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## METRO MATRIX MODEL FOR A NON-FRAGMENTED CITY: THE NEW METROPOLITAN MORPH-TYPE, SUCH AS A GREY AND GREEN GEOGRAPHICAL SKIN OF THE INFRASTRUCTURE

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### Abstract

The result of these years of unprecedented urban growth has been the Fragmented city, a phenomenon we have dealt with for a long time in our university research laboratory. Through Ortiz's metro-matrix concept, this experience has allowed us to define a model applied to the context and able to determine a continuity between the islands of the metropolitan archipelago by linking together the grey and green infrastructures. The harmonization between the two infrastructures develops an interchange point, geographically and historically defined by the metro-matrix model, which elevates the scale of the local context, placing the new urban functions. Close to the nodal point articulating the territory of the metropolis, the green and grey infrastructures obtain an urban and architectural geographical skin (Levy Strauss, 1955; Varela, 1991) which is the architecture of the metropolis inside the central mega block within its context (1mx1km) and new dimension. This new metropolitan morph-type becomes the skin of the infrastructure backbone of the metropolitan territory and the place of the continuous relations with the rest of the cosmos or metropolitan archipelago.

**Keywords:** Metropolitan Architecture, Metro Matrix, Archipelago, Green and Grey infrastructure

## **1. CASE STUDY: CABO DELGADO REGION**

### **1.1 Research scenarios**

The expectations related to the development of the energy industry and the rising of the tourism sector, together with the concerns about the fragile environmental conditions, are changing the structure of Cabo Delgado region. The rapid urbanization and the emergence of a new population require the experimentation of original settling models which can combine new densities and accessibilities to essential services with culturally relevant aspects.

The general design purpose consists in the elaboration of a systemic, integrated and shared view for the development of Cabo Delgado region through the definition of scenarios related to the possible transformation of the territory.

### **1.2 General strategic framework: the territorial vision**

Taking the move from an in-depth analysis of the region at the metropolitan-urban-local scale, the design proposal defines the strategies of integrated planning elaborated by us on the basis of Pedro Ortiz's Matrix, capable of positively directing the socio-economic impact and in parallel aimed at tailoring specific focus-projects in cooperation with involved stakeholders.

The establishment of a network among the cities of Cabo Delgado region and their territories, indeed, is obtained by planning specific points catalysing urban functions and modifying the articulation of the city structure in relation to the geography and its economic structural data. Urban growth is analysed in relation to: the ground (geography-geology-uses), pre-existence (history) and resources (environmental – energetic – economic), from a metropolitan scale (large) to an urban scale (medium) until a local small one, in relation to the metabolic operations of maintenance-substitution-transformation. Therefore the project involves a plurality of issues: spatial, environmental, and energetic as related to economic efficiency and governance.

The objective is to avoid the fragmentary nature of the projects which are expected in the region, also to prevent the destruction of territorial continuities. Indeed only the stability of continuous systems can guarantee the survival of the rich regional biodiversity and of an informal economy linked to the system of villages in the agricultural inland which must be connected to the system of villages on the coast, in order to establish the new agro-urban tissue of a city which will grow within 30 years from 170.000 to nearly 2.000.000 inhabitants.

Therefore the relationship among urban systems must be protected and supported through the project of an environmental and agricultural continuity, so that together they can survive and be complementary to the development expected on the coast after the discovery of huge gas deposits, thus guaranteeing the protection of environmental reserves which are essential for tourism which is the other important economic sector of the country.

### **1.3 Design framework: general strategy**

#### The present context

Cabo Delgado region is characterized by a constellation of small villages in the inland and few cities on the coast: a scattered settling model mainly based on subsistence agriculture. The proposal deals with two main emerging questions for the management of the new metropolitan relationships:

1) the runaway metropolitan growth due to the expectations related to the development of the

energy sector and the emergence of the touristic one, a growth which must be managed and directed through the proposal of different urban and urbanity forms;

2) the vulnerability of the territory due to the environmental conditions which are more and more fragile, related to three specific questions: exposure, sensitivity and the loss of adapting capacity. In northern Mozambique the exposure to environmental risks is high because of the tropical climate while the sensitivity due to rain-fed agriculture can't be soothed unless presently unaffordable infrastructures are realized. Therefore an adaptive strategy improving traditional coping mechanisms that are usually erosive is the only way to overcome this vulnerability.

