The Designed Ventilation Corridors to Mitigate UHI Effects

Improving Urban Planning Methods in Built-up Areas with Wind Corridors from a Landscape Perspective
Taiwan Railway BR-1 Nangang Marshalling Yard Urban Redevelopment Area Landscape Design Project

National Taiwan University, Department of Horticulture and Landscape Architecture, Class of B03 Graduation Design

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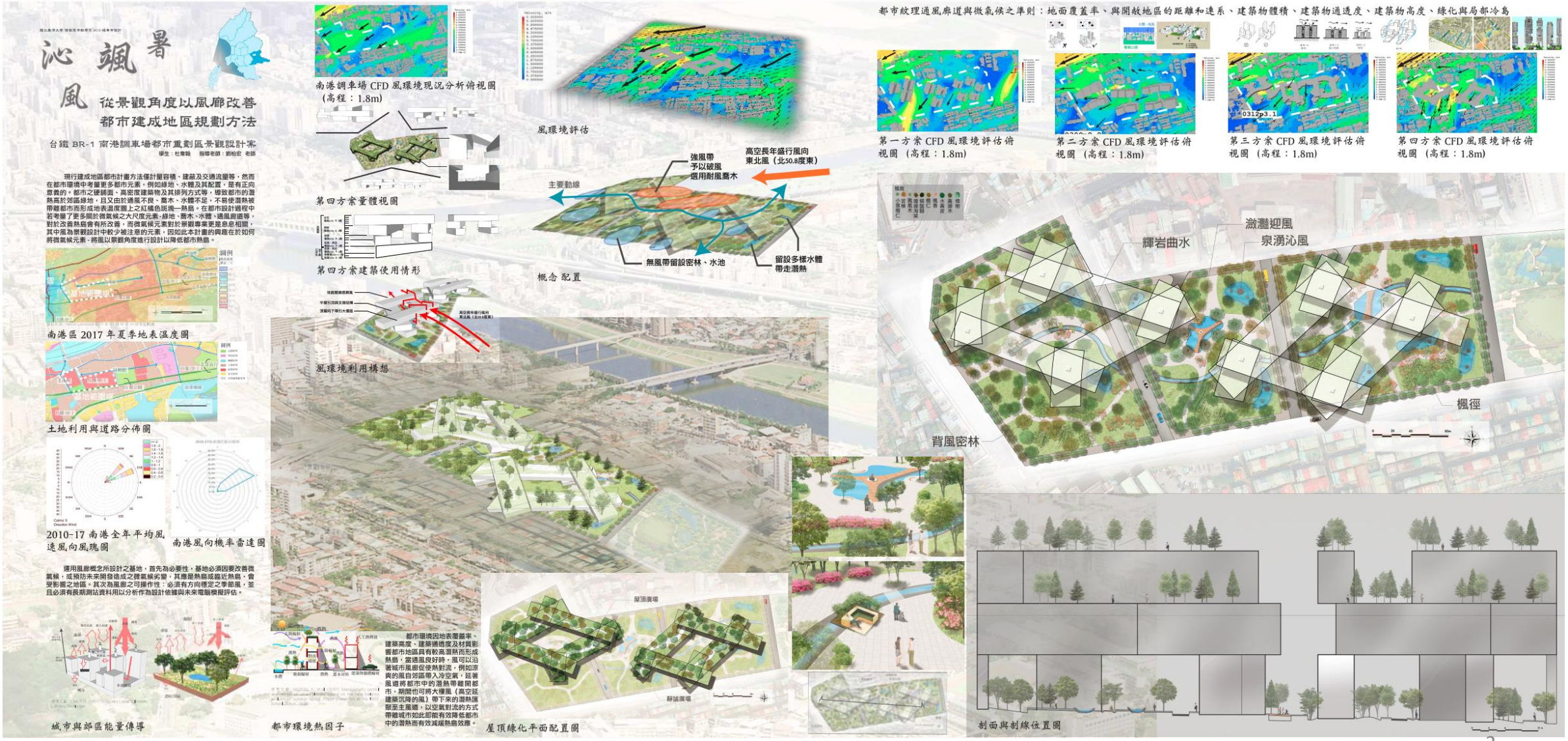
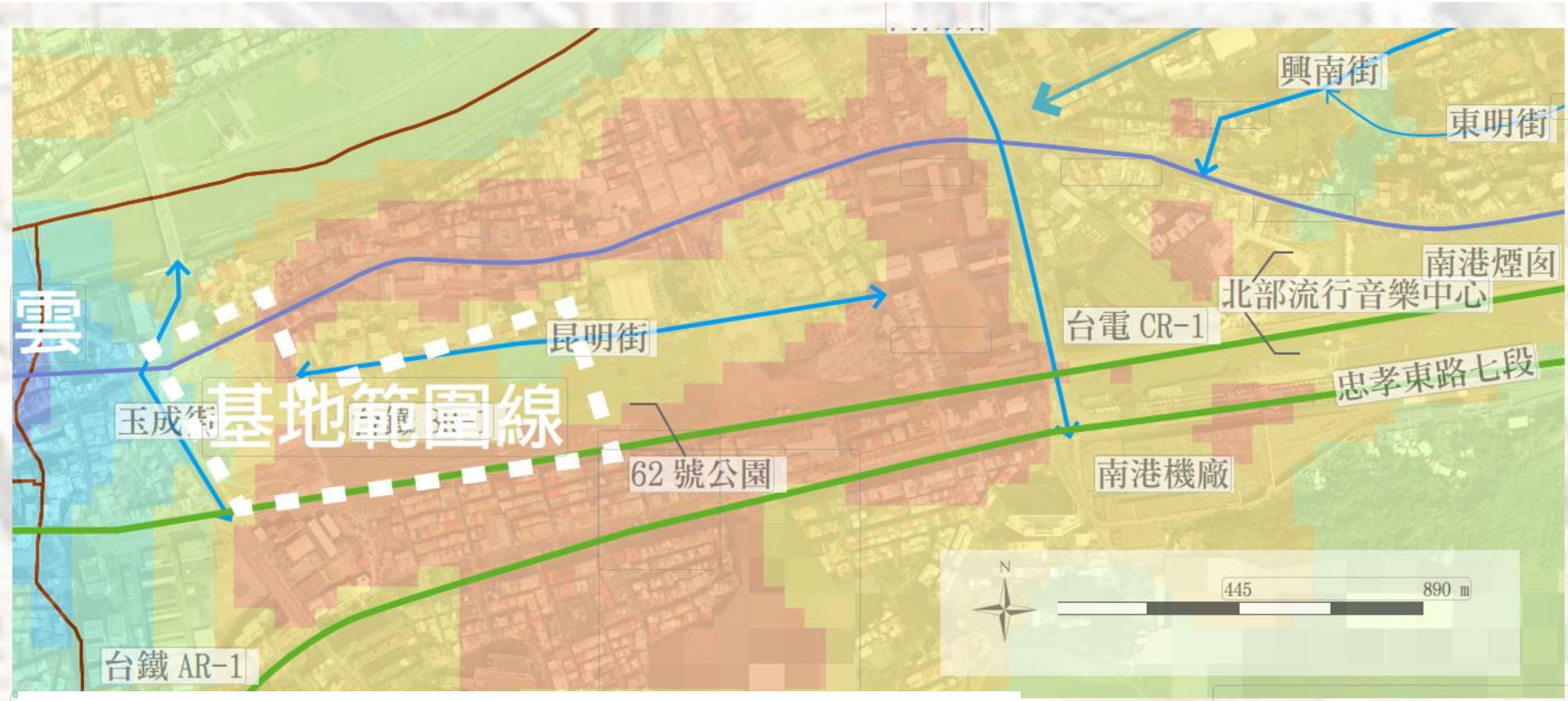
Poster Layout



Preface

- The current urban planning methods for built-up areas primarily focus on measuring factors such as floor area ratio, building coverage ratio, and traffic flow. However, considering additional urban elements such as green spaces, water bodies, and their arrangement has positive implications for the urban environment. The hard surfaces, high-density buildings, and their arrangement in urban areas result in higher latent heat compared to suburban green spaces. Due to poor ventilation and a lack of trees and water bodies, this latent heat is not easily dissipated, leading to red-orange patches on surface temperature maps, known as urban heat islands.
- Incorporating larger-scale microclimate elements—such as green spaces, trees, water bodies, and wind corridors—into the urban design process can help mitigate heat islands. These microclimate elements are closely related to landscape architecture, with wind being an often overlooked factor in landscape design. Therefore, this project is interested in exploring how microclimate elements, particularly wind, can be designed from a landscape perspective to reduce urban heat islands.

