

POND CITY : URBAN DESIGN AND INVESTIGATION OF TAOYUAN METROPOLITAN AREA

author | affiliation

Chang, Dao-Ming

Graduate of EMU (European Master of Urbanism), Milan, Italy
baitso@yahoo.com

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keywords

urban dispersion,
water,
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ABSTRACT

The horizontal urban dispersion has blurred the boundary between city and countryside. The significance of landscape and water structure is emerging. In the case of north Taiwan, the metropolitan area of Taoyuan faces pressures from development and a resultant sprawl is consuming the open space of the territory. The dispersion on Taoyuan plain has to confront the agricultural landscape, which is composed of paddy field and an old irrigation system of man-made ponds and ditches since 3 centuries ago. Today, agriculture has diminished as a driver of the economy and the irrigation purposes of the ponds has been superseded by other uses - including fishing and recreation - or

have been simply abandoned. The paper, by the investigation and literature, is to understand the actual dispersion together with it's water network. In order to tackle the country's pending water shortage, the paper proposed a scenario that assumes densification will continue and structures the new development by re-qualification of the area's ponds and ditches. New plots are developed according to the carrying capacity of the nearby water network. In the post-kyoto time, the scenario suggests that the ancient irrigation network could be used as an alternative water resource for contemporary urban planning and design.

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0 | Introduction

Taiwan has been always a water-lacking island due to its particular geographical condition. Taoyuan tableland is at the north part of Taiwan. On one side, it is a territory with dispersed urbanization. The densification is still rapidly taking place. On the other side, the landscape of the territory is composed of paddy field and an old irrigation system of man-made ponds and ditches. This three-century old water network was to tackle the country's long-existing water shortage. Originally, the different-sized ponds were separated from one another. However, following the major hydrological works in 1928 and 1963, they became an interconnected network (with canal) and were used as a comprehensive irrigation system. Today, the metropolitan area of Taoyuan faces pressures from development and a resultant sprawl is consuming the territory. Agriculture has diminished as a driver of the economy and the irrigation purposes of the ponds has been superseded by other uses – including fishing and recreation – or have been simply abandoned. The contemporary meaning of such an enormous water network demands a re-definition. The paper starts from the investigation of the water system and urbanization of Taoyuan. The issues are found in order to construct a possible scenario, which uses landscape and water as an alternative infrastructure for the future urbanization.

