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A Research of Waterscape Regulation on Microclimate of Traditional Human Settlements

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Abstract: This paper focuses on the element of waterscape's effect on the traditional human settlement's microclimate regulation, both traditional Chinese and international related cases were analyzed to see their similarities and differences on the concept of indoor and outdoor environment water treatment on the basic of water's key role as spatial continuity, ecological regulation, dynamic fluidity, natural containment and psychological effect on microclimate of traditional human settlements.

Keywords : *Microclimate regulation; Waterscape; Traditional Human Settlements*

Introduction

Water space is the comprehensive application of architectural space and water environment. Natural water bodies coordinate with the building and its environment, which are generally large water surface exist as background or base surface; while others are smaller water pools built within the construction site, which is more proactive, flexible and subtly integrating in the architectural space. In fact, only a few buildings have the condition to be constructed by a vast natural water surface, the other large majority of buildings, in order to introduce water into the built environment, can only take a variety of smaller artificial waterscapes, so as to give the building even more expressions and make the build environment alive.

Traditional Chinese regard water as the most spiritual and active element in nature, it is the source of life, be it human being, aquatic animals or plants. The greatest Chinese Philosopher Lao-tzu pointed out in Tao Te Ching: "The highest good is like that of water. The goodness of water is that it benefits the ten thousand creatures

; yet itself does not scramble, but is content with the places that all men disdain. It is this that makes water so near to the Way. And if men think the ground the best place for building a house upon, If among thoughts they value those that are profound, If in friendship they value gentleness, In words, truth ; in government, good order ; In deeds, effectiveness ; in actions, timeliness- In each case it is because they prefer what does not lead to strife, and therefore does not go amiss." It's clearly that the association between characteristics of water and space, people and nature has been completely interpreted by the wise ancestors and deeply rooted in people's subconscious, It is these characteristics of water that express the endless charm of the waterscape.

But when it comes to sustainable water treatment in indoor and outdoor environment, most of the frequent discussed topics may be more focused on measures to save water or water recycling technology. While some of the traditional waterscapes design in human settlements which follow adjust measures to local conditions and surrounding natural environment, are actually important factors to help create a natural ecology of the indoor environment , and they are definitely accord with the ecological design and sustainable development strategy. These waterscapes often use water, rocks, flowers, trees and installations to simulate the natural mountains and rivers, cliffs, hills, streams, green plants to borrow scene scenery into the indoor environment. Skillfully combine the building's surrounding natural terrain , with the indoor environment to create artificial, coupled with the water features of form and color, dynamic and static, order and freedom, limit and guide ,etc., one can create a comfortable fitting for indoor water environment as a whole. They not only play the role to help microclimate regulation in the living environment, but also give people a lot of experience on comfort and psychological pleasure as well. So the following will respectively render water's key role as spatial continuity, ecological regulation, dynamic fluidity, natural containment and psychological effect on microclimate of traditional human settlements..

1. Spatial Continuity

Water can play a visual guiding role in the space and express the spatial fluidity and continuity. Surface or water flat is the main feature of water and is the most widely used in architectural space with contact, transitions, background, contrast, and other spatial effects. As surface water feature the feeling of spatial extension, it is often used between architectural shape, form, and the constituent elements to create a visual and

psychological transition. The water flat here acts as a connecting factor to unify the scattered elements and buildings. When a series of water flats are used in many architectural shapes, forms or building elements, there will be continuity in the united space. In traditional Chinese gardens, water flat is used incisively and vividly. Multi-layer water flat and corridors, stairs, balcony and other design elements help to create the spatial experience of the migratory garden. As the architect's purpose is to make people continuous dialogue with nature when touring in the garden through the turning paths, the fluidity of water makes it one of the best medium of dialogue.