Analysis- Nangang District 2017 Summer Surface Temperature Map



Label

Surface Temperature Unit: ˚C

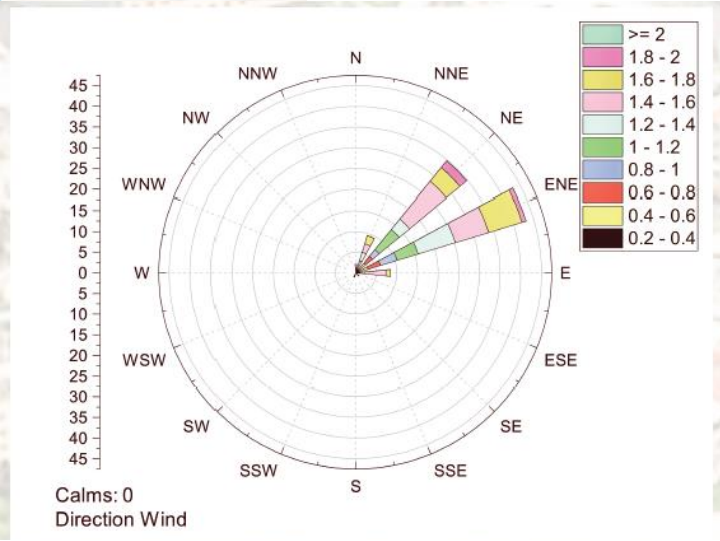
- <16
- 16-18
- 18-20
- 20-24
- 24-28
- 28-30
- 30-32
- >32

Source: NASA Landsat8, Microsatellite Data, July 16, 2017, 14:00.

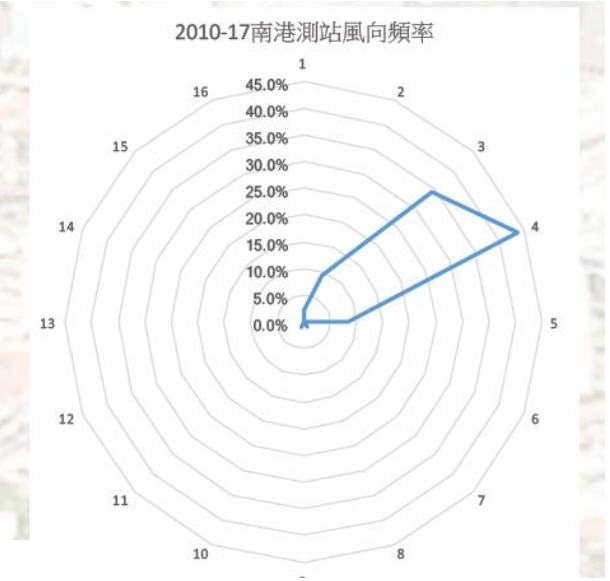
Analysis

Land Use and Road Distribution Map

The design of the site using the concept of wind corridors is based on two key factors. First is the necessity of the intervention: the site must require microclimate improvement or the prevention of microclimate deterioration due to future development. It should be an urban heat island or an area adjacent to it that is likely to be affected. Second is the feasibility of the wind corridor: there must be a stable seasonal wind direction, supported by long-term meteorological data from monitoring stations, which can be analyzed and used as a basis for design and future computer simulations.

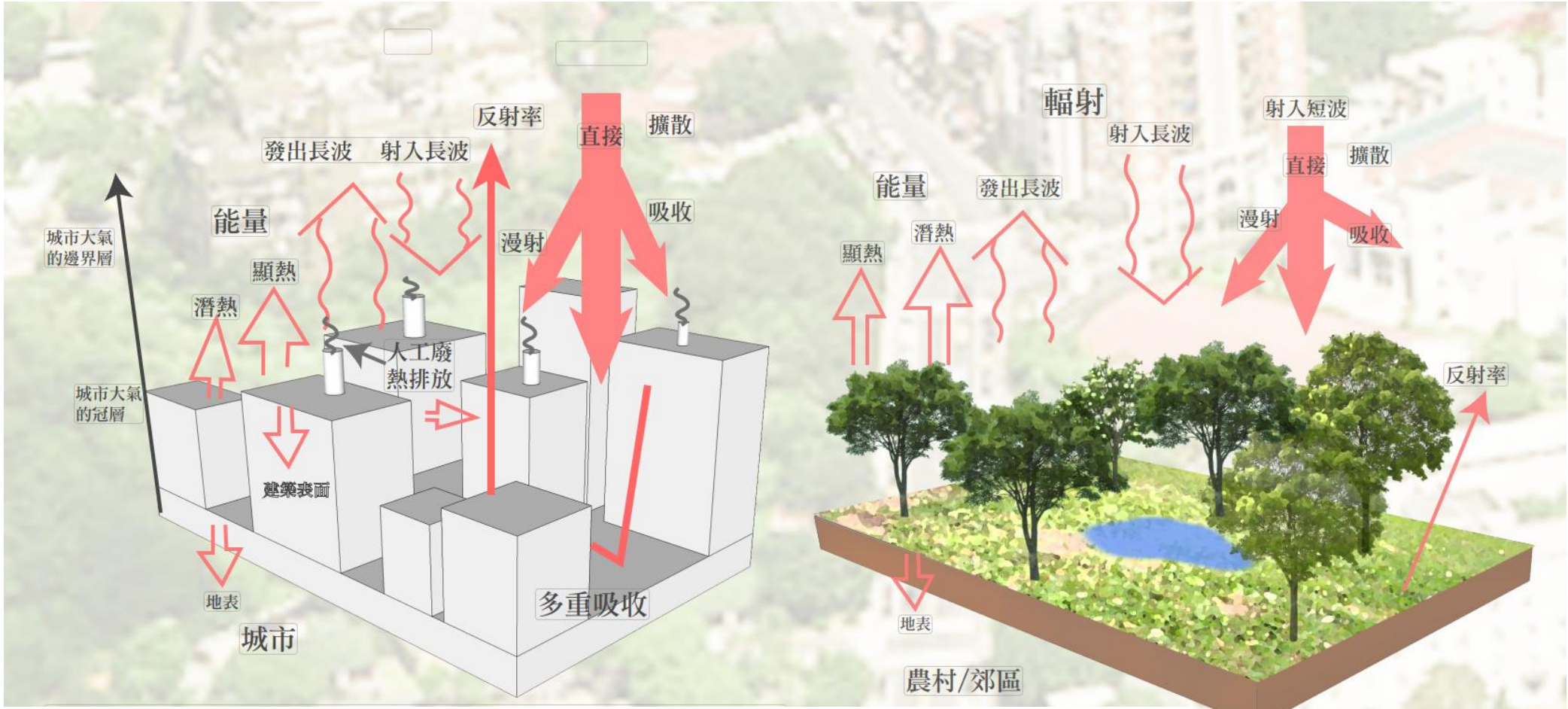


2010-17 Nangang Annual Average Wind Speed and Direction Rose Diagram



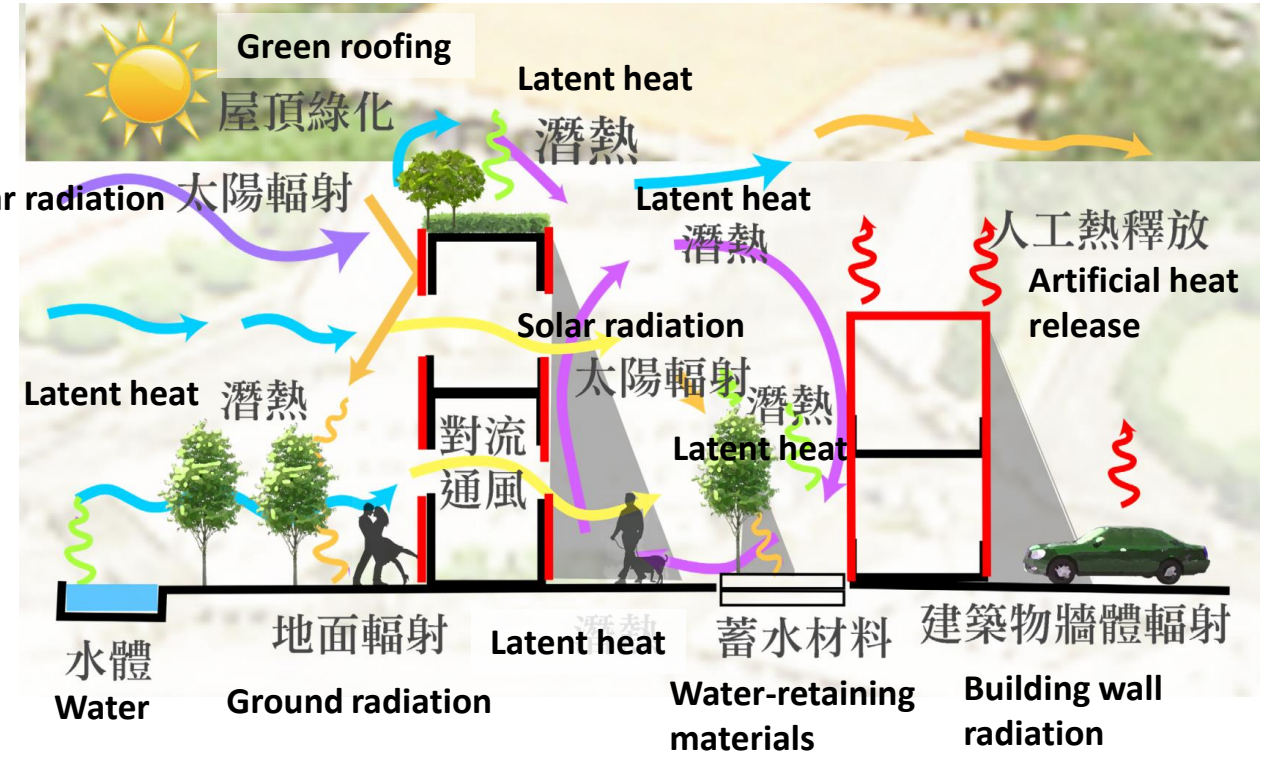
Nangang Wind Direction Probability Radar Map

Urban and Suburban Energy Transfer



Reference: Oke, T.R. (1987). *Boundary Layer Climates.* London, Routledge.