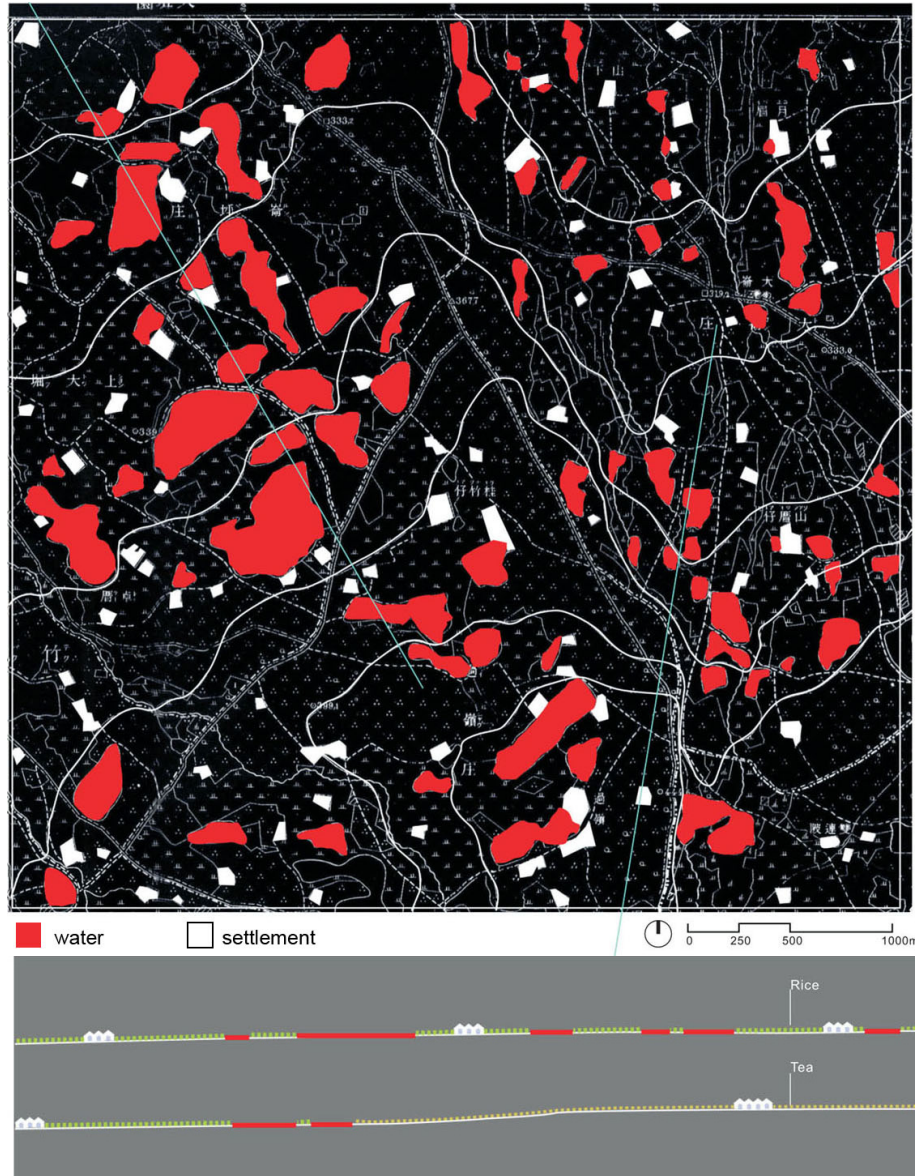


0.1 | The location of Taoyuan (1)
Taiwan is an island full of high mountains. Only 26% of the total surface is plain. Taoyuan is on the tableland in the north west part of Taiwan.

I | The historical water network in Taoyuan

Taoyuan is a tableland with a dense water network. The tableland has a considerably flat slope (from 1/75 to 1/100). The surface soil is the impermeable red clay. The cultivation of Taoyuan started in 1680, in the moment that the agricultural activity was the main economical resource. Since the beginning of 18th century, the inhabitants had constructed a dense water network: ponds and canals for irrigating. There are

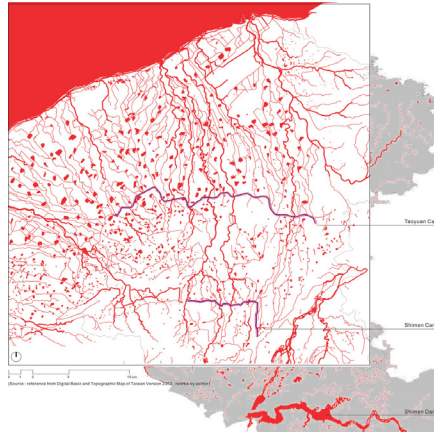
two functions in the irrigation system: The canals are for transporting water whereas the ponds are for stocking the rain water. Especially in the dry season, the water supply for the irrigation was sustained by ponds. The size of the ponds depends on different type of agriculture and topography. In general, the ponds are bigger in the flatter area where the rice grows. At the hilly area instead, the ponds are smaller as the tea trees doesn't demand the amount of water as much as the paddy field.



notes

1.1 | The analysis from the historical map (2) (reference: Taiwan Bau-Tu, 1904: no.58, redraw by author)

This illustration is based on the historical map "Taiwan Bau-Tu" made in 1904. On the map, the contour line is made every 1.5 meters. In the west, the bigger ponds locate at the flatter area. In the east, the ponds are smaller as the slope is steeper. Two sections are made to understand the landscape according to the topography. Paddy fields are with bigger ponds whereas tea trees are with smaller ponds. Settlements are usually at the flatter area.

