Adaptive Tower
Typology under Climate Change

MArch Studio Fall 2020 HKU
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Residetial Towers of Hong Kong (source: wang weijen)

Disaster and Resilience

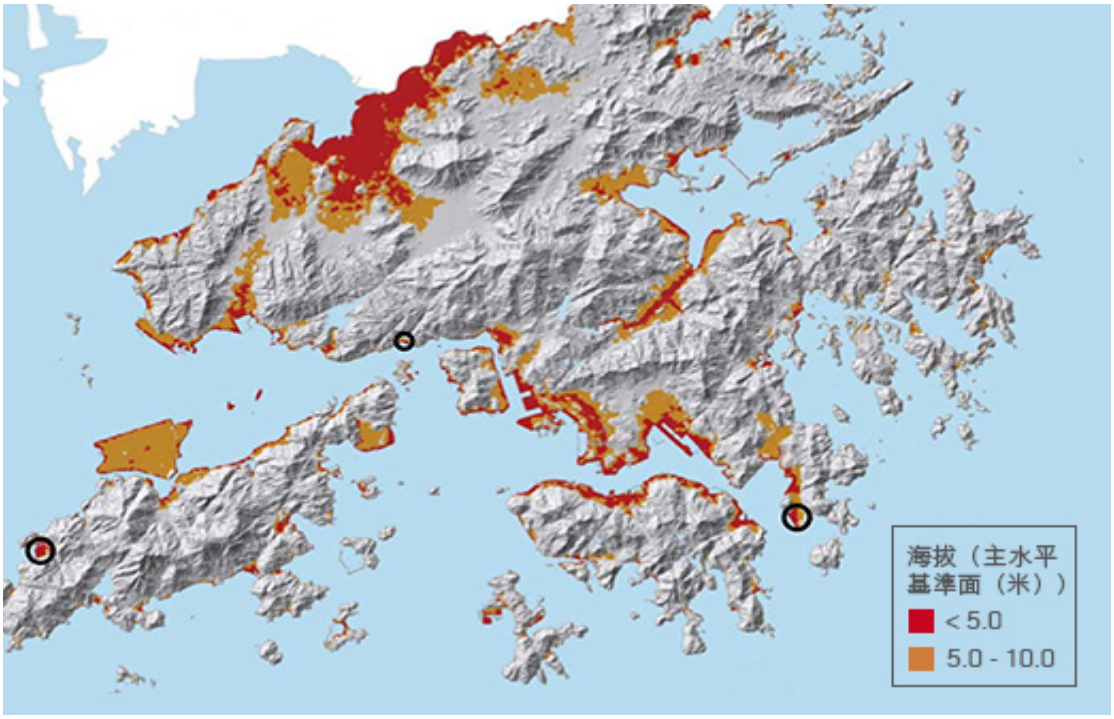
The studio is part of the international collaboration with APRU universities along the Asian Pacific Rim including UCLA, Berkeley, Washington, Chile, Tsinghua, Tohoku, Taiwan, Singapore, Melbourne, and HKU. The UN World Conference on Disaster Risk Reduction in 2015 adopted the Sendai Disaster Risk Reduction Framework to guide global disaster risk reduction. The Architecture and Urban Design for Disaster Risk Reduction and Resilience Initiative (Arc-DR3 Initiative) proposed by UCLA and Tohoku University is established in anticipation the 10th anniversary of the Great East Japan Earthquake, to host exhibitions and symposiums for the joint studio works in 2021.

With the treat of disaster on human habitation and natural ecology caused by global warming and climate change, the high-density urban model of Hong Kong and the Greater Bay Area are facing increasing challenges of sea-level rising and natural disasters like tropical storm. Invited by Arc-DR3 Initiative program, the studio will take part in the effort of developing resilient and adaptive design strategies responding to the potential environmental threat for tower typology. By participating the Arc-DR3 platform for exchanging knowledge, the studio is to re-evaluate the performance of Program, Structure and Landscape of Tower typology through interdisciplinary approaches for research and design, exploring modes of transforming architecture as an integral part of nature, for reducing the risk of recurring disasters and enhances resilience for our changing urban and rural environment.

Climate Change: Sea Level and Storm Wind

The average global sea level has been rising since the start of the 20th century. Between 1900 and 2016, the sea level rose by 16–21 cm. Data gathered from satellite radar reveal an accelerating rise of 7.5 cm from 1993 to 2017, roughly 30 cm per century. By 2050, the sea level rising is estimated to reach 50 cm if the situation of global warming continues. Linked to thermal expansion of warmer oceans and melting glaciers, the change in sea levels is induced by the continuing global climate change. Along with global warming and sea-level rising comes the increasingly intense tropical storm and tide. Increased risk of damage to human habitation and ecology caused by intense hurricane and typhoons along the coast will be intensified through on-going global warming. With 4% increase of tropical storm wind speed and 8% increase of tidal wave per 1 degree of temperature rise, it is estimated to reach 30% higher of storm tide assuming 4 degrees temperature rise in the near future. With large urban area of reclaimed land, Hong Kong is at risk of storm tides at around 5 meters about sea level brought about by typhoons by as early as 2030.