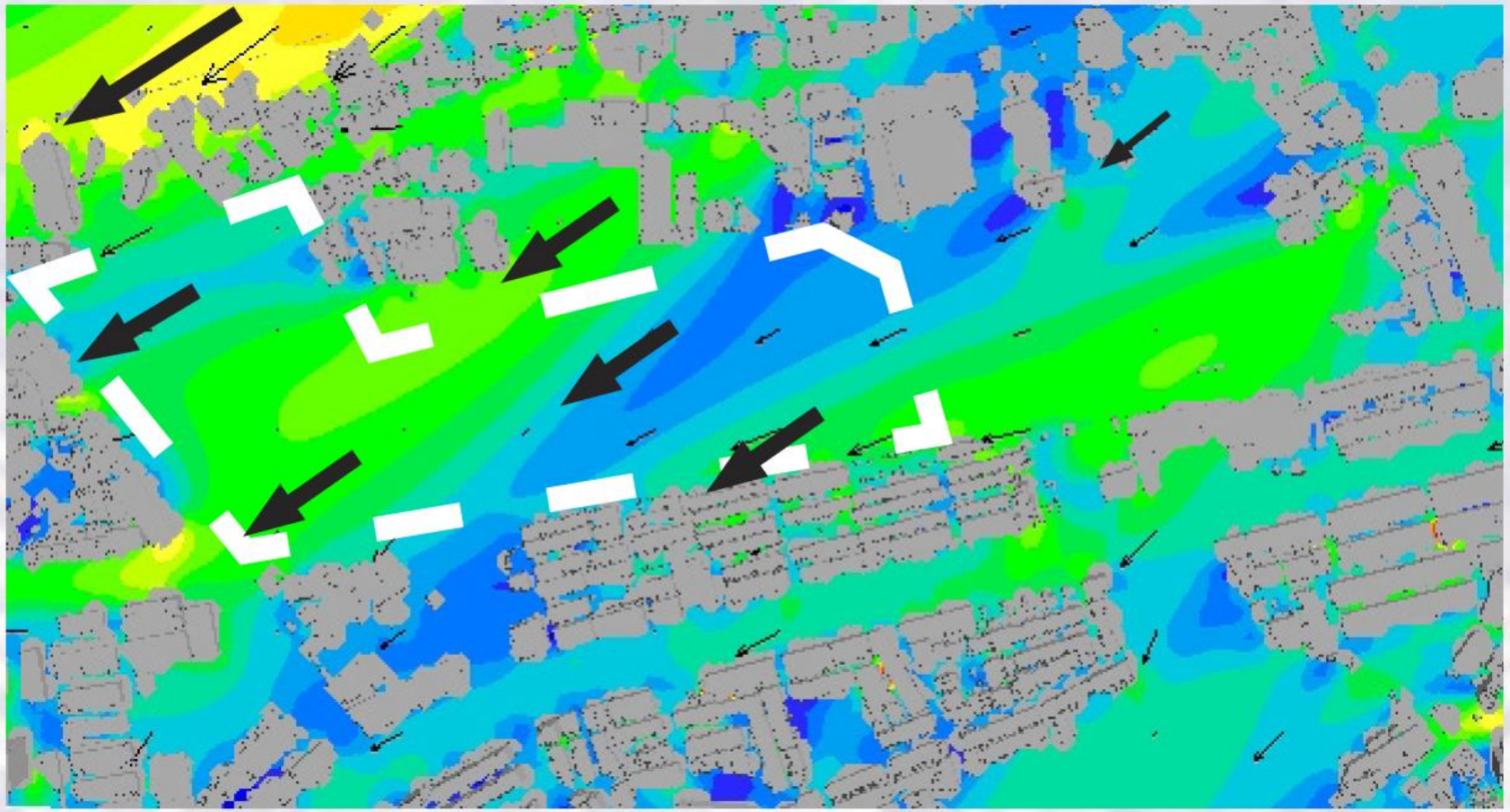
Urban Heat Factors

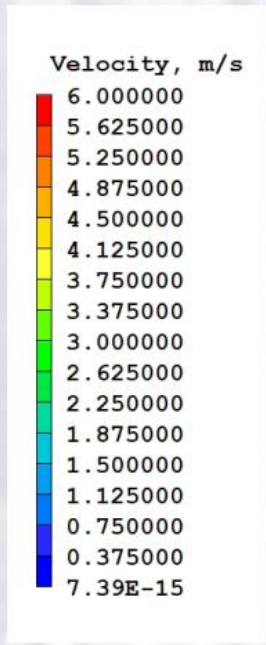


In urban environments, factors such as surface coverage, building height, building permeability, and material type affect the potential heat, leading to the formation of heat islands. When ventilation is good, wind can promote heat convection along urban wind corridors. For example, cool winds from suburban areas can bring in cold air and carry away latent heat from the city along these wind corridors. During this process, latent heat collected from high-rise building winds (the wind descending due to building height) can be channeled into the main wind corridors, effectively removing latent heat from the city. This method can significantly reduce latent heat in urban areas and mitigate the heat island effect.

Reference: Mochida, A., et.al. (2007). Management, control and design of urban climate based on the heat balance analysis of outdoor space. Paper presented at the ISWE School, Tokyo, Japan

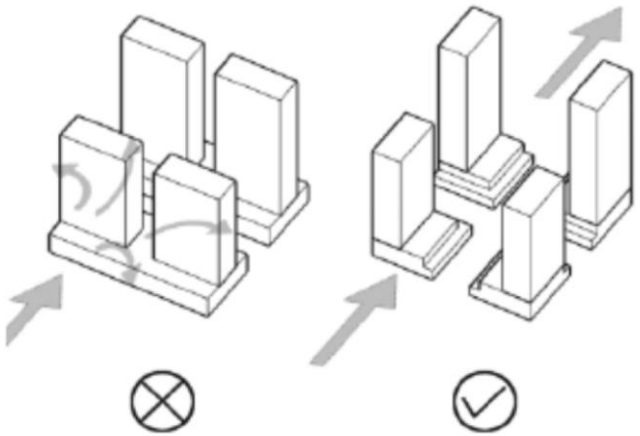
Nangang Marshalling Yard CFD Wind Environment Current Situation Analysis Plan View (Elevation: 1.8m)

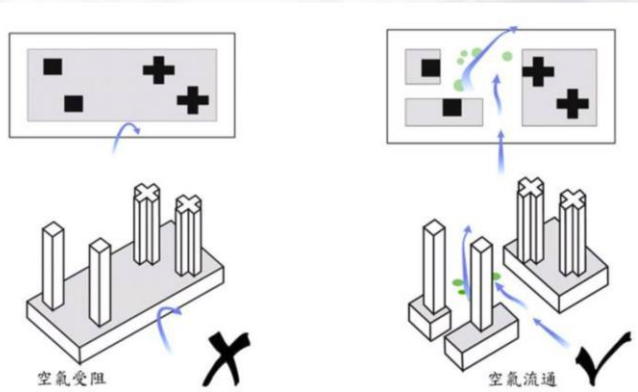




Guidelines for Urban Texture Ventilation Corric Microclimate (1/2)

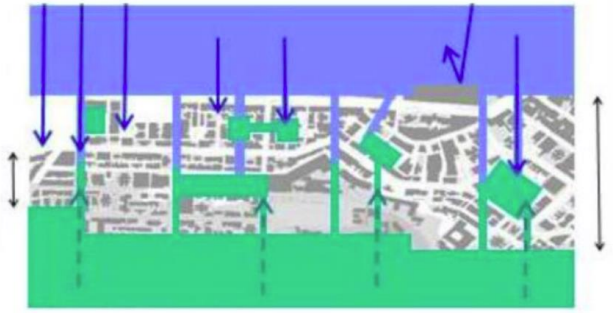
Ground coverage, Distance and connectivity to open areas, Building volume, Building permeability, Building height, Greenery and local cooling islands