These conditions produce:

1) the growth of the population and its migration towards the main urban centers with the consequent phenomena of runaway urbanization and increase of housing, services and natural resources demand;

2) the increase of food insecurity, since we consider the food sovereignty as a fundamental condition for food security. Indeed the inadequacy of the agricultural sector makes the need to import staples at high prices increase, from near countries too.

#### The design hypothesis. Desakota city

The potential attractiveness and the competitiveness linked to Cabo Delgado metropolitan development must be managed to guarantee a fair development through redistribution of resources and occupation for next generations, by improving the multipolar growth of the metropolitan region. In particular, our proposal concerns the development between Palma and Pemba, Mueda and Mocimboa. The territory which divides them and will be affected by a metropolitan development must be considered, managed and designed in a synergic manner according to the "Desakota" hybrid model (Shane, 2011), with "desa" meaning village and "kota" meaning city. The Desakota model links urban processes related to infrastructures to rural space and agriculture, setting out the necessity of a global framework for the management of metropolitan growth together with necessary resources to foster it.

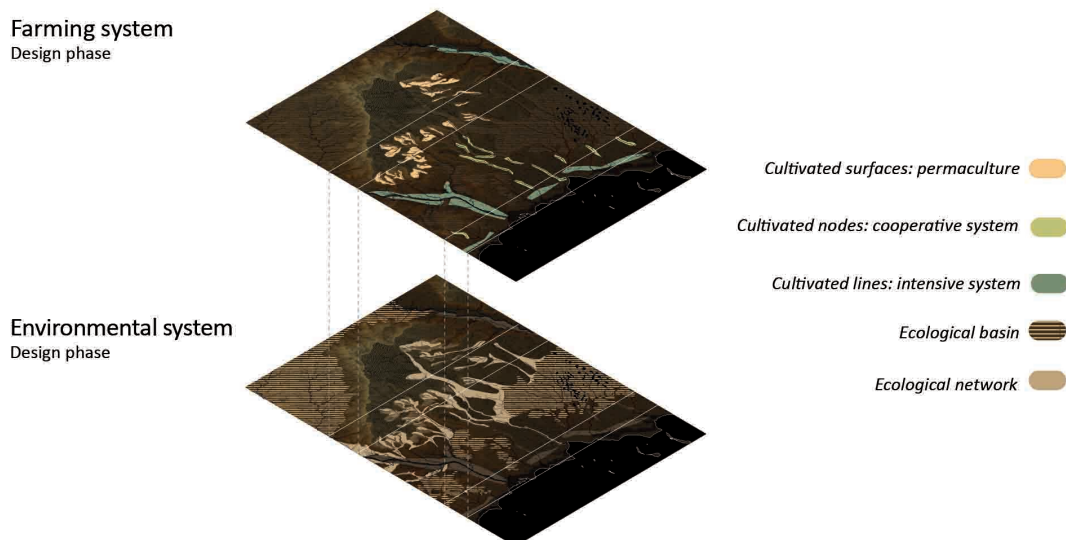


Figure 1. Environmental and Agricultural System of Cabo Delgado. Their connection and continuity will constitute the form of Cabo Delgado metropolitan area

This proposal is consistent with the dynamics already activated by the local population dealing with the inaccessibility to the formal market by engaging with the informal food sector, which is defined by FAO as a series of activities ranging from urban and peri-urban food production to retail sale of fresh or prepared products, as well as catering and transport.

Environment, tourism and gas extraction have to be made compatible in the coastline. Inland has to provide for the necessary infrastructures to support capital investment in industry as well as for agro-alimentary production and food processing.

The territorial structure, then, takes form under a series of related parallel gradient lines which work together in the same social and productive mechanism. Development might start from the specific points of Palma and Pemba, Mocimboa and Mueda, and a clear vision of the overall structure will allow the development of other potential urban settlements, productive and touristic locations in a sustainable long-term framework.

