. Herbarium 2.0 aims at being a compendium of tools and actions capable of strengthening latent or underway processes dealing with temporary and evolving landscapes within the urban environment. In this framework, vegetation becomes the main element of broader transformations opposing the widespread idea by which "nature" must be kept under control, and disorder is equivalent to decay.

HERBARIUM 2.0

In its original form, "herbarium" is an analytical collection, or a figurative compendium, of preserved plant specimens aimed at studying their botanical features and healing properties. It represents an essential tool for studying plants taxonomy, their geographical distribution and the analysis of their morphological changes over time.

During the Middle Ages, the herbarium had its spatial counterpart in the Benedictine monastic garden (the "hortus conclusus" meaning literally "enclosed garden"): originally being a place for learning, working and meditating, with no ornamental characterization.

The herbarium was conceived to virtually reflect the structure of an idealized garden so much that was also called as "hortus siccus" (i.e. dry garden). The analogical relationship between the herbarium – as an investigative tool – and the garden – as a space of empirical verification – has constantly been renewed over time up to the great examples of the botanical European gardens during the XVII and XVIII centuries. Somehow, between the herbarium and the garden, it has always been a kind of correspondence capable of "producing" new landscapes. Such correspondence starts to change with the advent of the industrial city, ceasing to evolve beyond the already encoded models. Some recent examples, as the "Eden project" in Cornwall, still goes towards this direction, emphasising nevertheless that sort of historical detachment from the urban context typical of botanic gardens.

The proposal of a "Herbarium 2.0" aims at inspiring new strategies in order to trigger effective changes in the field, starting from original interpretations of landscape