The typical modern Chinese waterscapes used in human settlements are the elegant, poetic, natural-imitated micro water pool and mountain, like those in the Hotel of Fragrance Hill (or Xiangshan Mountain, Beijing, Built in 1982) and New Suzhou Museum (Built in 2002) both designed by Ieoh Ming Pei, the American-Chinese Architect. In the Hotel of Fragrance Hill in Beijing, there is a small pool with lotus plants beneath the screen wall at the gateway, while walk through the lobby, there is another larger open space of water right in the backyard, with artificial mountain and local plants around. These indoor and outdoor water-flow system forms an effective transition from the exterior to interior space, which help to accelerate the natural ventilation and introduce the natural scenery into the building and enlarge the inner immediate visual experience (Fig.1). After twenty years, Pei has brought these design strategies to a new high, in the courtyard of New Suzhou Museum complex, the waterscape is even more splendid and incisive, features as a holistic organic integration of the nature and



Fig.1 Waterscape in Hotel of Fragrance Hill (Built in 1982, Beijing, designed by Ieoh Ming Pei). The inner small waterscapes and backyard water pool.

human settlement. Stone-steps and bridges stretched on the water surface , green pines and verdant cypresses strewn at the corner , levels of artificial mountain stacked up to resemble the layer of peaks and knolls, golden fishes swimming leisurely in the water, visitors lingering around to enjoy the pleasure, all are naturally united as one in this eternal, harmonious and sustainable space.

Beside, waterscape itself can be used as an independent aesthetic installation, through space division, limit, connections, penetration, to make the spaces independent as well as inter-dependent and echo each other at a distance, and increase the richness of environment space levels and the feeling of return to nature. As the traditional Chinese ecological idea always advocate, "interest and charm like natural itself, don't bother to add any more artifact".

2. Ecological Regulation

More important is interior waterscape can accelerate the microclimate regulation in indoor environment with the water's ecological role in self- purification, air-purification and micro-climate regulation. Large area of water can assimilate dust and purify the air; green plants on the water can absorb carbon dioxide and release the negative oxygen ions in the air. Water and plant leaves' evaporation can increase the indoor humidity, and regulate the environment temperature to a comfortable degree in the micro climate of the interior space.

Self-purification: Nature water has a certain capacity of self-purification. Most of the pollutants can be purified through a series of physical, chemical and biological changes after getting in the water, then this water partially or completely restored to its original condition.

Air-purification: Water pond can keep away the traffic contaminants such as dust, exhaust gas. Particularly when the water molecule from the pond, or a waterfall, intensively impact with the oxygen molecule in the air, a large amount of negative oxygen ions is automatically produced. Known as "air vitamin", negative oxygen ions is conducive to human physical and mental health when people enjoy the "air baths" in the splash of spring water.

Micro-Climate Regulation : As water's radiation properties, heat capacity and

thermal conductivity is quite different from land, when occupied space and water flat surface expand reached a certain amount, changing heat and moisture exchange between the water surface and the above atmosphere, temperature will slowly changes and humidity will increases in the space around the water surface, local microclimate near the water will then becomes more pleasant, more suitable for growing certain plants.



Fig.2 The Two Only Founded Rustic Air Conditioning in QingYunXuan in Xidi Village, Anhui Province and YiPuYuan Garden in Wuxi.

With well awareness of all these great ecological advantage of water, Chinese ancestors not only learned how to bring water to the courtyard and the garden, but also try to divert water from afar to the inner space. Generally they would build the stilt house above the water with vents opened on the interior floor, when the water vapor upward through the gap into the room, the microclimate of interior space can be correspondingly adjusted. If there 's no large water source in the neighborhood, like the two only cases we currently found in China, Qingyun Xuan in Xidi village ,Anhui Province and Yipu Yuan Garden in Wuxi, both are well-preserved noble family house built in Ming and Qing Dynasties period(Fig.2). In order to regulate the interior temperature and increase the comfortable level, the homeowners drew the water from afar source through underground channel or covered slot to a temporary tank under the room, then dug a vertical well straight-up through to the upper room floor, when open the cap of the wellhead in hot summer, the coolness of groundwater will rose up from underground reservoir through wellhead and distributed to the around indoor space (Fig.3). The deeper the well, the cooler the water .There is a cap on the wellhead that the users can open, half open or close at any time depend on the weather and demand. The Cooling efficiency is steadily at an average of 2~5°C, the water vapor from the well can also help to increase the humidity

of the inner space and provide a pleasant environment for the resident inside the house, so this facility also win a name as Rustic Air Conditioning.