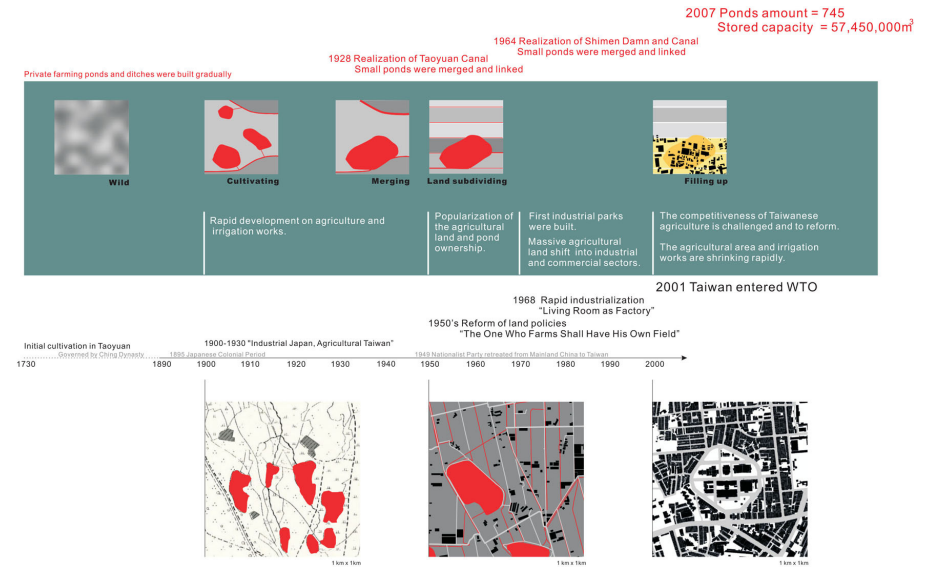


2.1 | The water system of Taoyuan tableland (3) (reference: the Digital Basic and Topographic Map of Taiwan version 2002, redraw by author)

The water system of Taoyuan is made with rivers, ponds, canals, and dam. In general, the rivers are parallel to each other towards the sea in the north. There are ponds that are connected to the river with ditches. Two big canals are made in west-east direction connecting the rivers in order to control the water supply. The Shimen Dam, located in the southern mountain area, is the most important water source of Taoyuan and the surrounding regions in the north Taiwan.

2 | The modern works changed the indigenous landscape

From the beginning, in the 17th century, the farming ponds were made independently. However the modern irrigation works changed this situation vastly. The realization of Taoyuan canal in 1928 firstly changed this way of irrigation. In order to control all the water supply of the territory, the independent ponds were connected to the canal by enormous ditches. The construction of the canal changed the landscape as well. A huge amount of ponds were merged as bigger ones, which were connected with each other by ditches. The second and the last significant irrigation works was done after 36 years. In 1964, the Shimen canal and Shimen dam were built for a more stable water supply for agricultural and industrial use. The surface and amount of the ponds were reduced for the second time. Today, when we go through the territory of Taoyuan, the elements of this indigenous landscape is still evident: ponds, dykes, ditches, paddy fields, roads, and houses spread over everywhere.



2.2 | The revolution of the irrigation ponds (4) (reference: Lin, 1996; Guo, 2002; The database of Ponds and Canals of Taoyuan County, 2007; GIS system of Taoyuan City, 2007; Taiwan Bau-tu, 1904; redraw by author)

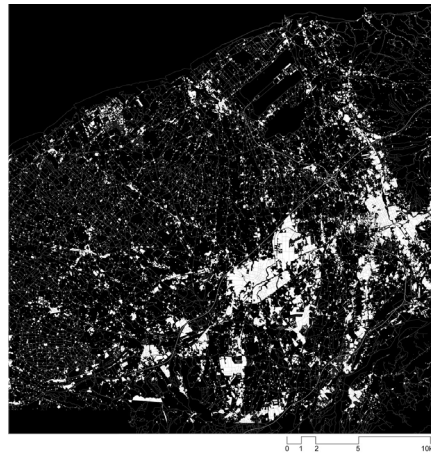
The revolution of ponds can be seen as a political landscape of Taiwan that is generated in different periods of time. The agricultural activity in the pre-colonial and colonial period, the land policies after the Second World War, and the urbanization after the industrialization had been the motives of the change of landscape.