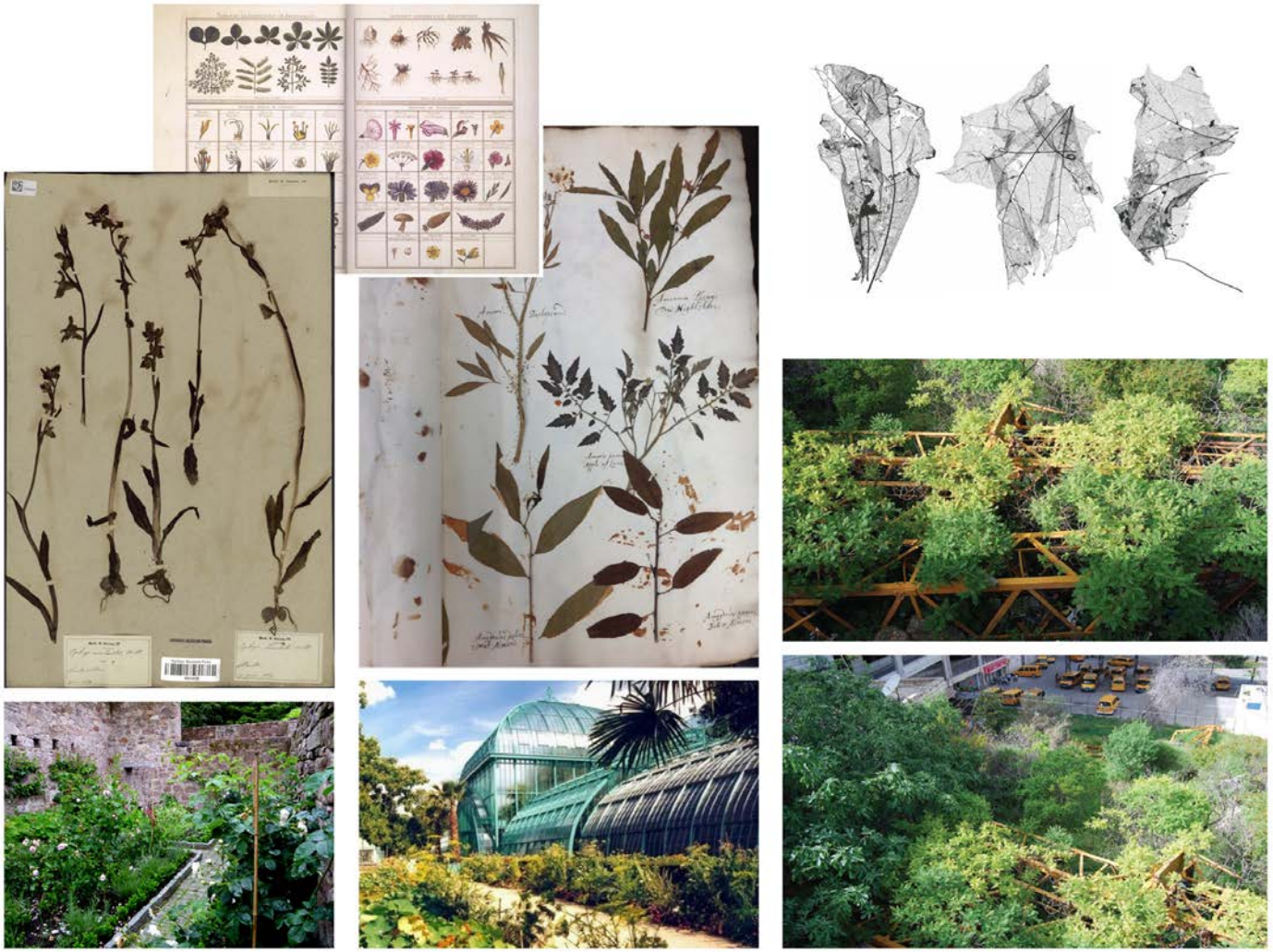

Figure 1: Collection of herbaria and their "homologous" gardens.

in the contemporary city as the concept of "Third landscape" by Clément (2004). The frayed nature that characterizes the post-industrial city – in its infrastructural interstices, neglected areas, brown-fields and abandoned buildings (David, 2000) – represents an opportunity to revive the relationship "herbarium/garden" under a different perspective. Such urban spaces colonized by a sort of "second-hand nature", as defined by the artist Lois Weinberger (Zanfi, 2009) are often fundamental oasis of biodiversity: regulated by precise growth and propagation criteria, associated with specific boundary conditions, they eventually correspond to different biotopes of the urban ecological habitat. If intended as a network, they might represent a concealed "green infrastructure" spread out across the whole urban landscape, a "widespread garden" with its own logic of development, an experimental laboratory that matches an updated plant species taxonomy: the "Herbarium 2.0".

To achieve this goal, a shift in the perspective is necessary in order to carry out the transition from a static (i.e. 1.0) to a more dynamic (i.e. 2.0) model. "Herbarium 2.0" aims at being a compendium of tools and actions capable of strengthening latent or underway processes dealing with temporary and evolving landscapes within the urban environment. In this regard, two main objectives should be pursued simultaneously: defining the new taxonomy criteria and developing the new herbarium spatial homologue.

TAXONOMY CRITERIA

Reaching this first objective involves to catalogue plant species according to specific features and pragmatic implications that their proliferation induces on the surrounding environment, rather than considering their own intrinsic properties. The strategy adopted by many plants to spontaneously grow and develop in particular environmental conditions can be analysed in order to identify their best use and to address specific tasks. Some plants are capable of drastically decrease the quantity of metals in the atmosphere, capturing CO_2 and other greenhouse gases and fixing them through photosynthesis. Some of them bring nourishment to depleted soils, cleaning contaminated lands and accumulating earth in ruined and rocky areas, growing and spreading across asphalt and concrete.

Starting from the extensive scientific literature on this matter it is possible to collect a great amount of data on plants skills, but the main challenge is how to organize them so that can be used within design actions. In the framework of this brief dissertation, it