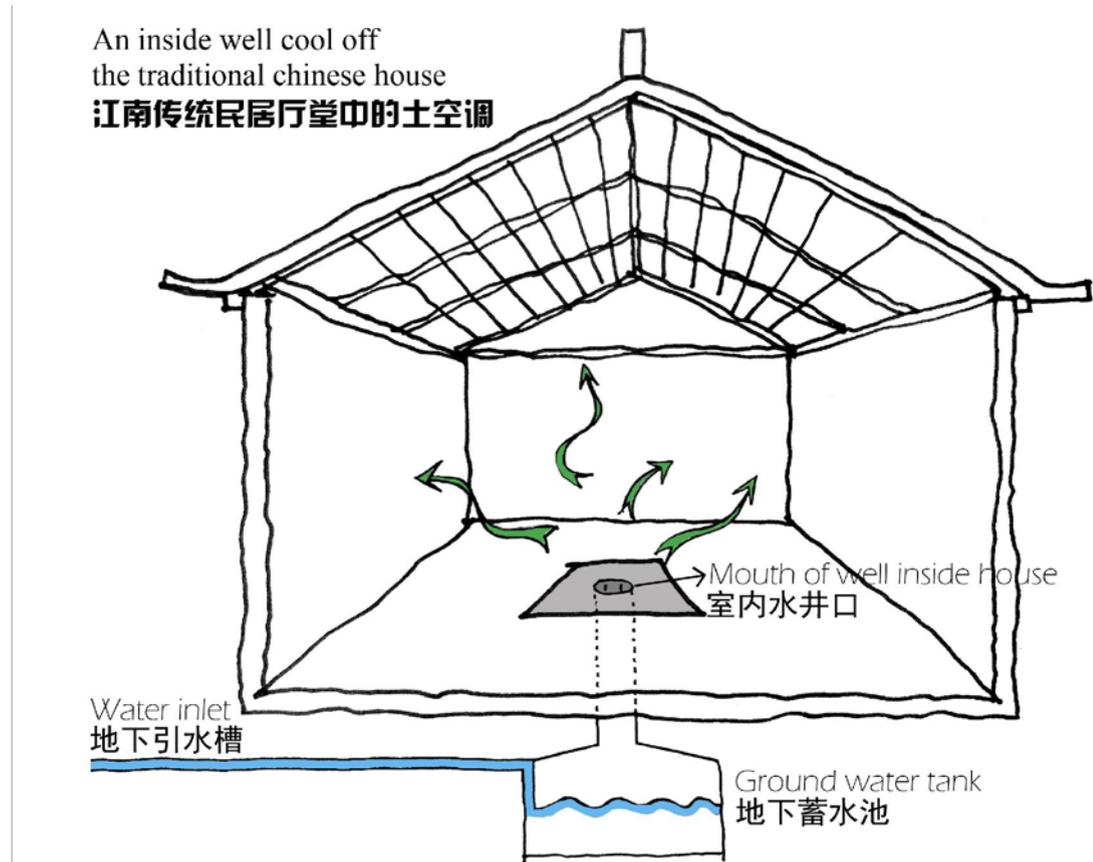


Fig.3 The Chinese indoor wells and the water system (Drew by author). The water vapors from the indoor well to cool off and regulate to microclimate in Chinese traditional house.

Despite all these convenience in use and comfort effect, the cost of the whole construction system is really high, including the water channel from distances, the underground tank, and the straight-up well. So this Rustic Air Conditioning is usually built in the room of multifunction or can benefit people at large, like the living room or the main guest hall in the large family courtyard house, and they are rarely seen in ordinary family, only the noble or the wealthy family can afford that as well. However, the invention and use of this Rustic Air Conditioning are the evident of generation of ancestors' ecological wisdom and technology achievement to tackle the arduous climate and explore for a better living condition before the modern electric air conditioning are produced, it is also a good inspiration for us today to dealing with daily problems in a low energy consumption and environmental friendly ways.