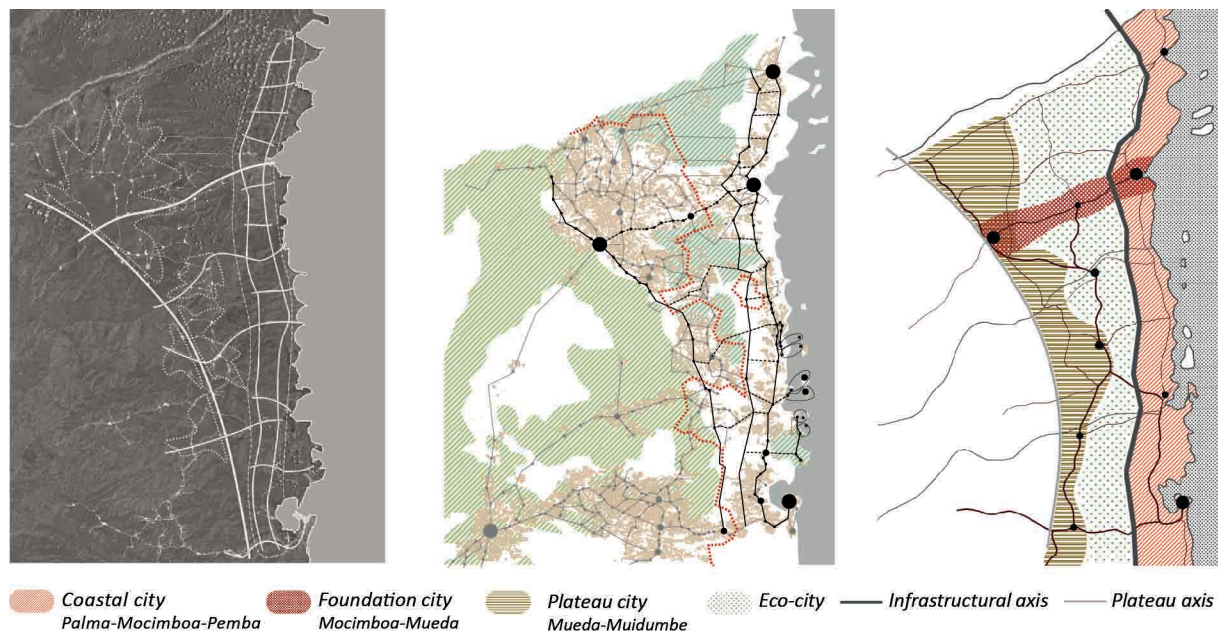


Figure 2. Plan proposed by Ortiz for Cabo Delgado according to the Metro Matrix model

### The two-phase development

During a first phase, the strengthening of the informal food sector must be promoted:

- firstly, by improving agricultural yields and reducing the risks of crop failures;
- secondly, by distributing the different activities of the sector among different specialized actors who have to be taught how to carry out their specific task and how to coordinate among them in a sort of food supply chain.

While in the short term the strategy will be focused at soothing the price side of economic inaccessibility, in the long term the question of unemployment will be managed through the settlement of industrial activities following an axis parallel to the coast. Since these characteristics of Mozambican agriculture can't be changed unless infrastructures and access to credit are provided through presently unaffordable capital-intensive operations, some free interventions fostering the

traditional knowledge by introducing principles from conservative agriculture are considered to be the most viable proposal in the short term.

Mixed cropping, cultivation of secondary crops and intercropping are all practices which are not capital intensive and only concern the learning of smarter cropping patterns. However, in our project this improvement is only the first step of a “twin track approach” which will provide some basis for a sustained economic growth in the second step, when the satellite activities related to companies interested in exploiting mineral and energy resources will be developed. Our aim is to achieve adaptation to the given conditions within a system characterized by positive feedbacks between the rural and urban informal sectors integrated into the future *desakota city* so that, when private investors will come, capital intensive initiatives will meet an economic and social environment suitable for making them take root, thus realizing an inventive system able to intentionally change the territory which will finally grow besides the restrictions of the given conditions.

Since the strategy is chronologically twofold, the matching of the different temporal horizons is a pressing issue. Indeed, the present occupation of the territory is based on micro-codes related to local relationships between the villages and their agricultural areas. This way of settling in the territory could be preserved in the first phase related to small-scale interventions and introduction of practices but would be inconsistent with the second phase as it lacks the metropolitan dimension required by the overall social and productive mechanism made of parallel gradient lines based on the transformative function.