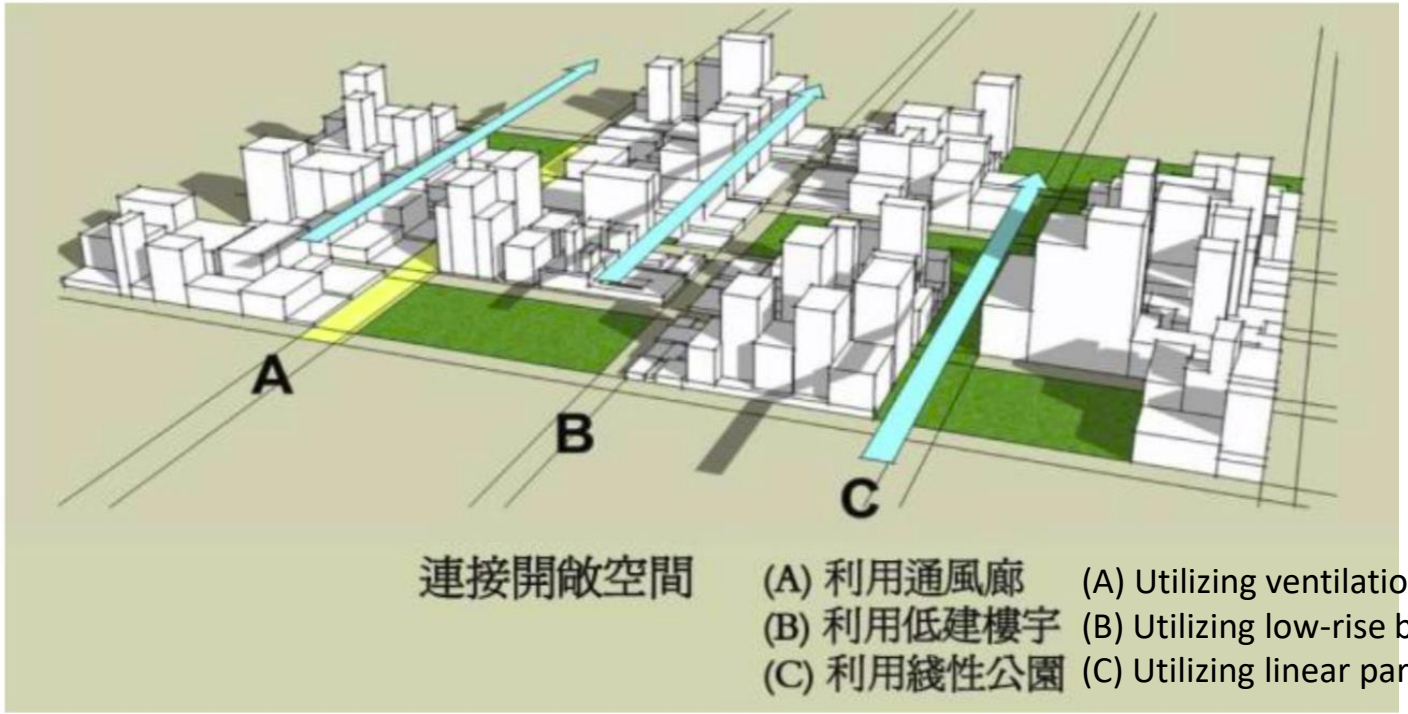


Water bodies - sea breezes

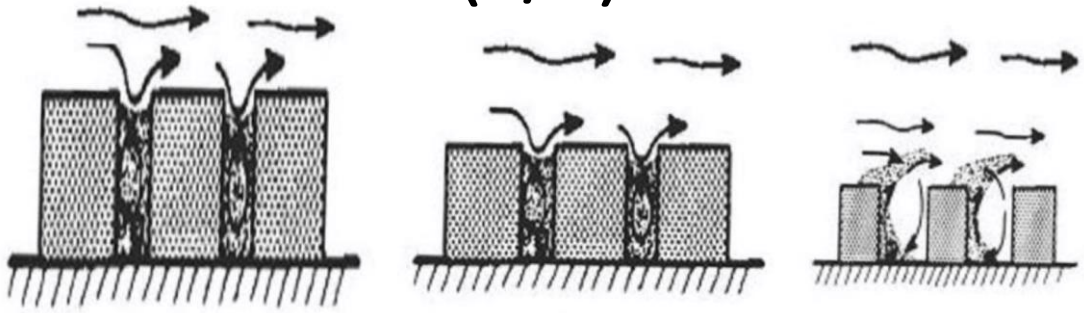
水體 - 海風



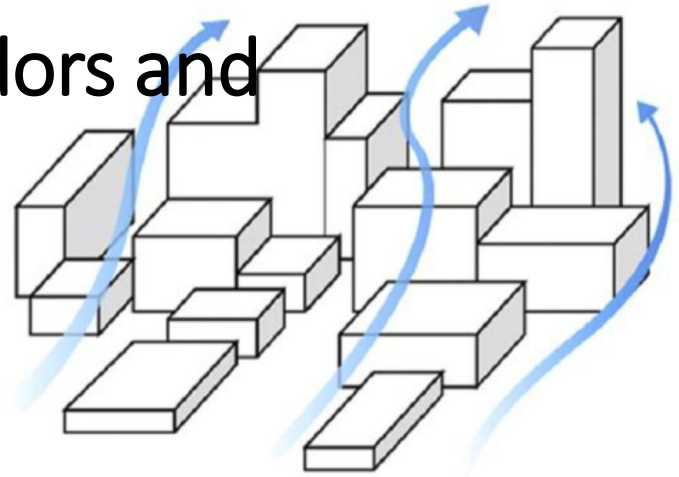
植被山坡 Vegetated slopes



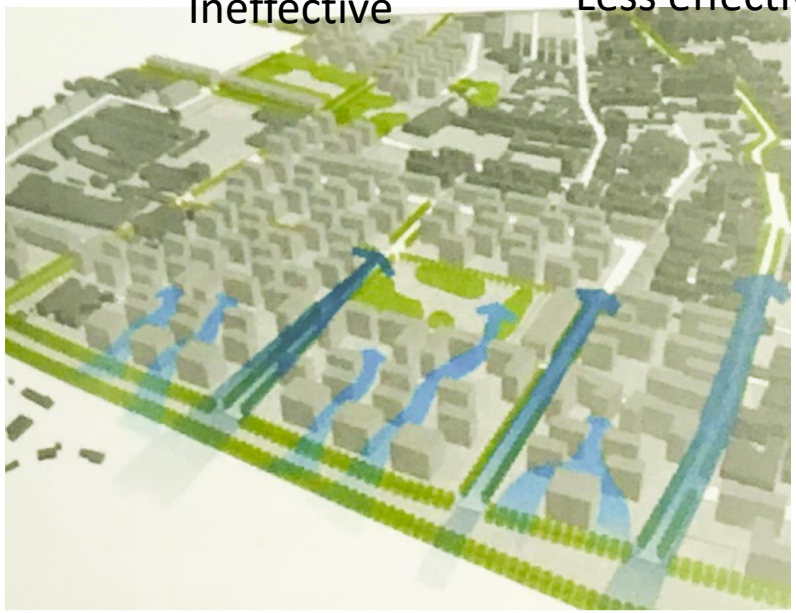
Guidelines for Urban Texture Ventilation Corridors and Microclimate (2/2)