2.3 | The landscape of the pond (5)
The elements of the landscape is composed of ponds, dykes, ditches, paddy fields, roads, and houses

3 | Taoyuan Metropolitan Area, an urbanized and industrialized territory

Taoyuan Metropolitan area is densely inhabited. There are two high-dense cities (Taoyuan City and Chungli City) and other small towns over the tableland. The evolution of the urbanization started from the spread-over small agriculture settlements. They existed on the flat area. The size and the density were almost even everywhere. The ponds for irrigation were made nearby each settlement. During the process of urbanization that went together with industrialization in the 60's, the built space concentrated surrounding the planned cities and along the main infrastructure. Therefore it is evident that the linear sprawl has been occupying the territory. The industry is an important factor in the urbanization of Taoyuan. The total surface of industrial site in Taoyuan is the second largest among the other regions in Taiwan. The ratio of population working in industry is higher than the average percentage of the country. In Taoyuan, 46.24% of the population works in industry. There are several big industrial platforms. Apart from them, the factories became one part of the urban tissue. Having the typical Taiwanese characteristic, the industry here are usually small and medium enterprises. Thus they are dispersed together with urban sprawl through the road network. These small medium factories mixed with dwelling can be found along the accesses stretching out from the city center. As the globalization effects the distribution of the world's economy, the moving-out and reform of the Taiwanese industry is now another challenging variante in Taoyuan.



3.1 | The urbanization and road network of Taoyuan (6) (reference: the Digital Basic and Topographic Map of Taiwan version 2002, redraw by author)

There are two main cities in Taoyuan Metropolitan Area. The dense road network gives accessibility to the inhabitants reaching every part of the territory. There are two features of dispersion. One of them is the densely urbanized stripes stretching from the center to the periphery. The other one is the dispersed settlements in the middle and west part of the tableland.



3.2 | The dispersed industry as part of the urban tissue (7)

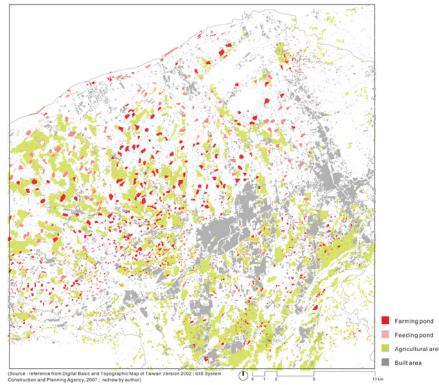
The area with urban dispersion in Taoyuan is connected to industrial production. Factories are attached to collective housing or single house. The small and medium enterprises have been always important in Taiwan's economy.

4 | The tension brought by the immoderate densification

The metropolitan area can be covered with a square of 30 km by 30 km. Comparing with the other two examples of urban dispersion in Europe, Veneto and Flanders have the density around 5.3 pop/ha whereas Taoyuan has 15.40 pop/ha. Although the population has reached 1,8 millions inhabitants, the density is still increasing. Taoyuan has the second highest ratio of population growth among the six metropolitan areas in Taiwan. Considering the local industrial development and the proximity of Taipei, the densification of Taoyuan is still expected in the following years. However, the inhabitants living in the suburban area has to suffer from the traffic congestion for commuting. Today, many public transport projects are being realized in Taoyuan. The new stop of high speed train is giving a new model of development: A new town is installed as a new centrality in Taoyuan. Nevertheless, the consumption of open space doesn't take the existing landscape into account. The agricultural land is being fragmented by the urbanization. The irrigating devices, ponds and ditches, are covered for gaining more profit from the land. The tension between the landscape and urbanization is generating an uncertain future of the territory.