3. Dynamic Fluidity

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The virtuous find pleasure in mountains while the wise delight in water. The wisest architects create the most delightful space of diverse water peculiarity with a sophisticated command of the concrete form, depth, width of water and its contamination to the building and the environment.

The flowing water is good to adapt to the terrain, acute or slow, wide or narrow, in a variety of water formations that can be experienced through all sense of human like vision, sound, smell and touch. That is also the main reason why many private and public buildings tend to integrate a dedicated multi-level water element in the environment, water curtain, fountain, interaction pond, to name but a few, to create an attractive, lively and flexible atmosphere and naturally guide people interact with the water and the surrounding nature.

Frank Lloyd Wright's Falling-water Mansion is one of the most classic designs in the western world. It perfectly express Wright's claims "organic" design philosophy, back on a steep cliff, large cement balconies scrambling stack on a cascade between stones, with different length and direction ,as if it will jump out from the villa, suspended above the waterfall. Wright was also deeply impressed by Lao-tzu 's Philosophy "Clay is fashioned into vessels ; but it is on their empty hollowness, that their use depends. The door and windows are cut out(from the walls)to form an apartment ; but it is on the empty space(within), that its use depends. Therefore, what has a (positive) existence serves for profitable adaptation, and what has not that for (actual) usefulness". He was quite absorbed by this traditional Eastern Philosophy when he travelled around Asia in his early ages, and kept exploring and reinforcing his own theory during his latter practices in America and Western Europe.



Fig.4 WaterFalling Villa(designed by Frank Lloyd Wright in 1935), The downward staircase stops suddenly right above the pool and waterfalls.

But unlike tranquil Chinese waterscape, the natural Bear Run streams and waterfalls have been the interdependent parts of the building forever. Small glass windows are enclosed at diagonal of the room, so as to avoid the stream of water and water vapor into the room.

And one of the most attractive and dramatic scenes is, through the hanging stairs that start from the bottom layer and reach down to the water surface, but suddenly stop right above the small waterfalls. Habitant can't really touch the water but actually witness the streams with moist wind and the gurgling sound wave, the human experience has been transferred from metaphor into reality then eternity, in a real way of communication and containment between the motion flowing water, the static building complex and the near nature forest (Fig.4).

Although their forms and expression is different, there are strikingly similar ideas underlying these Chinese waterscapes and the westerners' practices. They both integrated the space of the interior simultaneously with the space outside. Wright was familiar with Lao-tsu's metaphor of water pitcher to vacuum and applied the metaphor to his design and saw architecture as space, not form, and focused on the connection between space and nature surrounding. Human settlements are part of nature and must be in harmony with it. Therefore waterscapes are designed to help divide up and structure the space so that people can moving through space functionally and our experience are comfortable, and inspiring.

4. Natural Containment

The fluidity of water can produce a variety of waterside-places, so as to help people access, shared and coexistence with the environment while not touch or ruin the nature with containment. In traditional Chinese vernacular residential area, series of water spaces function as the main spatial planning framework of the whole community, many traditional towns and villages of Jiangsu and Zhejiang in the vicinity of rivers and lakes are even natural growth according to the water network, but with the local resident's containment and protection to the waters, the nature system are still maintained in shape during thousands of years' civilization. Hongcun, a traditional village in Yixian County, Anhui Province, China, is the most typical water village. The rain water from the mountain afar were introduced to the village, through numerous twists and turns in front of each household, short rest in the half-moon-shaped pond in the village center and finally run all the way down to the artificial lake at the lowest part of the village. This extraordinary

