Mangroves: A Potential Coastal Defense for Shanghai in the Future

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- 29 August 2023
Coastal wetland ecosystem restoration: A necessity for Shanghai

Mangrove Plantation as a potential Nature-based Solution

Current Progress and future prospects
Coastal wetland ecosystems help achieve SDGs

Coastal wetland ecosystems, which offer numerous ecological services, frequently rank among the most densely populated areas and are facing escalating human impacts.

- raw materials and food
- coastal safeguarding
- Erosion control
- Biodiversity conservation
- Water purification
- Carbon sequestration
- Tourism, recreation, education and research

…
Shanghai (31°14′N, 121°29′E), is a coastal modern megacity with high population concentration, located at the Yangtze River Estuary.

- With more than $25 \times 10^4$ ha coastal wetlands
- Controlled by East Asian subtropical monsoon climate
- Facing threats from reclamation, exotic species invasion, coastal erosion and climate change
Factors threaten Shanghai’s coastal wetland ecosystems

Reclamations not only directly modify wetland morphology and hydrology

→ but also cause severe water and soil pollution

→ lead to biodiversity and habitat losses

→ impair wetland ecosystems functioning and ecosystem services

Meanwhile, the expansion of *S. alterniflora* is the main factor that threatens the remaining tidal wetlands quality in the near future.

(Zhang et al. 2023)
Increasing vulnerable to disasters induced by climate change

To ensure Shanghai's sustainable development, a comprehensive plan for conserving and restoring coastal wetlands is crucial.

The average mean temperature increased rapidly since 1980

- Sea-level rise
- Typhoon storm surge
- Rainstorm waterlogging
- River floods

(Yang, et al. 2022)
Planting mangroves may be a possible NbS to restore degraded coastal wetlands in Shanghai

Mangroves, woody plant communities thriving in the coastal intertidal zones and river estuaries of the tropics and subtropics, constitute a unique form of forest adapted to the transitional zone between land and ocean, likely delimited in latitudinal range by varying sensitivity to cold.

Mangrove ecosystems provide outstanding ecological, economic and social values
Opportunities: the ranges of plants are moving in response to recent changes in climate.

Mangroves northward expansion in Florida: due to a reduction in the frequency of “extreme” cold events (−4°C) (Cavanaugh et al. 2014)

Mangroves need a relative velocity at 0.95 km yr⁻¹ so as to keep pace with climate change (Loarie et al. 2009)
Artificial mangroves have been established in Zhejiang, China.

Mangroves in China are naturally distributed in 8 provinces and regions except Zhejiang province, where mangroves are introduced.
Monthly mean minimum temperature in January in Shanghai is warming (1950~2020)

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<tbody>
<tr>
<td>annual average temperature(℃)</td>
<td>15.67</td>
<td>15.67</td>
<td>15.65</td>
<td>16.01</td>
<td>16.94</td>
<td>17.78</td>
<td>17.80</td>
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<tr>
<td>Minimum average temperature in January(℃)</td>
<td>0.35</td>
<td>-0.23</td>
<td>0.74</td>
<td>1.06</td>
<td>1.98</td>
<td>2.86</td>
<td>3.71</td>
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Screening cold tolerant mangrove plant species in the past decade

10 mangrove plant species were introduced altogether from Fujian (natural) and Zhejiang (artificial introduced) province to Shanghai.

2013-16
2 mangrove plants (Kandelia obovata & Aegiceras corniculatum) survived and reproduced in plastic greenhouse successfully.

2016-17
Relocation of planting areas, most of the previously surviving mangroves destroyed.

2018
3.33 hectares seedling nursery was established, Kandelia obovata was reintroduced from Fujian and Zhejiang province.

2021
Keeping warm by flooding, Kandelia obovata & Aegiceras corniculatum survived overwinter (-6°C) in the field without plastic greenhouse.

2023
Antifreeze insulation is ineffective in helping mangroves survive winter below -6°C, artificial introduced mangrove seedlings have better cold tolerance than natural seedlings.
Scientific research: northward migration of mangroves has a long way to go

The mangroves planted in our experimental plots have survived the winter (-8°C) safely by flooding.

The mangroves planted on salt marsh outdoors haven’t survived the winter (-8°C) even with the protection of antifreeze.
Ongoing scientific research: revealing the molecular mechanism of cold-tolerance & conducting cold tolerance training on the propagules of *Kandelia obovata*

Under cold stress, natural and artificial introduced *Kandelia obovata* exhibited different hormone responses
Public science education and hands-on activities
Thanks to the Shanghai Municipal Science and Technology Commission Fund, as well as to the public welfare funds donated by Gangcheng Group Company and Morgan Stanley Securities.

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