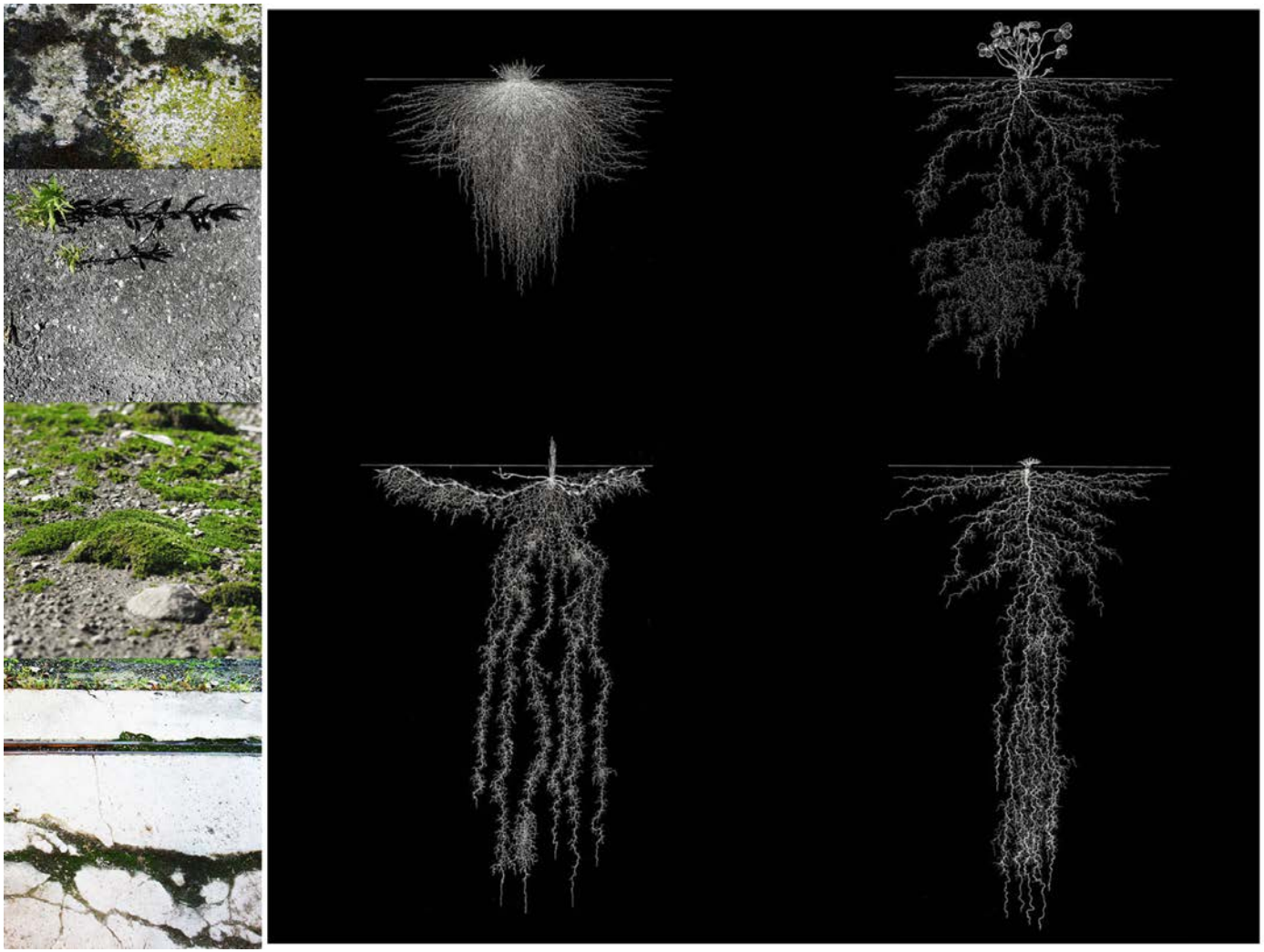

Figure 2: "Vectors": different steps in colonizing process by pioneer flora and its anatomy.

is only possible to suggest some elements hypothetically composing a first hierarchy level of this taxonomy. In parallel with chemical reactions components, the following main categories have been identified:

- "Reagents": as plants or plant specimens that directly affect changes within the physical and/or chemical characteristics of the environment in which they are introduced. This category may include high-performative plants as the so called "hyperaccumulators" (Sarma, 2011) or more common species whose morphological features affect, for example, soil temperature (through the plant habit, foliage density, etc.).

- "Vectors": as the ones whose skill consist in colonizing new habitats, beginning a chain of ecological succession that ultimately leads to the arrival of more complex species. The pioneer flora is an example: these highly specialized plants develop anatomical and physiological responses to harsh contexts and conditions (due to salinity, dryness, etc.). Thanks to the small exposure surface and their disproportionate root system, they are able to escape the pruning and reach the water at great depths increasing effectively the soil fertility, starting new naturalization processes.