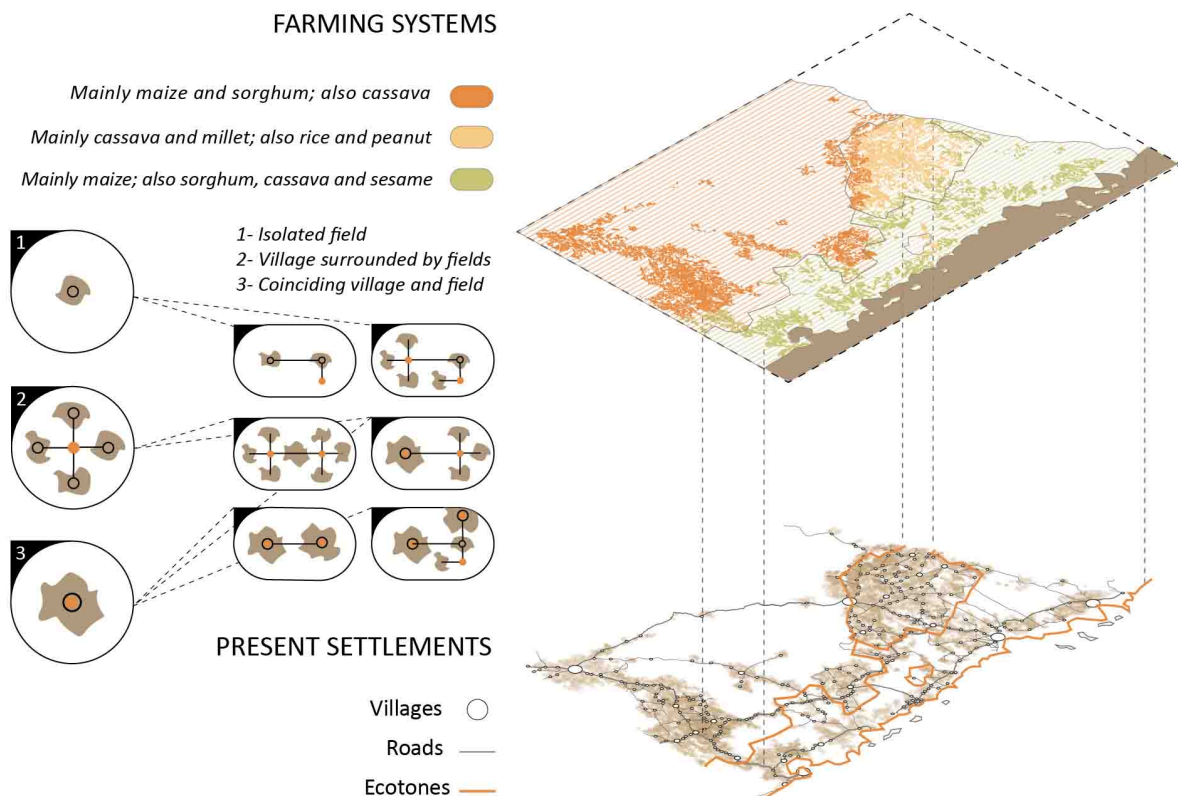


Figure 3. Present micro-codes connecting villages to agricultural areas and among each other according to local topological and environmental conditions. The result of this bottom-up process is a field (Allen, 1997) characterized by intricate local connections but lacking the overarching schema necessary for future growth as proposed by Ortiz

Nevertheless, a pre-ordained master plan imposing a future scenario would not withstand the dynamics of informality. Therefore we propose to tap into the logic of the present micro-codes rather than to oppose them, and to consider the territorial matrix not only as the final purpose, but also as a tool working in the way of a pre-emptive armature (Gouverneur, 2013) which can accommodate the self-organizing system of the first phase in the semi-rural mega blocks of the *desakota* city, without undermining, therefore, the realization of the long-term vision. So our hypothesis of metropolitan scheme becomes not only an objective, but also a pre-emptive armature to integrate territories, economies and new citizenships.

#### Reference to priorities identified in Mozambique planning documents

This context fits perfectly in the priorities identified in the planning documents of the target country. We have to take into account, share and define within the local Institutions and communities many issues to get this goal:

- \_ architecture: gradient formality, new architectonic and urban typologies;
- \_ mobility and urban planning: setting the armatures for a smart growth;
- \_ energy and environment: energy industry and energy accessibility for a fair development;
- \_ agro-food economical system: water capital protection for landscape economic and ecological robustness;
- \_ new cartography and media for education: feeding knowledge through interactive and implemented new media.

We want to produce a true “sustainable” model of conceiving and building a new city in order to achieve these outcomes, put them into a system and make them interact with the expected urban explosion through the Matrix model (Ortiz, 2014), which defines the infrastructural structuring of the three urban stripes, thus allowing the integration of logistical projects (Pemba harbor), energy transformation (Palma harbor), processing plants for agricultural produce (Mueda), touristic harbor (Mocimboa).



