ECOSYSTEM SERVICES IN SHORELINE PLANNING AND DESIGN
CASE STUDIES FROM THE NORDICS

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2. Nordic Design Experience

3. Nordic “Green/Eco” Solutions Framework
Concepts in Soft-Engineering for Waterfront Planning & Design
WHAT IS “SOFT ENGINEERING”? 

Use of **ecological principles** and practices to **reduce erosion** and achieve the **stabilization and safety** of shorelines and surrounding area..., while **enhancing habitat**, **improving aesthetics**, and **saving money**.

Caulk et al. 2000
• Design structures that do not degrade or create obstacles in the surrounding ecosystem

• Incorporate multiple purposes and functions

• Preserve, protect and/or enhance vital ecosystem services

• Encourage habitats and natural communities hospitable to native species
(a) Artificial island without eco-engineering

- No mangroves means that the island is susceptible to storms and erosion
- Low biodiversity due to limited habitat availability
- Poor water quality with no natural biofilters like bivalves and corals

(b) Artificial island with eco-engineering

- Reef balls and oyster castles can enhance fisheries
- Rehabilitated seagrass beds provide habitat for fish and food for dugongs and turtles
- Mangroves provide coastal protection and habitat for wildlife

- No coastal wetlands which can treat anthropogenic discharge
- No mangroves providing coastal protection or habitat for wildlife
- Shrimp ponds hot with no shade or refuge from predation. Banks collapse easily

- Artificial wetlands can treat anthropogenic discharge such as wastewater and runoff
- Eco-engineering enhances biodiversity and other ecosystem services
- Mangroves around shrimp ponds provide shade and refuge from predation. Banks stabilised by mangrove roots

Chee et al. GEC, 2017
NORDIC FOCUS ON URBAN DEVELOPMENT

Liveability & cultural identity

Increasing demand for cities and suburbs to be developed as integrated communities with focus on city planning and urban open spaces to enhance “Liveability” and create cultural identity for citizens

Climate change & adaption

Climate change / extreme weather events are encouraging both human and natural disasters from flooding to rising sea levels... actions are required to fundamentally change current practices

Green agenda

Cities are taking concrete actions to reduce greenhouse gas emissions and climate risks through regulations, mandates and incentives such as building energy policies, climate action plans and fuel standards
Tianjin, China
Completed 2012

The urban lake is a storm water feature, handling 10-year cloudburst events and buffering 100-year rain storm events.

Tree and marsh plantings act as a cleansing biotope by linking subsurface retention trenches that feed water to the lake.

The lake is a self-sustaining natural ecosystem and helps reduce local temperature extremes.
Stuttgart, Germany
Completed 2011

A cloudburst water capture and retention system integrates generous planting around a pond and a restored creek with a recreational path and viewing areas.

Streetscapes are distinctively pedestrian, but fully accessible for vehicles, with parking options in an underground garage situated between gardens on the unique load-bearing planting substrate.
Singapore
Completed 2014

Catchments and sub-catchments support an urban water management masterplan with short-term and long-term solutions for flood protection and drinking water collection while creating benefits for the landscape, city recreational spaces and biodiversity.

Blue-green infrastructure includes floating wetlands, rain gardens, swales, wetlands, cleansing biotopes, naturalised canal edges and retention ponds.
Copenhagen, Denmark
Completed 2013

Responding to severe city flooding caused by July 2011 cloudburst, a new city masterplan divided Copenhagen into catchments that integrate planning and implementation of blue-green infrastructure projects.
Native eco-habitats, including grassland, wetlands, and wooded areas, were retained to support native wildlife species and a natural corridor connecting the park and surrounding environment.

Natural topography and water elements were enhanced to support water flow. Bio-swales purify and channel rain runoff to a wetland, where it is circulated through a cleansing biotope for further purification, before being reused for non-potable uses.
Fornebu-Oslo, Norway
Completed 2008

Created a lake system to shift land use of the small fjord island from an abandoned airport to a park and residential area.

The lake’s ecological infrastructure receives and treats storm water run-off from the surrounding development. Therefore, it manages stormwater and helps protect water quality in Oslo Harbor.
Scandinavia's largest city project, covering 625 football fields. A sustainable mixed use urban landscape design capable of handling extreme cloudburst and tidal events.

The area is serviced by elevated metro and bicycle networks in green arteries. Elevated metro tracks provide cover for bicycle paths, so cyclists stay dry at all times.
Nordic “Green/Eco” Solutions Framework
RISK-BASED RESILIENCY PLANNING

1. Determine Risks
   - Climate Change Risk Assessment
   - Eco-Vulnerability Review
   - City Master Plans

2. Understand Nature
   - Habitat Surveys
   - Env. Monitoring
   - Biodiversity
   - Seasonal Changes

3. Plan & Design
   - Integrated Planning & Design

4. Measure Effects
   - Flood Mapping
   - Risk Mapping

5. Evaluate Costs
   - Avoided Damages Return on Investment Over Time

Iterative process

RESULTS

STEPS

TOOLS
PLANNING AND BUILDING TOGETHER

Public & Stakeholder Engagement

1. Vision for Future
   • Current Master Plan
   • Resident Values
   • Economic Growth
   • Environmental Needs

2. Current Conditions Review
   • Environmental Assessment
   • Social / Cultural Assessment
   • Financial Constraints

3. Scoping Document
   • Conceptual Focus & Actions
   • “Design for Environment”
   • “Design for Community”
   • Funding Options

4. Decisions & Designs
   • Technical Studies
   • Master Planning
   • Regulatory Coordination & Approvals
   • Funding Applications

5. Final Design
   • Final Designs
   • Merger with Master Plan
   • Local, State & Federal Approval
   • Funding
   • Implementation
   • Management & Monitoring
"TOOL BOX" APPROACH TO INTERVENTION MEASURES

Blue / Green Infrastructure
- Placement of Dunes
- Smart Street
- Bioswales
- Living Reefs
- Littoral Sand Replenishment / Management
- Marsh Islands
- Sculpted Land
- Blue-Green Parks / Public Facilities
- Wetlands

Built Infrastructure
- Floodgates
- Elevated Structures
- Outfall Invert Flaps
- Deployable Flood Barriers / Gates
- Integration with Inland Storm Water BMPs
- Pond / Lake / Stream Management
- Raised Streets / Barriers
- Legislation and Planning
- Retreat and Land-use Planning