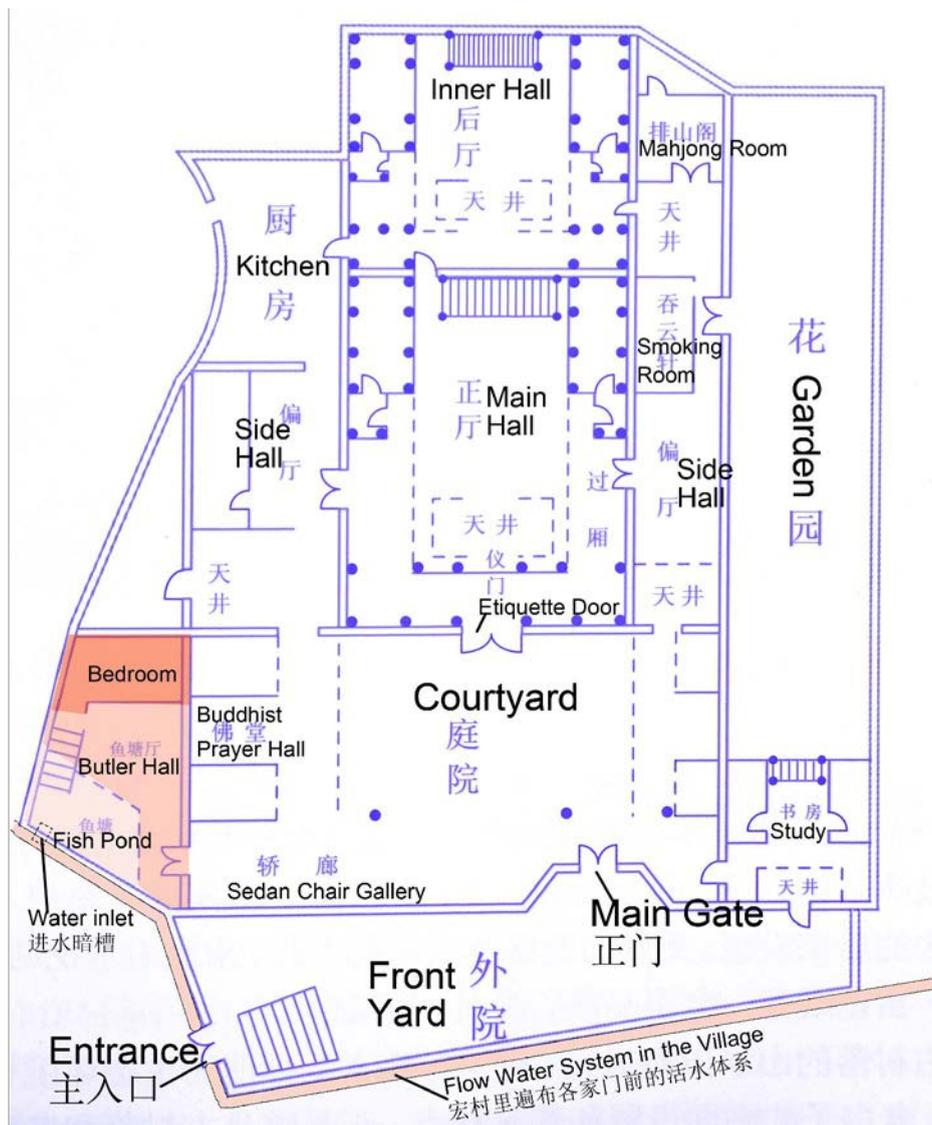


Fig.5 The Master Plan and Water System in Side Butler Hall of ChengZhiTang, a traditional Chinese Courtyard House in Jiangsu Prov.

water system was the accumulated wisdom of generations of local residents and perfectly fit their daily need of drinking, washing and even fireproofing. Till today are still being preserved the ancient houses of civilian homes with white walls, black roof-tiles, delicate bridges over flowing waters in a poetic setting and diverse appeal.