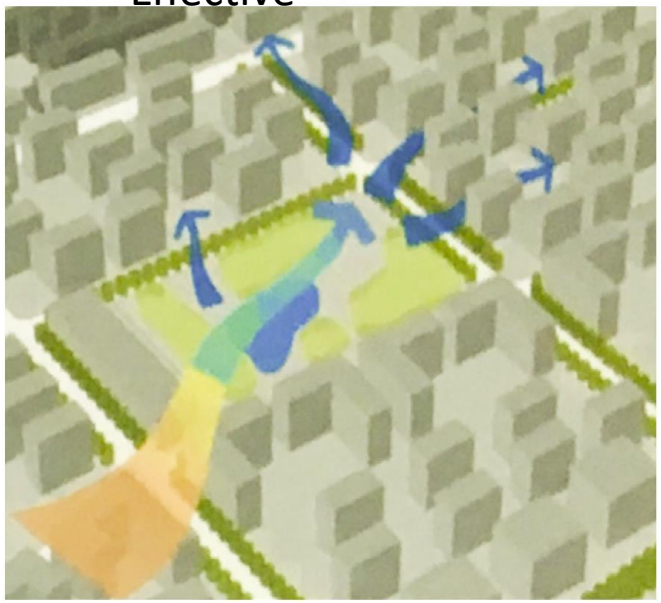


Ineffective Less effective Effective

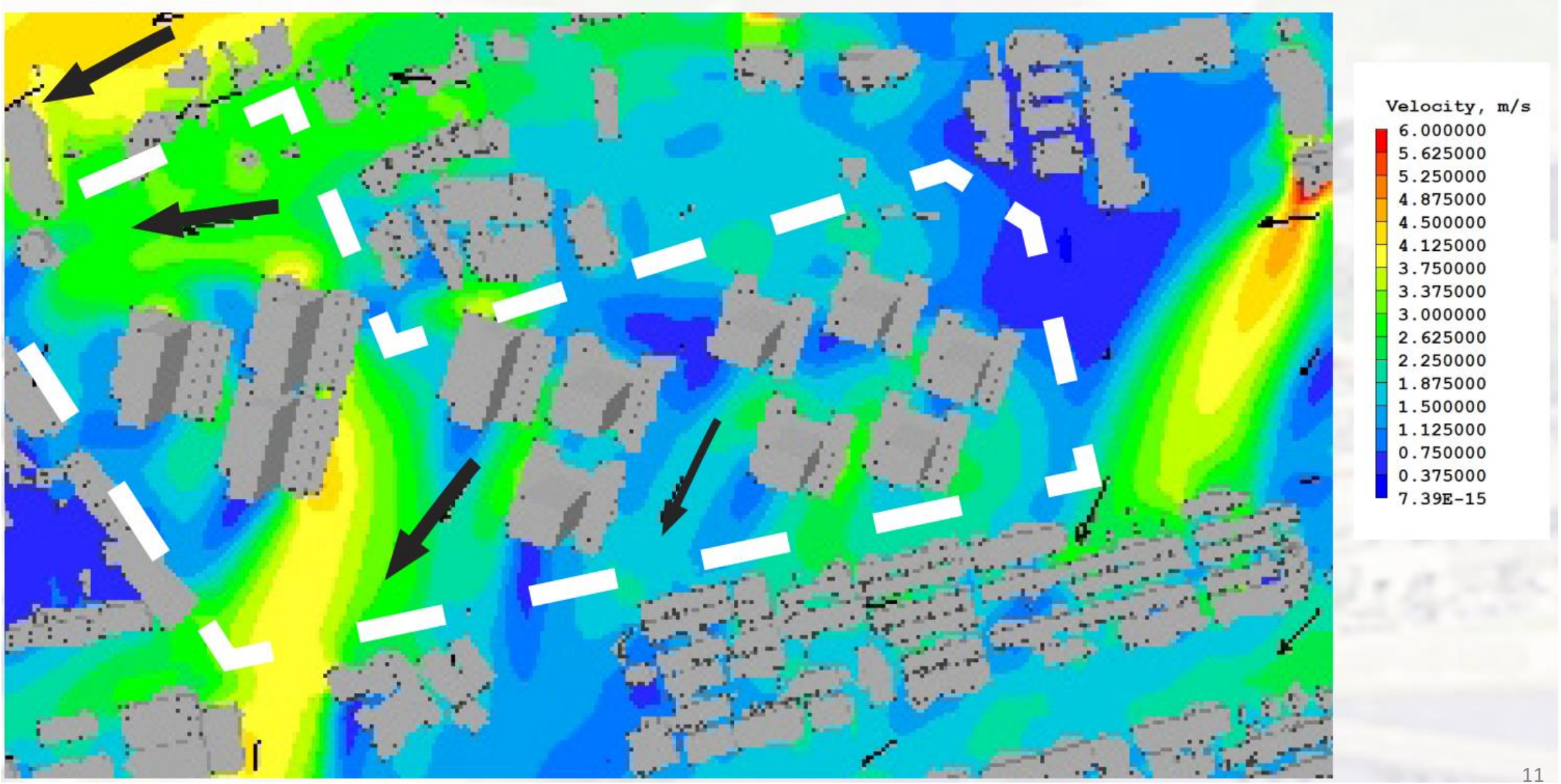


prevailing wind 盛行風

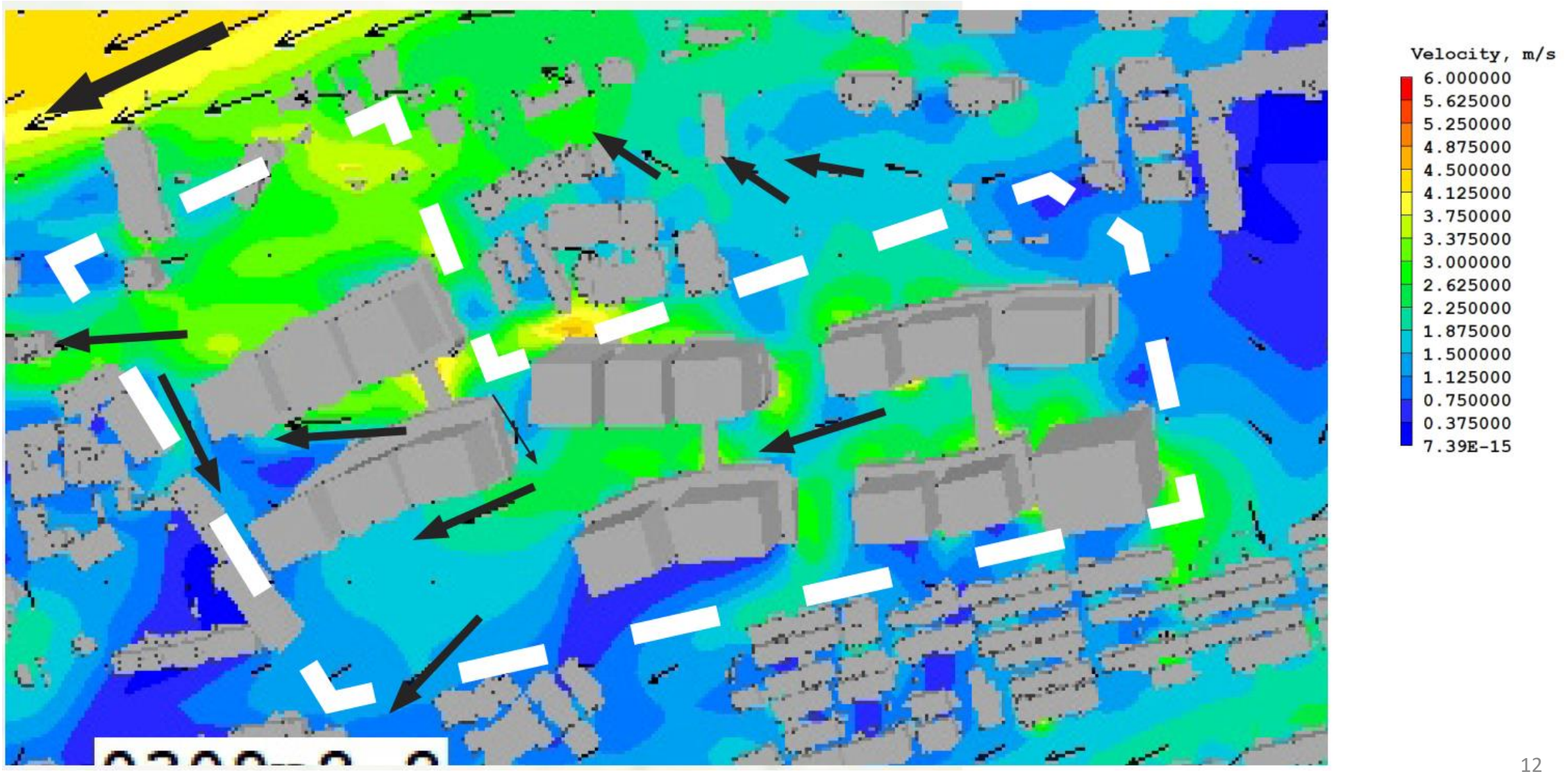




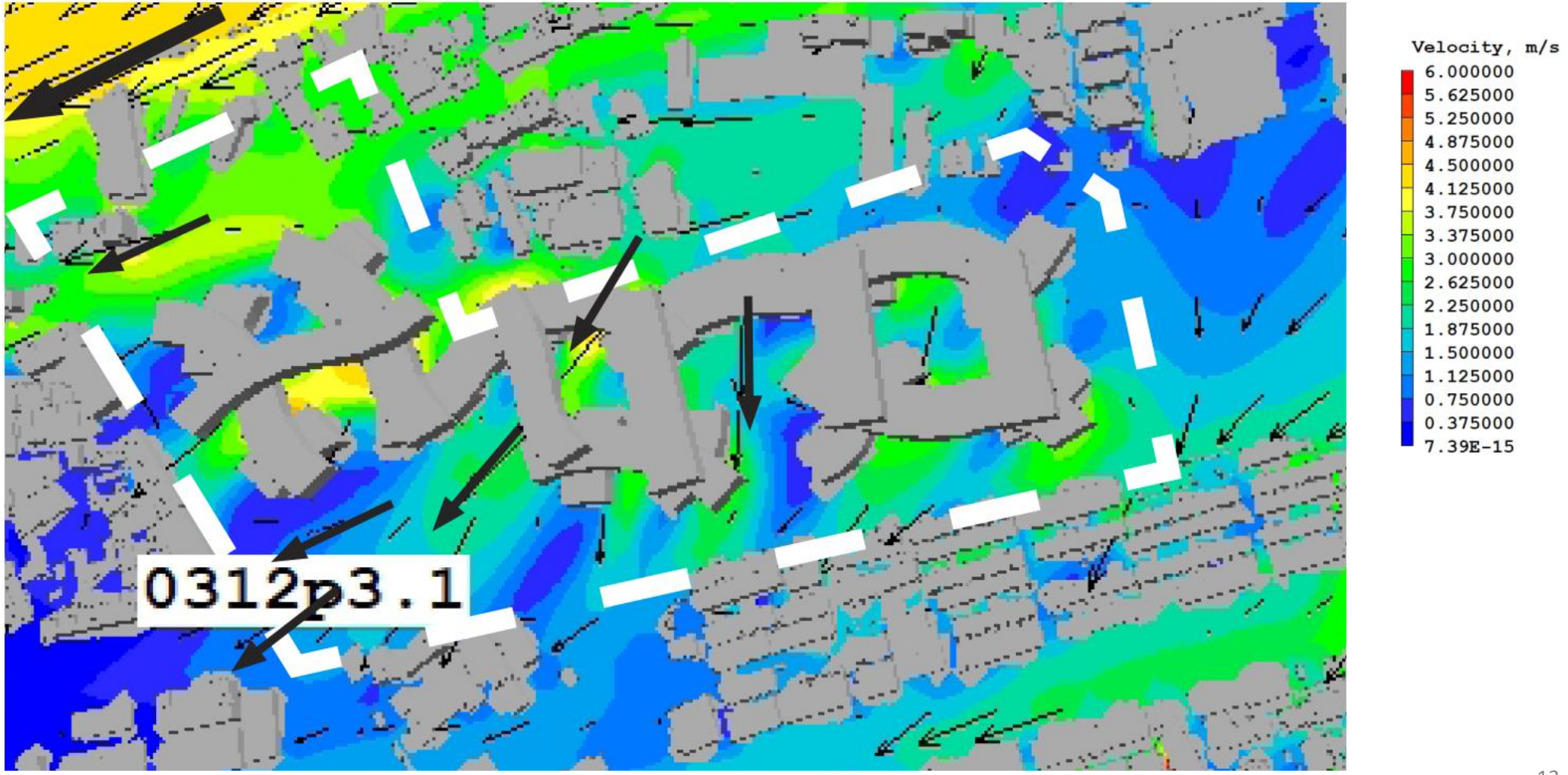
First Plan CFD Wind Environment Assessment (Elevation: 1.8m)