5 | The irrigation device as a potential

These irrigation ponds are diminishing. The role as a irrigation device is to be re-defined. Since industries has replaced agriculture as the main economy of the region, most of the ponds are not used for irrigation but for other use like fishing, in very few cases as a public space, or simply abandoned. Being under the pressure of urbanization, some ponds are even filled-up for gaining more land surface to develop. As a matter of fact, the revolution of the ponds and ditches is a reflection of Taiwan's land, water, and agriculture policies. This irrigation work is not only a part of historical landscape but also have the potential of water supply for new urbanization. It is forecasted that in 2021, the daily need of water in Taoyuan will be 270000 cubic meter more than nowadays. In fact, the total storing capacity of all the ponds is 57,450,000 cubic meter which is one-fifth of the total capacity of Shimen Dam. Building a new dam gives absolutely a huge environmental impact while re-using the existing ponds could offer an alternative solution.



5.2 | The urbanization and agricultural landscape (9) (reference: the Digital Basic and Topographic Map of Taiwan version 2002, redraw by author)
The agricultural landscape is being fragmented by the urbanization. Many of the ponds have changed into fish feeding ponds or abandoned.

6 | Scenario construction

Due to the complexity and unpredictability of future, the paper uses scenario construction as a tool to explore a strategy that is capable to deal with the possible variable in the future. In the case of Taoyuan, the dispersed urbanization has to be considered with multiple issues. The intervention of public transport, the shrinking of agriculture, the simultaneity of urbanization and landscape, the uncertain tendency of industry that is linked to globalization, and the crisis of water supply are factors that provokes the question of 'what would happen if ...' Therefore, three scenarios are made on the territorial scale in order to intersect these variants.

7 | three scenario's

The hypothesis of the scenarios starts from different infrastructures. The scenarios aim to understand the possible consequence of urbanization under these hypotheses:

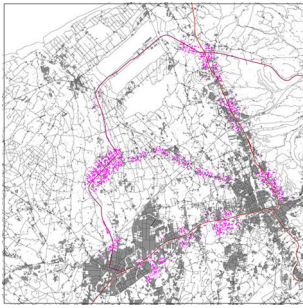
1. What if the existing road network is used as the depended structure for the urbanization?
2. What if the new public transport is used as the depended structure for the urbanization?
3. What if the irrigation system is recuperated as water supplying and purifying system for the urbanization?

The first scenario is regarded as a conventional development in Taiwan. We could imagine there would be another dense urbanized area in between the existing main city and the new town of the high speed train station. This could be the most economical strategy for the development of industry. However the agricultural landscape would shrink enormously. The second scenario could be the most economic one in the sense of energy consumption of mobility. Since the densification could concentrate along the metro line, the space in the middle of the table land could become a vast open space. The road network should be limited in certain way. Therefore the location of industry is not yet clear in this scenario. The third scenario is to densify the whole tableland according to the existing ponds and ditches. In other words, the existing water network would be re-qualified as a water supplying and purifying device for the new urbanization. There would be large amounts of small built areas dispersed in the territory. In the third scenario, the environmental capacity is regarded as the first priority for the new urbanization. In order to explore an urban strategy starting from water, the paper is to test the third scenario.



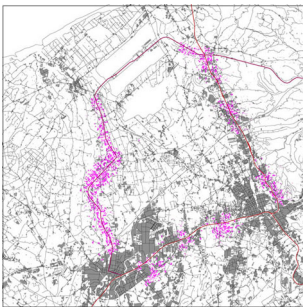
5.1 | The abandoned pond (8)

The abandoned ponds become a space for ecological conservation. The bank of ponds is recognized as the Inland Freshwater Wetland which provides bio-diversity to the local ecology system.