Figure 4. The metropolitan matrix

If in the transformation we want to strengthen how the inhabitants can participate and share their growth movement, we have to find the interchange and densification places of the new scale where to introduce the development in order to avoid a runaway growth. The definition of the urban densification points is allowed by Ortiz's Matrix model.

#### The cartography tools for social interaction and cooperation

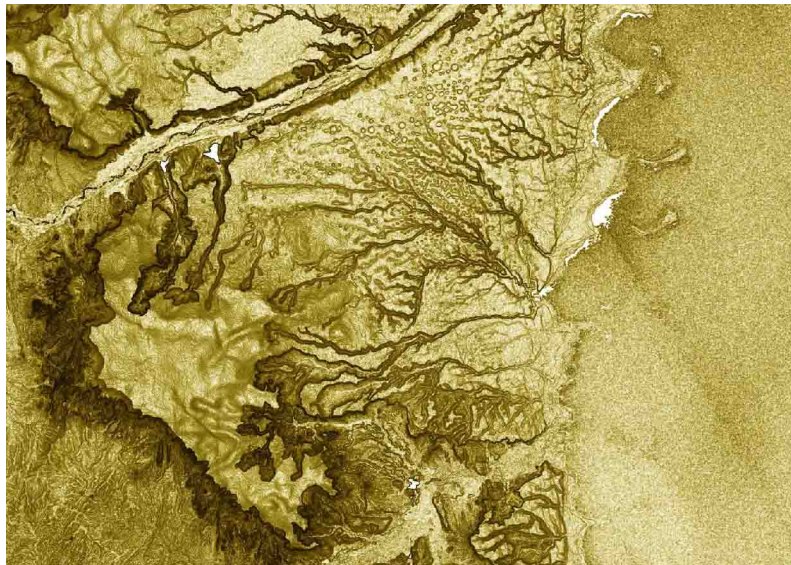


Figure 5. Geographic map of Cabo Delgado

For the project related to Cabo Delgado region our tools are a new mapping project through a new hybrid mapping and the use of specific computational tools which can help us to build a series of topological models. These models describe and bring into connection the main mechanisms that generate the physical space, simulating an on-going reality and calculating the most probable evolutions starting from a series of inputs. Following this methodology, it is possible to obtain, through a critical reading of the pre-configured scenarios, forecasts and models of sustainable development which are characterized by a close link with the physical and cultural context.

One of the problems that we face when we want to apply our research to developing countries is the lack of maps. This time we want to be able to reach the territorial information through implementable open source maps. Our research aims at reaching a full mapping of territories through the integration between the dimensional scales and the building/coding of a meta-data repository which connects actions to spaces, multiplies the tools available to researchers and creates an observatory equipped with updated datasets. Our maps are almost able to report the real-time social and urban areas changes, and are capable to act as an actor in the participatory processes.

#### The broad timeframe for the action and the communication of the project

The proposal wants to apply the planning and architectural concept of the new urban reality to the Cabo Delgado region territory within the communities that live there. In fact we want to avoid the imposition of a standard "so-called sustainable" city as it usually happens in similar cases. Desakota model value can allow an approach of transactive environment and urban sustainability, in other words a model of well-developed grey infrastructure adequate for passengers and freight traffic and

an urban model which preserves natural resources for the whole region, while increasing food production and security. The design principles linked to this model are an urban-rural mix and a reconfiguration of the urban settling system within the metropolitan mega region.

## **2. FEEDBACK TO METHODOLOGY RESEARCH. RETICULAR METRO MATRIX INTERPRETATION**

### **2.1 The Reticular Metro Matrix mapping: a new way to conceive and represent a metropolis. A Mental Map for the Metropolitan Architecture**

Let's return back to our methodological tools. The Reticular Matrix is a system of axes: few structural geographical axes and some penetrative artificial ones, which firstly determine the development of the centre along lines and secondly, define hinge points of densification. The matrix assumes its value through the definition of the logic of settlement-distribution, which makes possible the localization of interchange nodes in peripheral areas. Today, we recognize that the urban elements having an active part in urban phenomena changed, due to the new process of urbanization and following the subsequent huge spatial and temporal measures of the city. So we have to admit that the city structure, its physical and temporal relations with the citizens, is altered due to the change of its scale. It is because of this that the way of marking places and territories is changed too. Today not only the design and the representation of the architectural elements determining the growth, but also their effects on the territories, - spatial, economic, social - are limited and distorted by a lack of understanding, still placed into connection with a purely functionalist and quantitative vision of the new value of the space as a built place/icon/landmark. Therefore, we assume that the built space must be considered as what determines the common sense. Consequently, it can be the subject of a participatory decision. This means that a change of the urban space from the current situation of urban sprawl implies and requires the transformation of the citizen mental map. Then, the first result of the above change is a new mental map at the metropolitan scale: it is related to the transformation of the topographic space and to its space/time dimensions.