The frequent typhoons with tidal storm would impact large swathes of Kowloon and Hong Kong Island including most of the New Towns developed from reclaimed lands in the New Territories. The potentially impacted area includes the coastal districts of Hong Kong's vibrant financial and commercial sectors, with implications of severe damages to their economy and habitation due to the vulnerabilities of their architecture and infrastructure to natural disasters. The vivid example of Typhon Mangkhut in 2018 with maximum wind speed of 250 km/h demonstrated how tower architecture was affected by tidal waves and storm wind.



Reclaimed land below 5 meters above sea-level (source: hong kong climate change report 2015)

Vertical Program for Tower Typology

With limited land supply and increasing population, and the conservation of land for the country park, Hong Kong's planning employs a semi-autocratic approach to meet the density demand by establishing an efficient mode for building mega-housing of tower. Under the building regulations, a building is separated vertically into the residential towers, and the podium deck below for public and commercial program, including the shopping podium with rooftop garden above, and basement car park. Allowing high plot-ratio developments for the podium of nearly full site coverage, the mega-housing structure facilitates maximum number of modular towers vertically sit on its top. Based on prototypical unit-layout with extrusion of floor plans for over 100 meters height, one podium development can accommodate nearly twenty thousand people, and over ten podiums with a metro station make a town of two hundred thousand population. High-density developments for Hong Kong's New Towns along the urban fringe or reclaimed land demonstrate how mega-housing models of podium-towers are efficiently erected vertically, inter-connected horizontally through sky-walks between podiums, with infrastructure provisions including Metro station, hospital, sport hall and recreational facilities.

Facing challenges of climate change, how would the mega-structure of podium-towers respond to the potential frequent storm and flood? How can we re-program and design towers in the future with flexibility and innovation, allowing adaptability for programmatic intervention as well as new possibilities for commom spaces incuding commerce, communal and landscape? How can we re-think towers beyond vertical stratification to address horizontal challenges coming from environmental disaster of tropical storm-wind and sea-water tide? How can the new tower typology be resilient to disaster while enhancing the quality of our urban and communal life that can sustain in the coming decades?

Hong Kong's New Town system of mega-podium with towers (source: wang weijen)

Adaptive Tower: Water, Wind and Sunlight

The studio begins by mapping how different types of water: rain and waste running through a vertical tower? And how water moving through, around and by-pass the building sites into the river and ocean? How do we provide water supply, drainage and sewage system for a district, and how can we sustain water through collecting and recycling for a podium with towers? The studio intends to understand and maps the waterscape - flows, dissipation, and retention for a district from hill valleys to the harbor? And also how water coming from harbor were push into the lowland in short time during tidal waves? With the increasing frequency of heavy rainwater brought by tropical storm coming down from the hill, as well as the flooding water brought through horizontal tidal wave coming from the ocean, how would the movement pattern of water in and around a tower would change, and how do we provide resilience and mechanisms with renewed landscape to accommodate, adjust and re-channel the change?

The studio also maps how different modes of wind and sunlight, by different seasons and directions, run horizontally and vertically through the densely packed vertical towers. How different types of architectural porosity and protection we can provide to facilitate and also shield the ventilation and penetration of wind and sun through intermediate spaces of sky decks and gardens? With the increasing frequency of horizontal storm wind blowing through the vertical tower, how can we re-map the wind-scape and sunlight through transformations for developing the new generation of adaptive towers? And how our adaptive towers can provide new mechanisms to accommodate thermal comfort and quality of life while providing resilience facing the climate change and potential environmental treat? Facing constant storm, heavy rain and flooding over tower, podium and the ground level, the studio is also to explore how tower typology can be re-programed vertically and horizontally better for sustaining nature and ecology. By studying tower typology: its structure and foundation, program and envelope, building services and infrastructural system, the studio is to address architecture as an adaptive measure for incorporating the changing performance of wind, water and temperature.