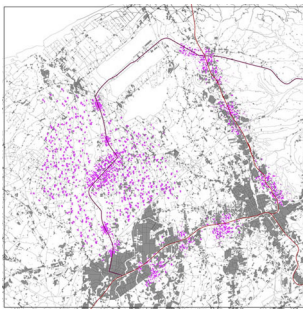
7.1 | The scenario of road-dependent urbanization (10)

The gray represents the existing tissue. The red lines represent the ongoing metro construction. The purple represents the possible consequence of the new urbanization.



7.2 | The scenario of public transport-dependent urbanization (11)

The legend is the same as 7.1.



7.3 | The scenario of water-dependent urbanization (12)

The legend is the same as 7.1

8 | Pond city: the requalification of the irrigation system

“What if the irrigation system is recuperated as water supplying and purifying system for the urbanization?” Pond City is a project that tests the maximal capacity of urbanization based the existing ponds and ditches. A site with 577 hectares is taken as an example. There are different strategies to tackle the problems in different issues. The scheme of the urbanization is like a mesh of built area surrounds the ponds. Within the mesh, the agriculture is kept as green pockets. The equipments are the platforms in between built area and landscape. About the water treatment, the idea is to distinguish the ditches in two types : ditches transporting the clean water and ditches purifying the domestic waste water. The ponds are the reservoir of the domestic clean water. To sum up, three kinds of landscape are created: purifying wetland followed by the mesh urbanization, buffering landscape enclosing the industrial platform, and productive landscape structured by clean water system. Pockets of artificial wetland could take place along the river in order to purify the water before going into the river.

8.1 | The guide scheme of Pond City (13)

The new urbanization is like a mesh in between the ponds. It uses the ditches as a sort of backbone, where the linear wetland can grow for water purification. The ponds are for stocking the clean water. Inside the built mesh, there are certain spaces for new type of agriculture. The estimated population of the site is 23,300 with the density of 40 pop/ha.

9 | Pond city: principles of plot development

The hypothesis is that the irrigation system becomes a water purifying system by means of artificial wetland. This idea is applied to every single plot. In the existing situation, each plot has one side with road and ditch on the other side. The distance between water and road is fixed as the existing dimension 105 meters, while the sizes of plots are different from one another. The existing ditches is widened and transformed into a purifying system for domestic waste water. Landscaping strategy creates wetland along the ditch for water purification and green arms connecting the public space to the ditch. Minimal dimension the width of wetland is 15 meters. In the case of higher density, more area of wetland is given in order to treat more domestic waste water. The density capacity of the plot 105m x 105m could range from 119.3(pop/ha) to 320.7 (pop/ha).The more land division there is, the more consumption of land to be asphalt. The medium-density development can leave more flexibility for architecture typologies.



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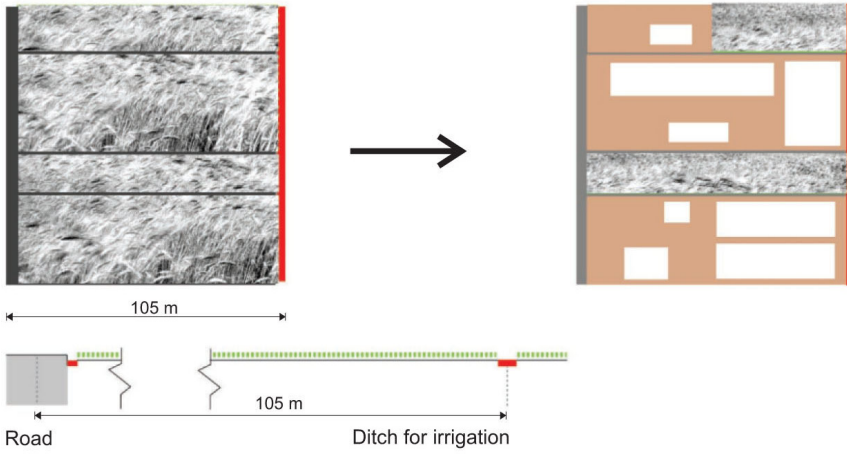
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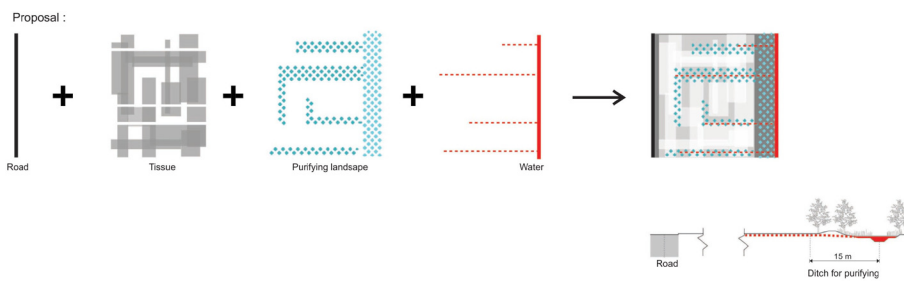
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9.1 | Actual plot development (14)