The architectural metropolitan project, therefore, is about how to give identity to the places through a figure and a robust image, but at a new dimensional scale. In order to keep the physical issue as a focus of the design approach, the Reticular Metro Matrix methodology produces a metropolitan city model through its maps/diagrams: we have in front of us a concept shape of the metropolis, that allows metropolitan architecture scenarios and studies their impact on the society and on legal and institutional forms.

Our plan for developing cities deals with the instruments firstly of the plan-form and secondly of the movement-form (new linear public infrastructural system: commuter trains and highways) as a meaningful element of the plan, assuming that a new concept of territoriality, at the geographical scale, is based on the organizing principle of land as a meeting place and mobility (Lynch, 1981). Four elements define the plan: Geography, Geometry, Memory and the Denial of the historic city (to change and reactivate it). The plan, by defining the localization of interchange nodes in peripheral areas, considers not only the inhabitants but the city-users too, according to the concept that what matters is the existence of an exchangeable organization along the space-time networks of the commuter trains, highways and airports.

That plan links to a simple square geometry. The digit of the plan is a square Figural Landscape Unit that defines a lattice topology, a geometric diagram, which is the device capable of supporting a mental map at the metropolitan scale. The plan increases and expands the strategic importance of discontinuous infrastructure (Housing, Productivity, Social) by incorporating it around the strategic nodes. At last, the Metropolis becomes a patchwork of dynamic urban or semi-urban patches and



interchange points, where people gather because of their natural attractiveness (Green infrastructure) and because of their accessibility (Grey infrastructure). Each district owns its distinctive character and these controlled territories constitute the basic structural form of the Metropolis.

Every Figural Landscape Unit centrality within other interconnected centralities, due to a different infrastructure hierarchy, constitutes the metropolitan city fabric. It is an area that has become dense due to metropolitan functions; it is always related to the existing city and it is the way to avoid urban sprawl.

## 2.2 Acting rules for the balance between the two continuous systems: grey and green infrastructures

Hence, studying the Metropolitan impact on the rural environment, the Reticular Matrix proposes a system of eco-armatures: the landscape ecological infrastructure, a balance between the green and grey infrastructure. Then, we could refer this balance methodology for intervention to Alexander's eco-morphologist patterns: by defining eco-green armatures as well as immaterial network infrastructure, we face the question of natural resources, which cannot be planned only on the basis of the model, but also on the basis of the rule of the particular local form. Indeed, according to Geddes' Valley Section that defined a link between man's work and his territory, some of the acting local rules for the balance between the green and grey systems are presented. The result is the Landscape Figural Unit, which means a metropolitan city unit, defined by a structure-figure that is the backbones of the environment. So we go beyond the land use unit concept to read the territory.

## 2.3 Methodological outlines: the form of the metropolis

In the presence of the disruption of the urban and territorial landscape, this approach promotes the appearance of a new scale of the types of settlement and their interrelations, but, above all, a substantial change in the urban/rural relation by a formality-gradient settlement type, able to capitalize, due to its city-centre proximity, some advanced services, which are determined especially in relation to new mobility structures.



Figure 6. Formality-gradient settlement type proposed for Mocimboa

Such strategic typology of settlement should also be able to communicate with the agricultural landscape that not only has the potential to provide products for consumption and sale to local communities (urban agriculture), but also becomes a component of urban regeneration as it is the link among the environmental system elements broken by the new urbanization. Green and blue infrastructure, environment and agriculture generate a continuous system together with the grey infrastructure: the new form of the metropolis.

For these reasons, the metropolitan projects made by the Measure and Scale Laboratory of the School of Architecture and Society of the Politecnico di Milano followed the Reticular Matrix. Our vision, in fact, is working on the flexibility of a physical configuration: such a scheme guarantees, from one side, the connection of every settlement to the mobility system (grey infrastructure) and, on the other side, the integration with the surrounding peri-urban agriculture and environment system (green infrastructure) through a local form-typology specificity (metropolitan city fabric).