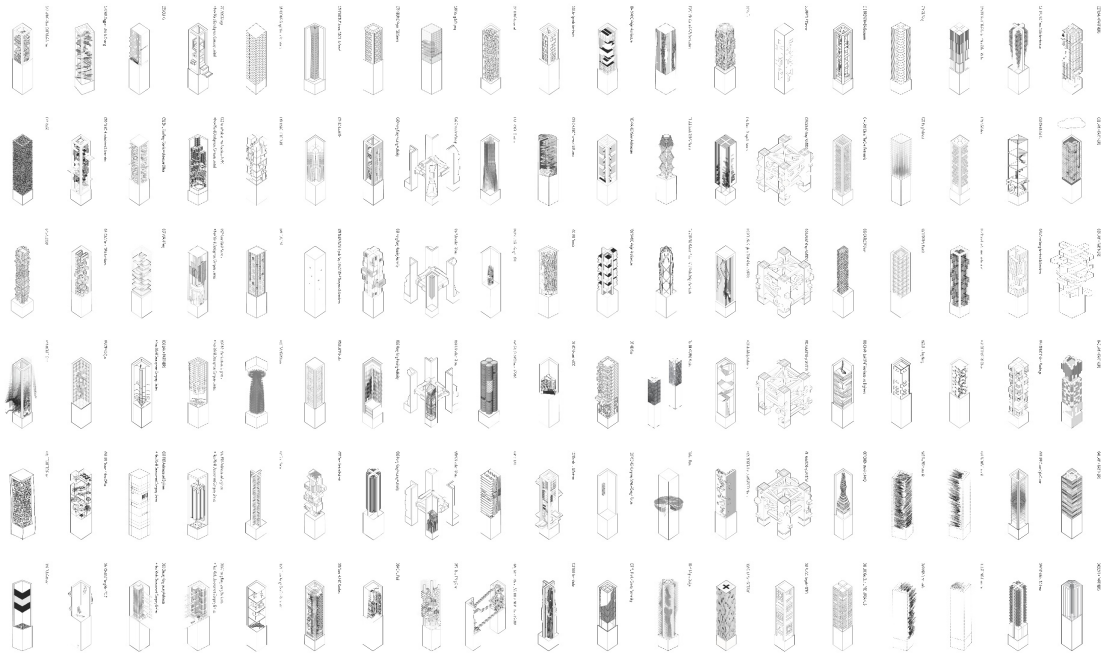
Hong Kong’s towers in the Tseing Kwan O New Town on reclaimed land

Adaptive Tower: Landscape and Common Program

Adaptive Tower continues its study by asking: what would be the impact on site and landscape for tall buildings in the affected urban area if they all have to face frequent flooding from tidal waves? How would they work as an individual for negotiating with retaining wall, substructure, topography, drainage, trees and plants, and what will be the landscape fabric they can work collectively for sustaining forward looing infrastructures and landscape spaces? The studio is to create a dialogue between architecture, landscape and urban design for re-inventing tower typology with urban and landscape systems

Working with *MArch studio by Ulrich Kichhoff* focus on tower Structure, and MLA Studio by Natalia Echeverri focus on tower Landscape, this studio is to address the re-Programing of Public Spaces for tower typology. By exploring the innovation for Common Core, Communal Deck, Roof Patio, Sky-Garden, Shopping Mall, Sky-Street and Car Park…. the studio investigates how alternative design of common spaces and urban-landscape systems can generate tower typologies resilient to climatic treats and environmental changes. With increasing amount of rainwater, wind speed, and summer heat, the studio explores adaptive towers addressing:

1. **Resilience:** re-thinking the planning and design of towers allowing flexibility to accommodate changes facing disaster
2. **Flexibility**: enhencing resilience for vertical towers by accomodating flexibility of programs, sturcture and infrastructure landscape.
3. **Porosity**: facilitate porosity for a tower at the gounds, podiums, and sky patios for communal spaces and also to allow resilience for natural forces.
4. **Connectivity**: facilitate connectivity at various strategic levels in between towers by sky-linkage to provide resilience and flexibility.
5. **Sustainability**: transform and re-think the design of towers addressing sustainability facing environmental challenges?



Hong Kong’s 100 towers in 2018 Venice Architecture Biennale (curated by Wang, Chung and Tsang)

Design Brief and Outputs

Grouping with students from Studio of Structure and Studio of Landscape, different environmental factors will be identified for study. In parallel, several pilot sites will be selected simultaneously for mapping their urban, landscape and architectural conditions in relation to their natural factors. And subsequent proposals are to be developed for transforming existing towers and landscape into adaptive ones responding to the climate change, before the final design project in a newly reclaimed prototypical site. With this study framework, the studio will cover a series of inter-related research and design exercises of four stages of study include:

Stage 1. Research on Environment and Sites in Hong Kong (3 weeks)
- Studies on Climate, Storm, Tide and Sea-level Change

Stage 2. Transforming Towers and Landscape in a Site (3 weeks)
- Studies on existing Typology of Towers and Urbanism; Mapping on the Migration of Water, Wind and Sunlight within and around Towers

Stage 3. Prototyping an Adaptive Tower with Programs (3 weeks)
- Exploring New Typologies of Adaptive Tower in the new site