The subdivision of land is usually long parcel. Each parcel has one side with the road and another side with the ditches. The actual development uses all the land as a completely impermeable surface.

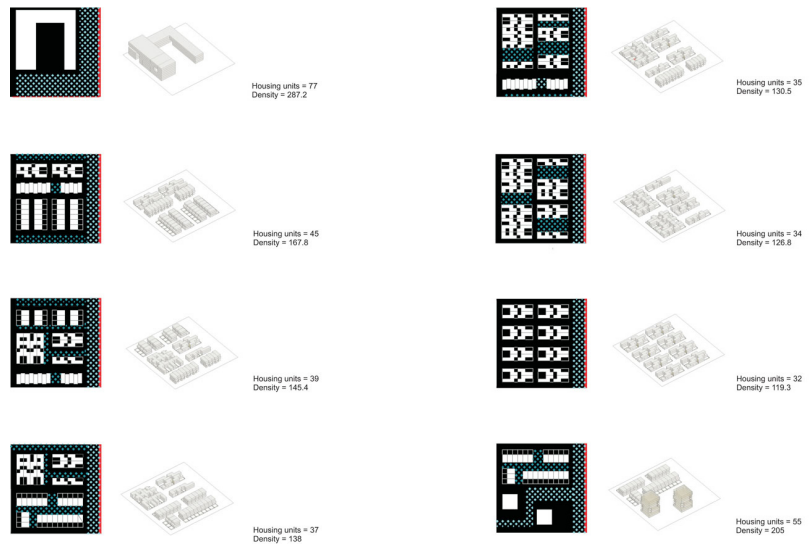


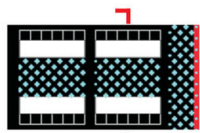
9.2 | Proposal of the plot development (15)

The water and landscape are given more space during the development. The ditch collects the water. The width of the purifying landscape should be at least 15 meters. The small parcels are developed at once to make the use of land more economical for public space.

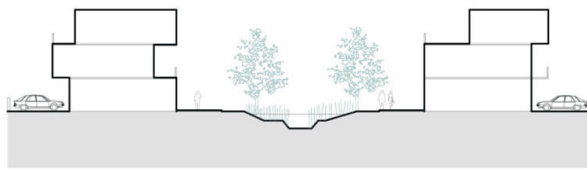
9.3 | Test of different densities (16)

These are the options of typology according to different densities. From 320 to 126 pop/ha.