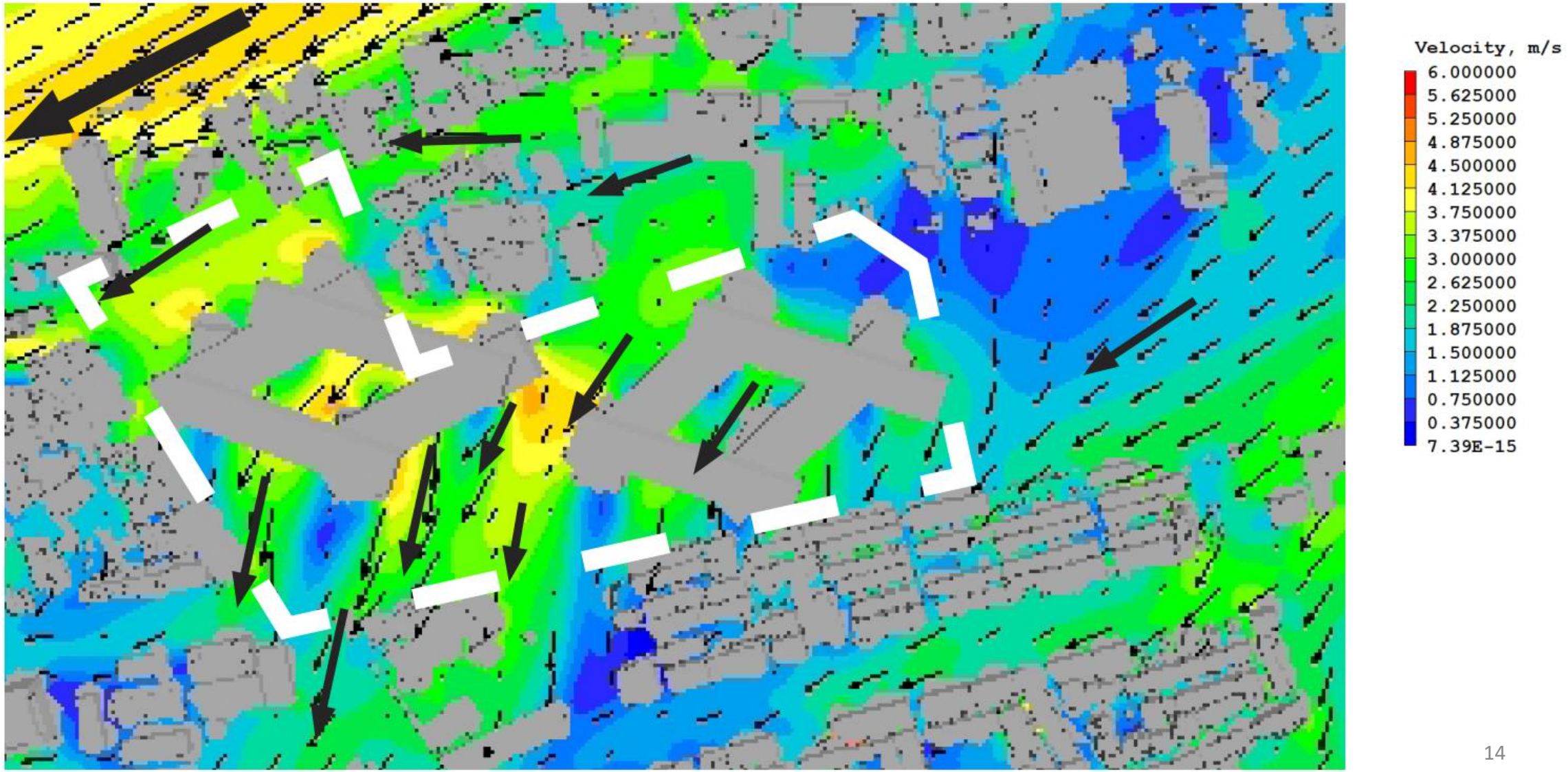
Second Plan CFD Wind Environment Assessment (Elevation: 1.8m)



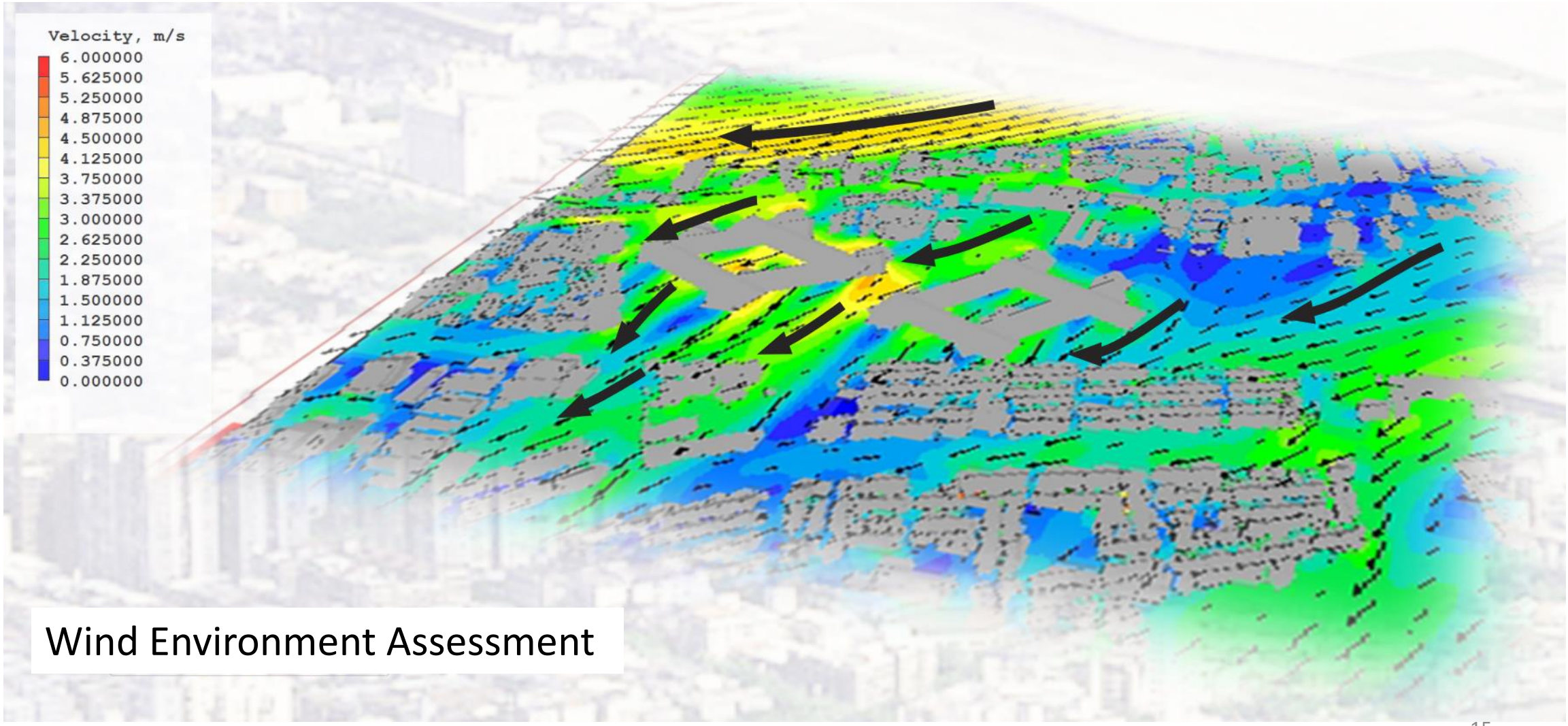
Third Plan CFD Wind Environment Assessment (Elevation: 1.8m)



Fourth Plan CFD Wind Environment Assessment (Elevation: 1.8m)