Within them, ChengzhiTang, a current well preserved traditional courtyard house, which was built around 1855 in the late Tsing Dynasty, located at the center of Hongcun Village. It was the courtyard house for the noblest family in this village and every inch in the courtyard was delicately designed. The most attractive part is this irregular triangle zone (Fig.5), which is in the west corner of the Wang Family's Courtyard, served as the special accommodation paradise for the butler of the house, with a sleeping space in the latter part, a standard hall in the middle and a fish pond in the front. The mini hall in the

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middle is completed equipped with an altar, two armchairs, a vase, a clock, a pair of calligraphy couplet and painting on the wall, while the two square meter fish pond is surrounded by two sides of high walls and two sides of open portico with Beauty-Sit (a kind of Chinese traditional bench with lazyback which wins its name for being sit by beauties). In particular, the outside flow water system in the village had been introduced to the pond by an underground channel, with several yellow, orange, red and white carp moving quietly and leisurely around in the rippling water of the lotus pond., which brings a fresh look for the viewers while they step down the staircase or sitting at the above beauty-sit overlooking the whole space. The flow water and swimming fishes in the pond is not only a relaxing scenery for the residents, the water evaporation from the pond can also increase the whole zone's humidity, reduced temperature and regulate the microclimate especially in the hot summer, and the front high wall and the sky-open help to accelerate the natural ventilation in the whole space like a chimney effect as well. We can be easily convinced that this comfortable environment will help even the busiest butler in the world to calm down and relax quickly when he returned to this neat shelter in the corner of the big house after dealing with all those tedious daily affairs (Fig.6).



Fig.6 The Real Picture of Butler Hall of ChengZhiTang, a tiny but well equipped and charming space.

It's well worth to point out again that, here in ChengZhiTang house, like the design in Wright's Waterfall, the staircase is stop just right above the water surface, deliberately keep mankind from the dedicated artificial nature and create a containment relationship between man and nature.

5. Psychological Certainty

Psychologically, these waterscapes benefit to the physical and spiritual health of residents in a way that they can slow down, relax, enjoy the pleasure and purify their soul through the tranquility. As the greatest Chinese Philosopher Confucius once said : "Water has five virtue, it may have kindness as it keep flowing and nourish every life in the world; it may have righteousness as it always moves downward with a certain rule and path; it may have Tao as it is vast and infinite; it may have courageous as it flows thousands of miles intermountain with no fear; it may be law-abiding as its surface are always flat; it may be integrity as it shape what it is; it may be perceive as it can go nowhere; it may be destined as it always source from west; it may be capricious as it can washing-up everything." And in traditional Chinese Feng-shui theory, a waterscape full of natural spirit in the indoor environment or courtyard means an accumulation of fortune and luck.

Water environment has a centripetal sense of place and it can bring life to the living quarters, attracts people to stop, interact and be socialized. The British scholar James Hope believes that the sense of belonging brought by the community identification is a special social value. Similarly waterscape environment's "local identification" brings people a sense of belonging and social pride, thereby increasing the cohesion and potential development of the community. "Live close to Water" is a reflection of the ancient principle of natural selection, expresses human beings' wisdom to adapt to nature, use of natural, and coexistence with nature.

6. Conclusion

In conclusion, waterscape is the most attractive landscape design, which can be plastic, static or dynamic, can have sound or reflection to the surrounding scenery features. It is these characteristics of water that express the endless charm of the waterscape. The association between characteristics of water and people has been deeply rooted in the subconscious, when seeing all kinds of performance of the water; one will come to the pure natural feeling of mystery, comfort, ease. Good natural waterscape can help create a good ecological environment, improve the micro climate of the indoor environment, enrich the visual experience of living environment and benefit for residents 'physical and mental health.

Various ways of water use can present diverse water formation, but the water used should be consistent with the expression of the construction, the character of the building and demonstrated water's own natural beauty and character through the consistent with the

architecture. In human settlement and built environment, water always functions as enriching the landscape, isolating noise and regulating microclimate.

But its meaning is more than that, when the architect can really make the water be heard, be touched, be evoked a resonance, the water itself will become one interdependent part of the architectural space and the possibility of building expression will be largely expanded, then the human settlement quality will be greatly improved. As the call of return to nature become increasingly pressing in this era, the building industry tend to make building as a naturally breathing container or a showcase of the natural elements of light, wind, water. While the ancestors would try every effort to create a waterscape even in no nature water environment, today our architects should take more serious attitude to cherish our current water environment, explore various performance ways of water itself, and delicately, subtly immerge it into the space sequence, formation and atmosphere of the human settlement.

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