- "Catalysts": as for chemical, their task is to affect the rate of a reaction saving the overall dispersion of energy. In this sense mutualistic relationships can be highlighted between plant roots and fungi, for example in mycorrhizal associations (Ollerton, 2006). More simply, the herbaceous plants act as catalysts for the fertilization maintaining soil moisture and spinning the growth of more complex organism in specific contexts.

- "Indicators": as vegetal species whose function is to revel the qualitative status of en environment or an ongoing process. These bioindicators can tell us about the cumulative effects of different pollutants in the ecosystem and about how long a problem may have been present. A good example of that are lichens, mosses and specific parts of trees as their bark, rings or leafs. Generally, indicators don't affect considerably the ecosystem but provide important clues about its health giving feedback on its development direction.

These proposed categories, far from being exhaustive, represent a first input to build the Herbarium 2.0 aiming to set an alternative taxonomy under a performance-based classification.

SPATIAL HOMOLOGUE

As already mentioned, Herbarium 2.0 requires a physical testing field, a spatial homologue. This potential garden has been identified within all the existing neglected urban spaces that should be connected in order to form a single network, a "widespread urban garden". Before analysing some possible strategies that may be carried out to create such spaces, it is useful to clarify through an example what a testing field is intended to be within this dissertation. The installation "Revival Field: Projection & Procedure", developed from 1990 by artist Mel Chin with scientist, Dr Rufus Chaney, tested some plants (i. e. hyperaccumulators, able to draw heavy metals) in detoxifying a soil. The contaminated earth was enclosed with a chain-link fence and divided by paths that formed an X; the project's boundaries were marked by a square. Chin conceived these overlays as a target, a metaphorical reference to the work's pinpoint cleanup. The divisions were also functional, separating different varieties of plants from each other. This project was all about the conceptual realization of scientific processes brought forward through art, about the possibility of integrating landscape design, green remediation and ecological consciousness.

Figure 3: Mel Chin, "Revival field. Projection and procedures from toxic soil to revived area". Minneapolis, Minnesota, 1990. A bird's eye view.

Figure 4: Joseph Beuys, "7000 Oaks – City Forestation Instead of City Administration ". Documenta VII, Kassel, Germany, 1982. A photo-story.

The diverse topics and purposes of this project should evenly address the strategy behind the development of the Herbarium 2.0 spatial homologue. In this perspective, 3 main procedures can be mentioned whose final goal is to connect widespread areas in a single networked garden:

- "physical connections" involving propagation means and conductors such as, for instance, "green corridors" and all the good practices facilitating seeds transportation (by water, wind, animals) throughout the city (Galí-Izard, 2006). Moreover, encouraging all those environments subjected to time variations (periodic, erratic and sequential habitats);

- "data connections" represent –in the forthcoming future– a powerful tool to unify green areas in a single ICT infrastructure and make them operate as "wired objects". Some experiences have shown the potential of RFDI (Radio Frequency Identification Devices) in trees protection and management and interesting applications may come from that in order to implement a diffused biomonitoring system for the urban setting (Luvisi & Lorenzini, 2014);

- "community-based connections" lie in the latent desire of citizens to interact with public spaces leading and participating to urban transformations. Starting from artistic projects like the Beuys's "7000 Oaks" for Documenta VII (Kassel, 1982) until more recent experiences promoted by municipalities, collective approaches are building awareness of a latent "green infrastructure" spanning the city.

Herbarium 2.0 obviously leaves some open issues concerning, for instance, the debate around "ecology restoration" and the utilization of certain plant species. Anyway under this proposition's perspective, it is not fundamental whether these species are autochthonous or allochthonous, overriding or invasive, but rather the extent to which they respond to environmental needs and to the landscape project's targets. The introductory essay to the book "Imperfect Health" (Borasi & Zardini, 2012) points out all the contradictions rising from the belief that "well-being lies in nature". By demonstrating that, historically, the conception of "nature" itself changes continuously, the authors underline how our feelings and perception of nature shape our attitudes and means of intervening in it. In this perspective, Herbarium 2.0 aims at being an interpretative tool of this constant changes, assuming both vegetation features and relapses as markers of possible outlooks in urban transformations.

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