Section E-E'



Section F-F'



0 2 6 12m



10.1 | A plan of maximal density (18)

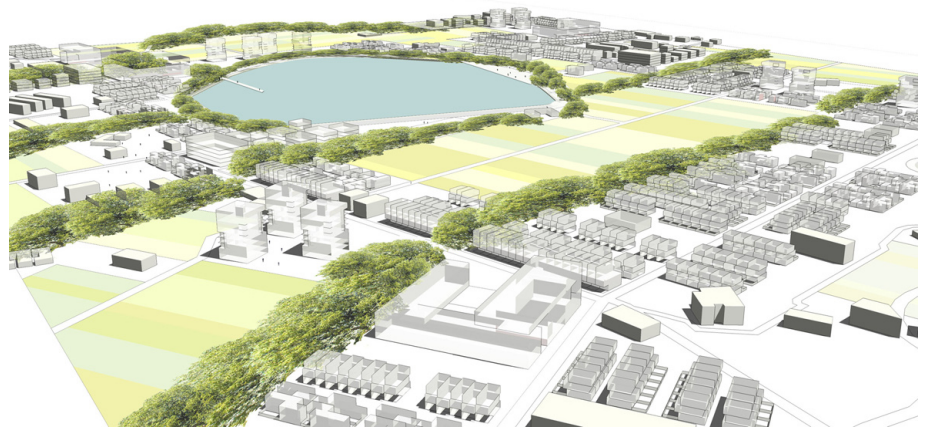
This is an example of maximal density of Pond City. In a site of 116 hectares, it can accommodate a population of 5240 people. The average density is 45 pop/ha. The urbanization grows along the green corridors, in which locates also the equipments that is represented in red.

9.4 | treatment of water and landscape (17)

The landscape of wadi collects the water. The ditches are widened for water-purifying and biomass. It is also an infrastructure for bicycle route.

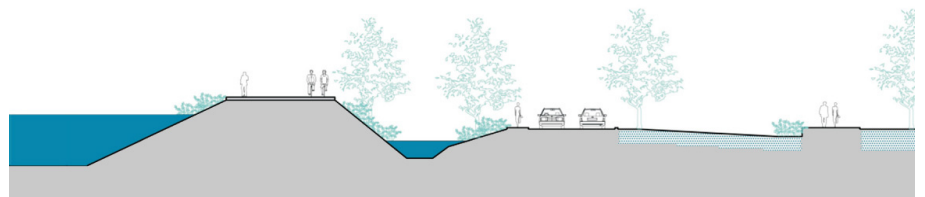
10 | Pond city: landscape as the backbone of the urbanization

A plan is made to test the study of the plot development. Corridors and patches of landscape are created as a back bone of the urban tissue. The platforms of equipments represented in red locate at the intersections of road and green corridor. New meaning is given to the irrigation pond. The water infrastructure could be a place for social practice in the dispersed urbanization. It is a device stocking and supplying water for the urbanization. At the same time it could work as a public space. The clean water is guided and controlled by the device of sluice gate to supply domestic water for the inhabitants. The pond could be a place interlocking public space, public service and to provide biodiversity to the local ecological system. More permeable surface is created and connected for water draining and purification.



10.2 | The urbanization sustained by landscape and water. (19)

The landscape along the ditches works as an infrastructure of the territory. Agriculture is conserved in between the mesh of the built area



10.3 | Section of the public space. (20)

The edge of the pond is designed as a public space for promenade and cycling. The ditch surrounding the pond can be widened as an artificial wetland. There is large amount of permeable surface in between the asphalt roads.

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10.4 | Pond as a public space (21)

II | Conclusions

The significant character of Taoyuan is that the modern dispersion is overlapping on an old rationality that used water network to cultivate and was followed by the agricultural settlements since 3 centuries.

The "Pond City" is to show how an urbanization can start from a to-be-abandoned irrigation system in order to accommodate the possible growth of population. The duality of this alternative infrastructure can create also public space. In fact, the water issue has become evidently the "inconvenient truth" of Taiwan. The average rainwater per person per year is lower than one-sixth of the world average. The water shortage is a pending problem but the dam construction is rather difficult since it generates environmental impact. As an island, typhoon brings the largest amount of fresh water among other water resource in the dry summer. But it is no more a reliable water resource. The disaster brought by Morak proves that the island is one of the first places suffering from the disastrous effect of global climate change. In order to decrease the load of the natural resource, minimal intervention such as re-qualifying the old rationality is needed for today's urban planning and design.

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