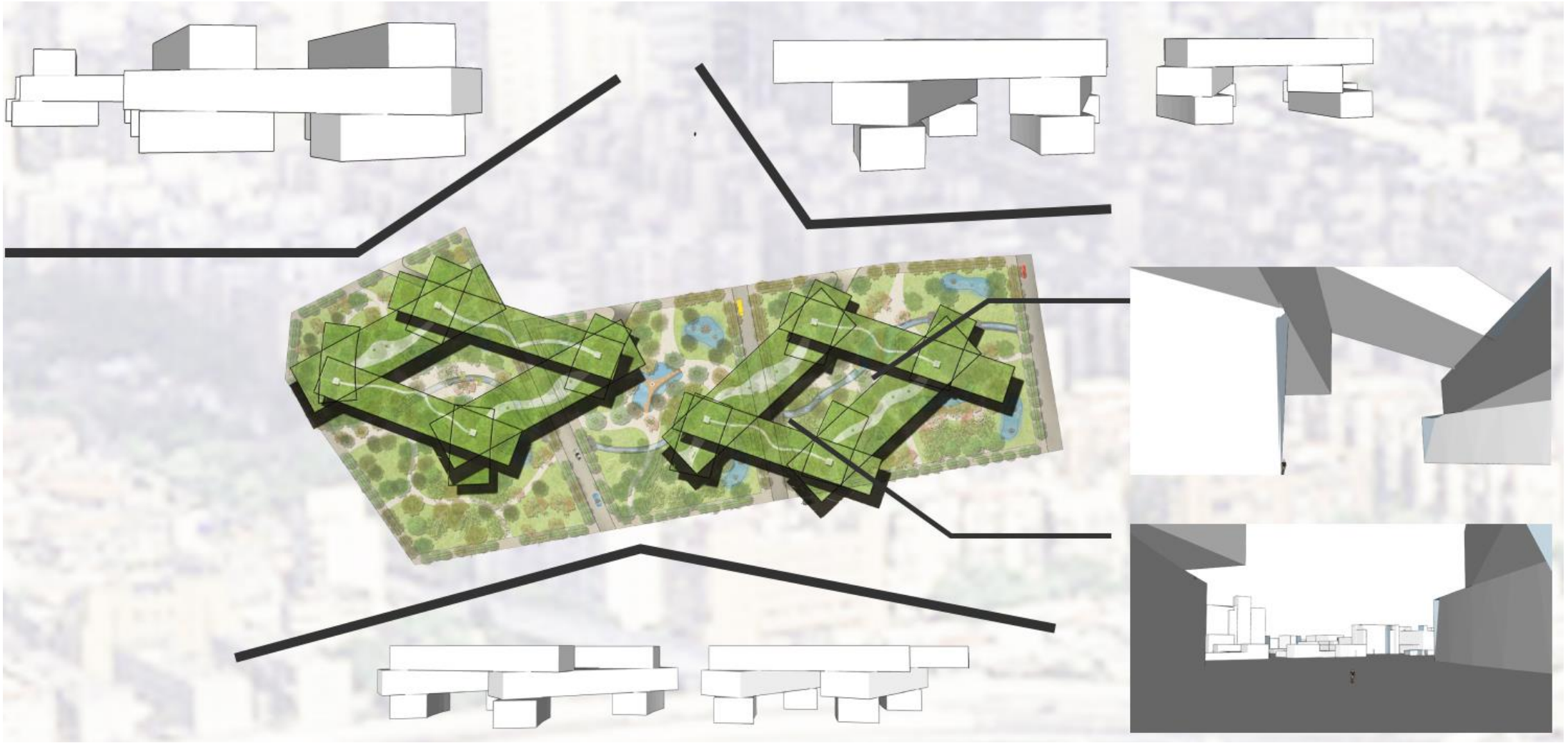


Wind Environment Assessment

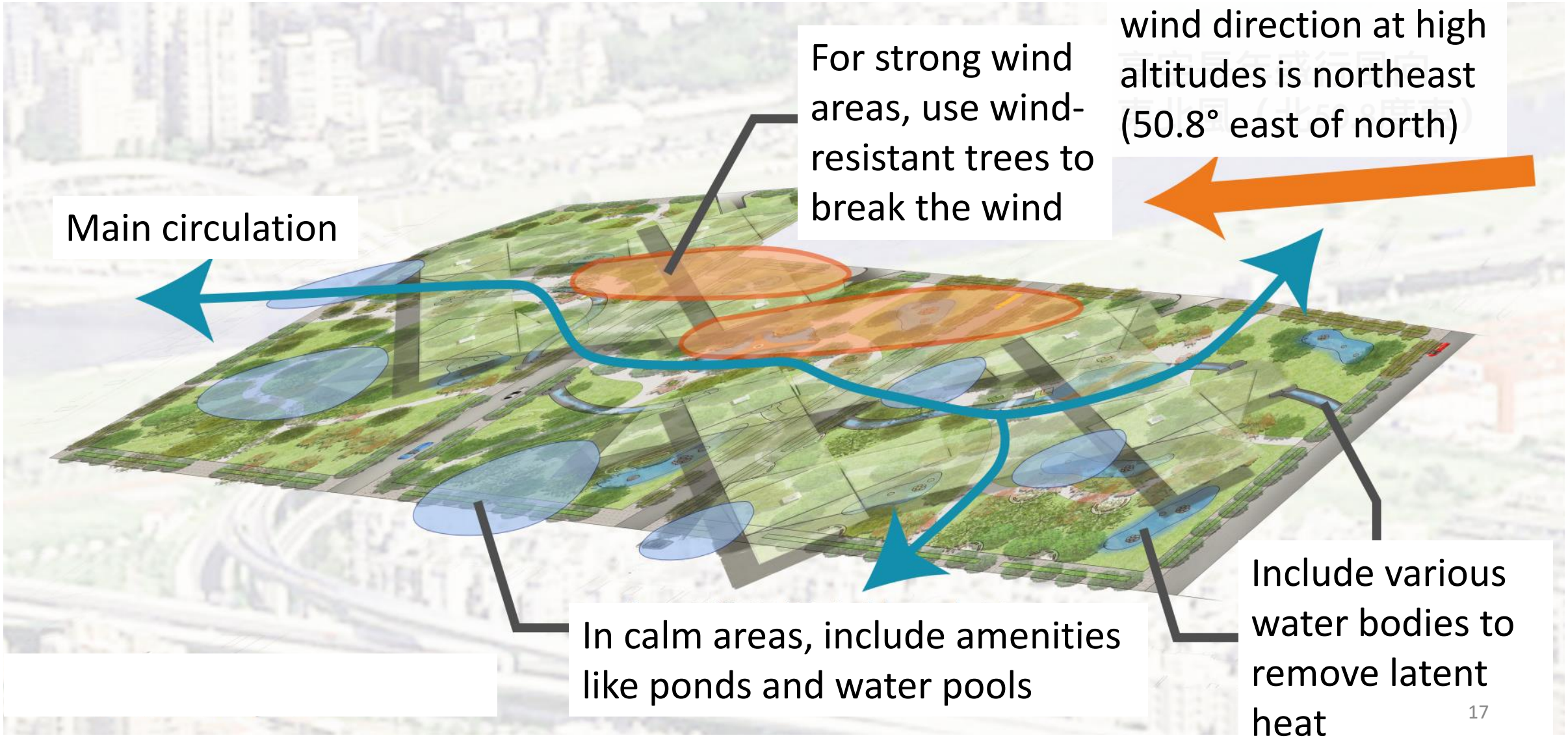


Wind Environment Assessment

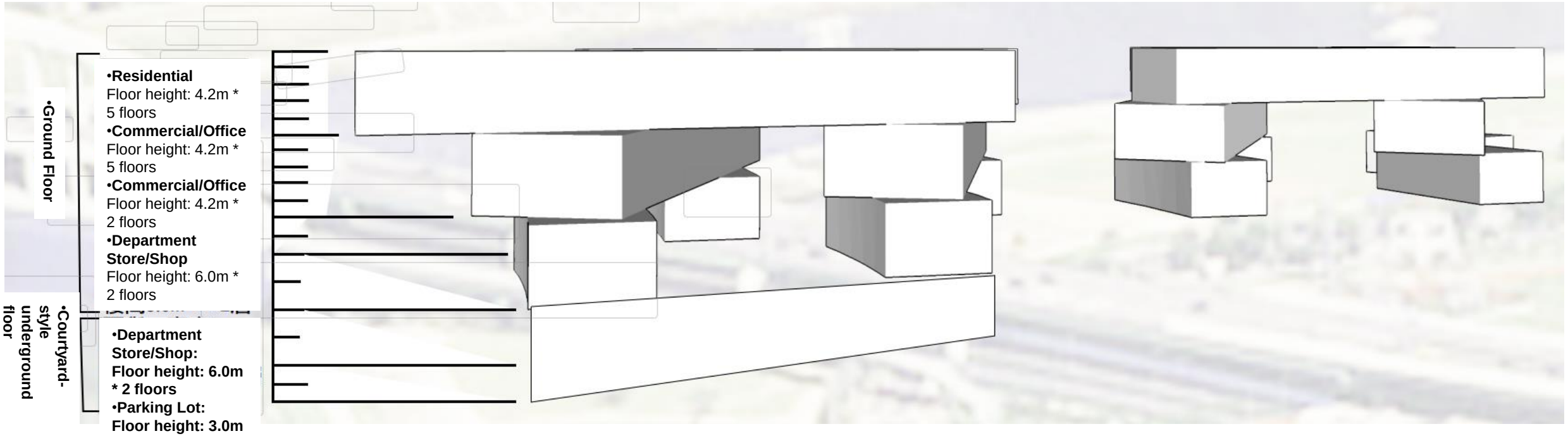
Massing View



Conceptual Layout



Fourth Plan Building Usage

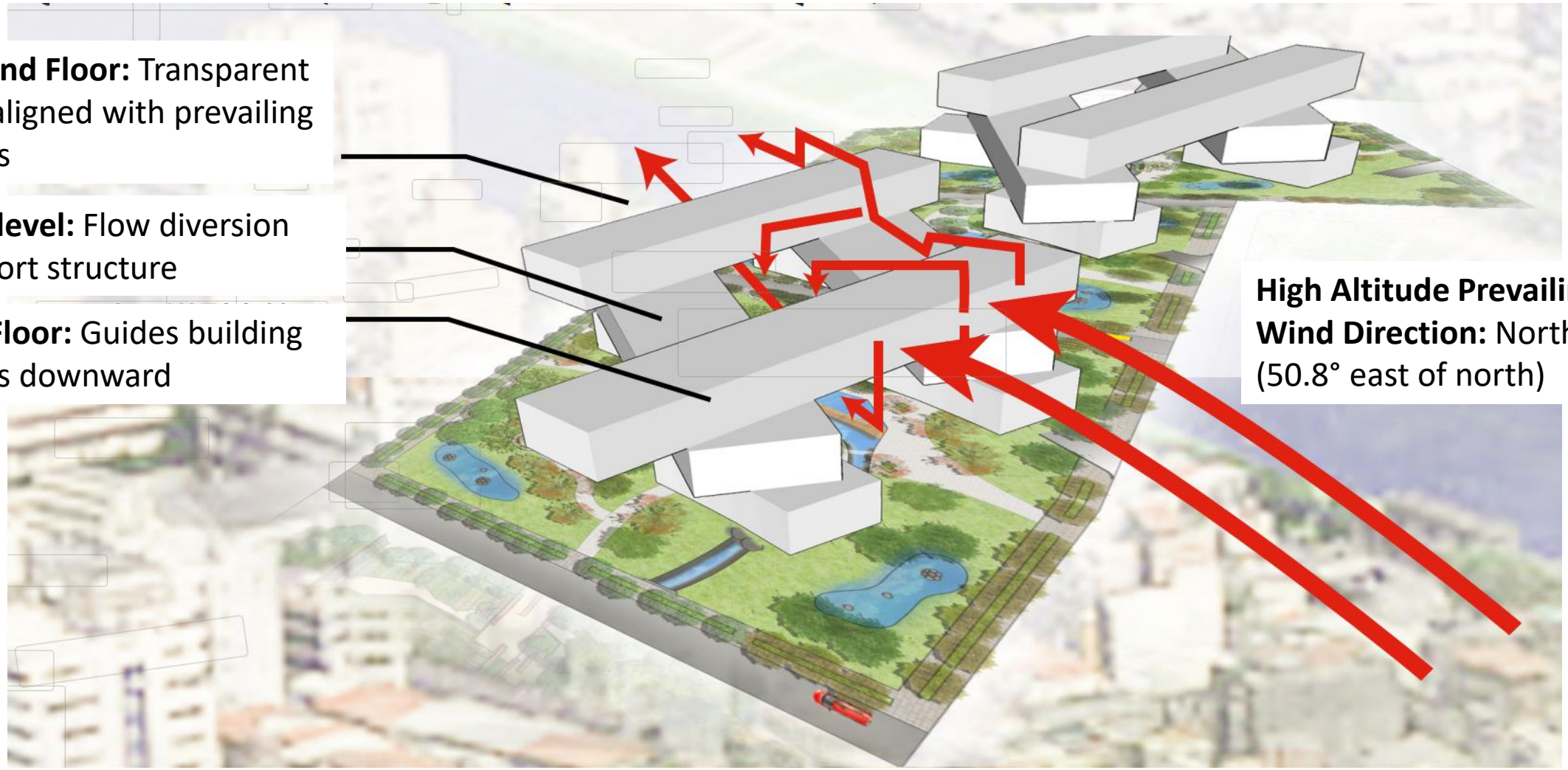


Wind Environment Utilization Concept

Ground Floor: Transparent and aligned with prevailing winds

Mid-level: Flow diversion support structure

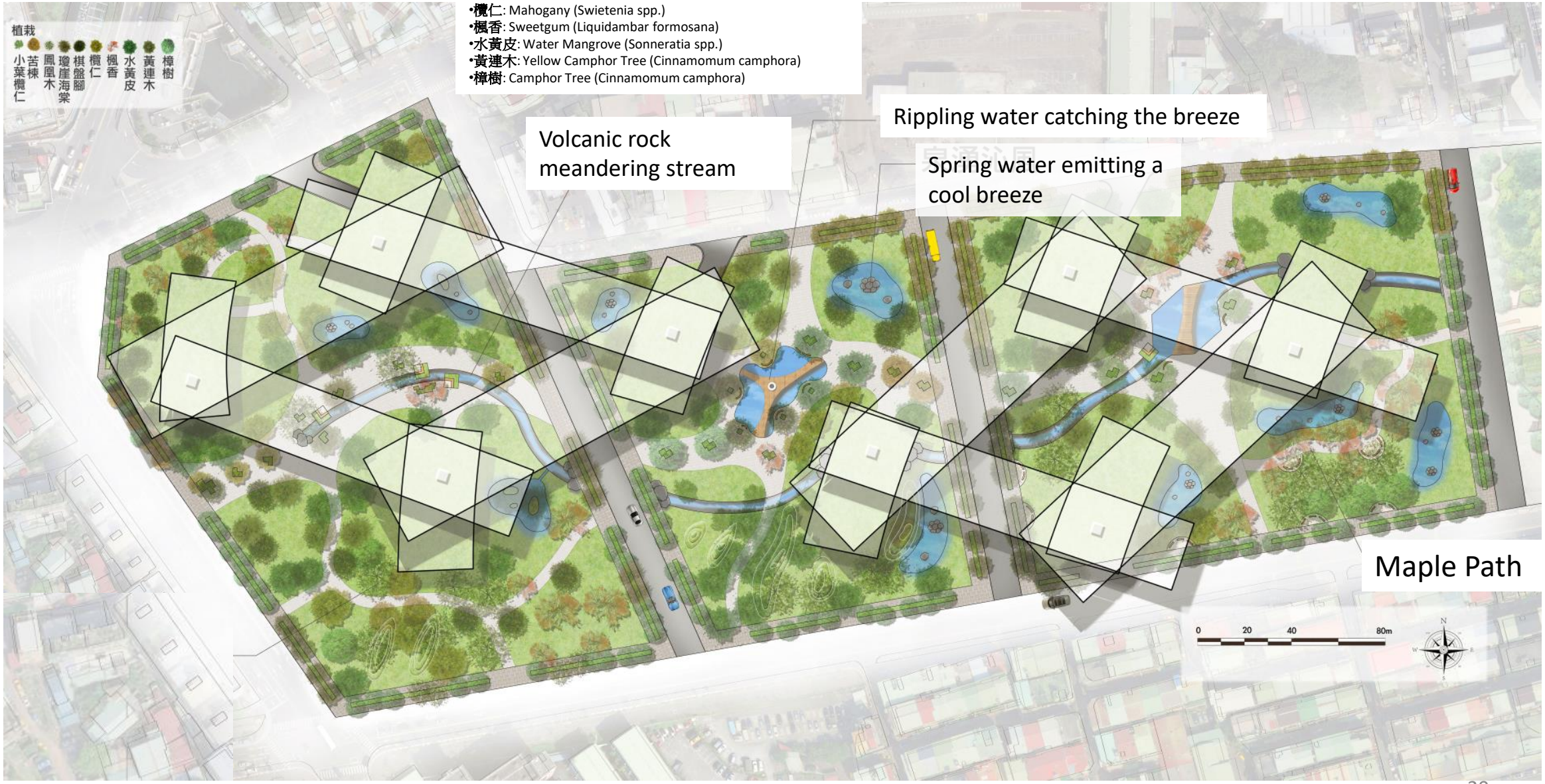
Top Floor: Guides building winds downward



High Altitude Prevailing Wind Direction: Northeast (50.8° east of north)