Stage 4. Developing Adaptive towers with Landscape (3 weeks)
- Proposals on Adaptive Towers with new Landscape and Urban Conditions

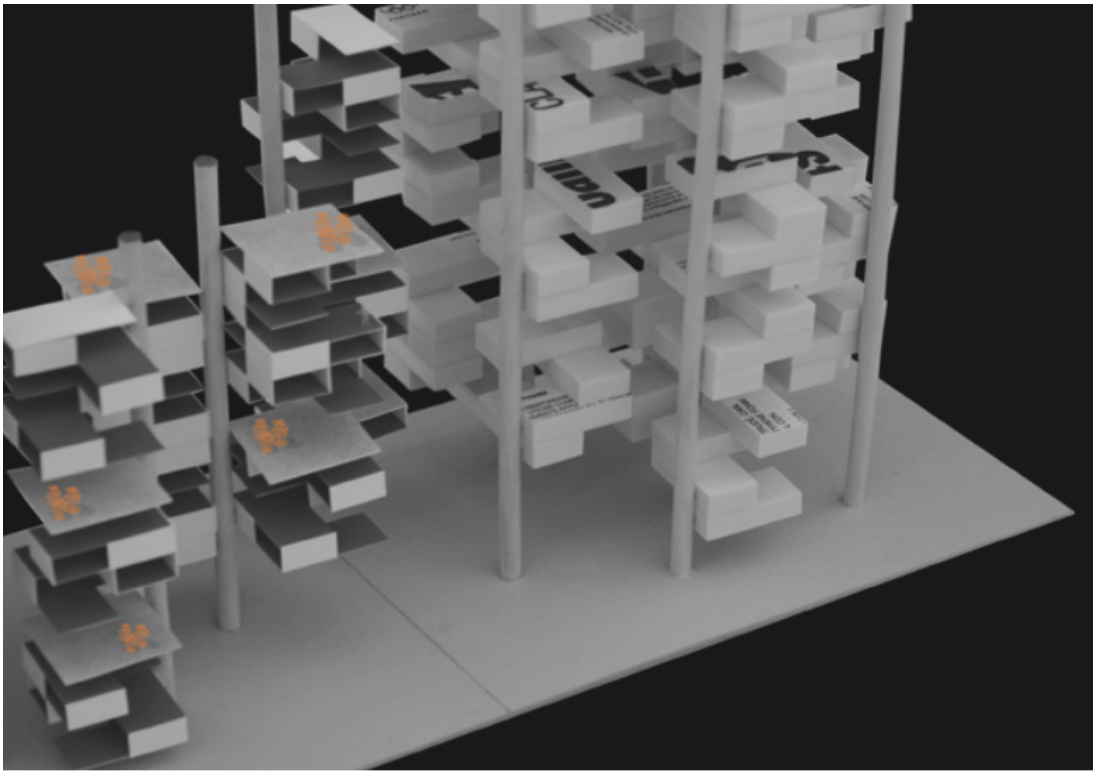
The study and proposal of Adaptive Towers would in particular, highlight the Performance of Sections to weave different systems together, acknowledging the complexity of architecture with landscape, water, wind, and sun. Given the landscape and the vertical stratification of towers with multiple ground levels, rains and tides are driven by wind and storm water as well as by the gravity. The tower and its landscape ground require architectural structures not only to erect up facing climate challenges of strong wind and sunlight, but also extend deep down into a complex mix of soil horizons, rubble, pipes, utilities. Addressing the tall towers facing the storm and wind high above, the performance of air movement patterns and speed in-between towers, and how it travels through the porosity of communal spaces and its sky-patios and bridge connections will become critical to determine the design. The continuity of human public movements and habitation, interweaving with the water and wind movement through the landscape and common space along the section of towers and the city, will be the key tool for design integration.

The final design outputs of Adaptive Towers include:

- 1/500 Site Plan and Massing Models for Urban and Landscape conditions;
- 1/200 Plans/Sections and Models for Architecture Proposal;
- 1/100 Typical Sections/Plans illustrating environmental and human performances

Schedule

- Sep 1/2020: Studio Briefing
- Sep 7/2020: Research and Mapping *Stage 1*
- Sep 21/2020: Transformation Tower and Landscape *Stage 2*
- Oct 5/2020: Initial Studies for the Final Site
- Oct 12/2020: Reading Week and Site Study
- Oct 19/2020: Kick-off Prototyping Adaptive Towers
- Oct 23/2020: Mid-Review
- Oct 26 2020: Developing Adaptive Tower and Evaluations
- Nov 16/ 2020: Developing Adaptive Towers with Landscape
- Dec 1-3/2020: Final Review
- Dec 4 / 2020: Studio Forum



Tower Programa Study of MArch Studio WWJ 2017 Spring