This approach has allowed us to frame the design of a Metropolitan Architecture, highlighting:

- 1) the soils, the waters, the geomorphology, the permeability of the territories to the infrastructure armatures, and the land use – especially as characters (variants and invariants) of the metropolitan context;
- 2) the vulnerability of the soil and the water conservation, which means the capability to express an opinion on the constraints on the metropolitan project we wanted to propose.

The possibility to formulate, through this method, a prior judgment through a strategic geographical and historical analysis on the design assumptions of the interchange points between the metropolitan scales, then, also constitutes a figural index (Figural Landscape Unit) for the project, because it allows us to get a synthetic image of the entire territory that is a continuous system due to a unified vision: the development model allows us to determine our points of intervention, at the scale of a metropolitan architecture together with the synthetic vision of the metropolitan area.

In some cases, through an infrastructure-sensitive project, for instance, we might even allow a removal of the current confused image of the ground/landscape, which could be rewritten to a higher scale (through the design of a synthetic “plan of plans” at a metropolitan scale). Or we could aim for the reactivation of some old central points through a new infrastructural connection; or plan the passage of a place from a neglected use due to the fact that it is no longer working at the new bigger scale, as in the case of some abandoned city centres, to a symbolic one, a sign of History and of a link with the ancient territory dimension, by looking at the scene from another point of view.

#### **2.4 The task of the Metropolitan Architecture**

The task of the Metropolitan Architecture, then, will be to build the affective scene, the new shape of the metropolis; the task of planning will be to establish a close link between planning and real estate development, aimed at a strengthening of a feeling of adequacy between the places and the people. To achieve this, the metropolitan landscape must be increasingly seen as a value, also economically important, and in general must be understood as a built cultural and natural heritage, which is one of the most effective ways to understand the deep meaning of the term “public good”.

The development of a unified vision project is therefore essential. It starts from a methodological study, which defines a new dynamic map of the territory; it recognizes the sites and their transformations through the recovery of their topography and geography; it enhances the entrepreneurship scattered on the territory, but also improves an ideal diffuse sensibility linked to the quality of the territories. Only this attitude can connect a sustainable development and an

integrated policy, which arise therefore from a real coordination between the actors involved, united by an idea of sharing values that directs the creation of the network.

### **3. CONCLUSION. THE METROPOLITAN MORPH-TYPE, SUCH AS A GREY AND GREEN GEOGRAPHICAL SKIN OF THE INFRASTRUCTURE**

Metropolis constantly changes and it is characterized by a variable degree of informality. This fact determines a syntactic and morphological reform of the city. It needs a cultural "jump" that should identify a new range and relations among elements in the metropolitan context, rather than simply upgrade the instruments of intervention and investigation. You need a better definition of the structural pattern of this new reality, in order to show the discontinuity occurring in the urban development and in the cultural awareness of such phenomena.

Our project presents a methodological indication for the development of the new metropolitan structure. This is the concern of the Matrix Methodology System applied in Madrid 2019 plan for the first time. It is a study of a way for regulating the growth at the metropolitan scale. It is a system of choices logically systematized. It is based on a method allowing us to describe and design urban phenomena related to the change of scale, which determines the mutation of types of morphologies, of urban spaces and landscapes, and a new mapping project.

The green infrastructure and the grey infrastructure of mobility that work together, through our Metro Matrix methodology interpretation, obtain an urban and architectural geographical skin (Levy Strauss, 1955; Varela, 1991) close to the nodal interchange point among the different dimensional scales. These points are shaped by and shape the compatible form of the grey and green infrastructure, articulating the territory of the metropolis. The architecture of the metropolis (new metropolitan morph-type) inside the central mega block within its context (1mx1km) inside the metropolitan digit dimension, in short, becomes the skin of the infrastructure backbone of the metropolitan territory. It is a skin connected with the geographical structure of natural and artificial soils, as it becomes the place of the relations with the rest of the cosmos or metropolitan archipelago. The physical consistency of the project, the Metropolitan Architecture new scale, becomes again the core of the question: one of the most important meaning of the architectural project is to be linked with the environmental system, so that it is able to determine the continuity of the metropolitan system. The unified vision of the city within its valley avoids the risk of a fragmented city that only means sprawl and slums that we don't want to recognize as a good way of human's "abitare".

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