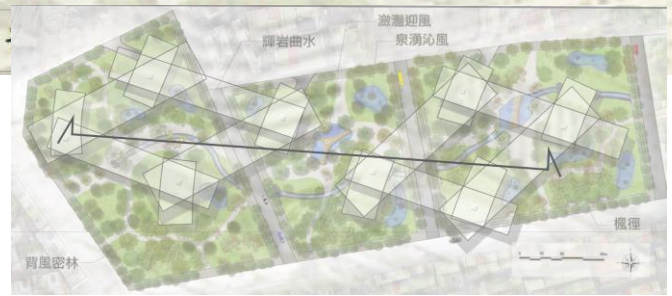
Masterplan

Plants:
- 小葉欖仁: Small-leaved Mahogany (Swietenia macrophylla)
- 苦楝: Neem (Azadirachta indica)
- 鳳凰木: Royal Poinciana (Delonix regia)
- 瓊崖海棠: Taiwan Cherry (Prunus campanulata)
- 棋盤腳: Ficus (Ficus microcarpa)
- 欖仁: Mahogany (Swietenia spp.)
- 楓香: Sweetgum (Liquidambar formosana)
- 水黃皮: Water Mangrove (Sonneratia spp.)
- 黃連木: Yellow Camphor Tree (Cinnamomum camphora)
- 樟樹: Camphor Tree (Cinnamomum camphora)



Roof Greenery Plan View

Section and Section Line Location Plan



Bird's-eye View

Landscape Simulation