

TEA BREAK / 茶歇



URBAN
SH/FT

**Conceptualizing
Nature as Critical
City Infrastructure**

将自然视为关键城市基础设施



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Global Facility for Disaster Reduction and Recovery

AN INTRODUCTION TO NATURE-BASED SOLUTIONS FOR URBAN RESILIENCE /

基于自然的解决方案在城市韧性中的应用简介



CLIMATE RISKS CAN BE ADDRESSED THROUGH NBS /

气候风险可通过基于自然的解决方案（NBS）加以应对。

Discussed in this presentation:

- Urban heat
- Urban stormwater flooding
- Coastal flooding and erosion from storms, cyclones, tsunami

Also relevant:

- Riverine flooding
- Landslides
- Droughts

本次演示中讨论的内容:

- 城市热岛
- 城市雨水洪水
- 风暴、飓风和海啸引发的沿海洪水和侵蚀

相关信息:

- 河流洪水
- 山体滑坡
- 干旱

DISPROPORTIONATE CONSEQUENCES /

不成比例的后果

The poor and disadvantaged suffer disproportionately from natural disasters

9 of the 10 most vulnerable cities to flooding are in developing countries (China, Ecuador, Vietnam, Côte d'Ivoire, Bangladesh, Indonesia)

贫困和弱势群体在自然灾害中遭受的损失最为严重。

10个最易受洪水影响的城市中，有9个位于发展中国家（中国、厄瓜多尔、越南、科特迪瓦、孟加拉国、印度尼西亚）。

COSTLY CONSEQUENCES / 高昂的代价

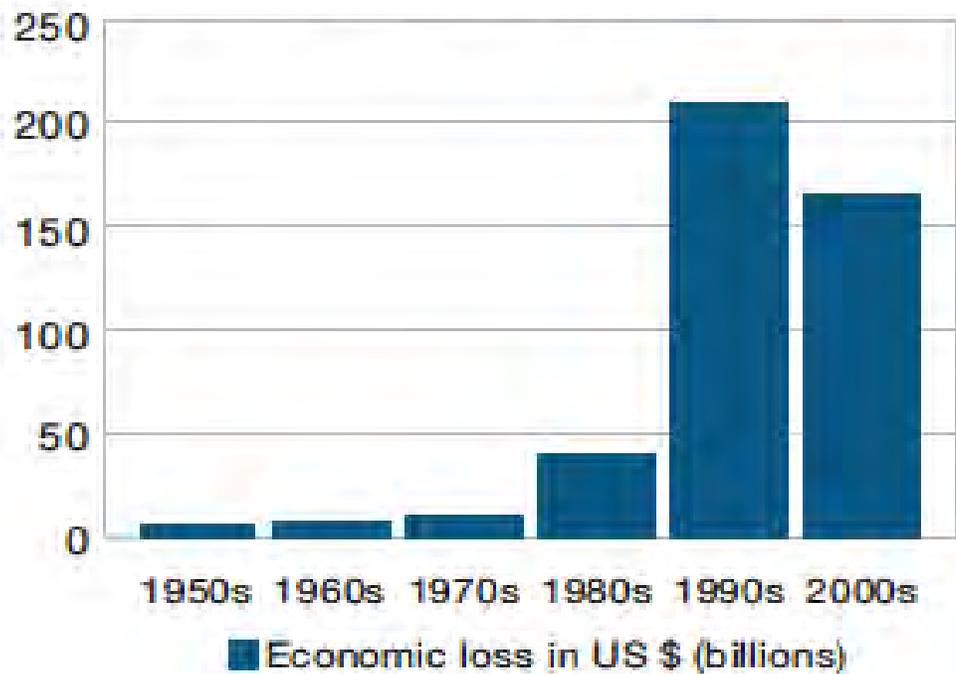
Among natural disasters, the occurrence of floods is most frequent, and flood risk is increasing. /

在自然灾害中，洪水发生最为频繁，且洪水风险正在增加。

Flooding is most frequent among natural disasters. Losses totaled over US\$40 billion in exceptional years. /

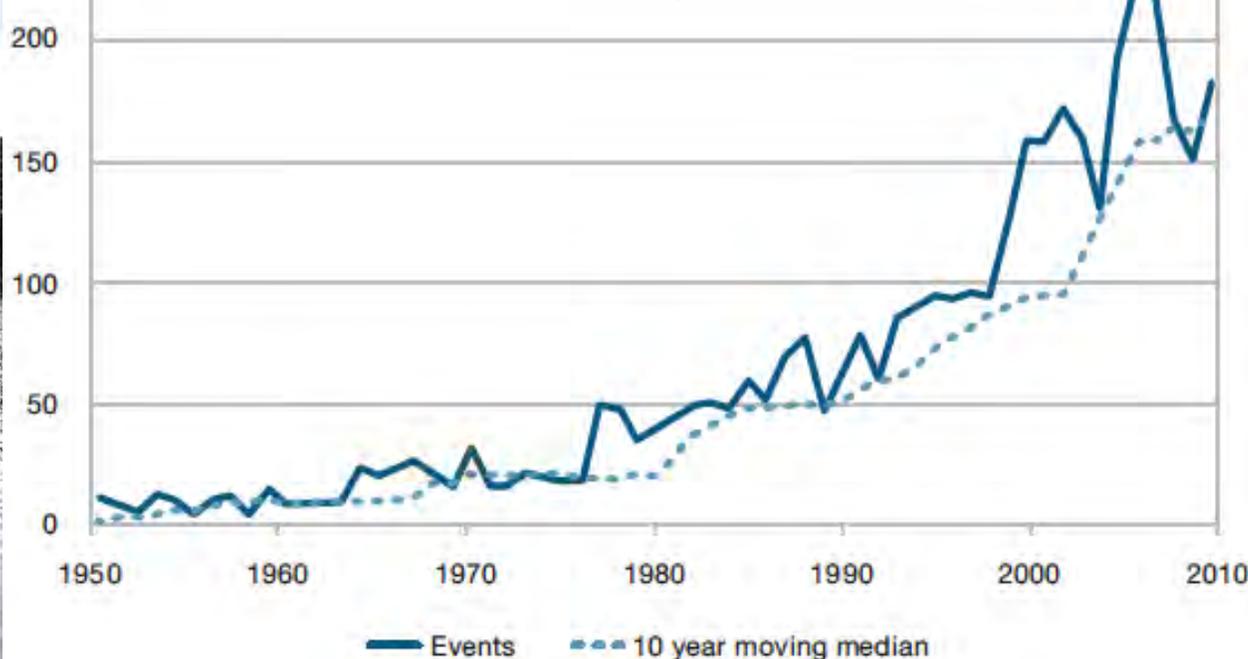
洪水是自然灾害中最常见的类型。在极端年份，洪水造成的损失总额超过400亿美元。

Global Flood Losses



250,000,000s

Global number of reported flood events



CONVENTIONAL: 'BUILT' INFRASTRUCTURE /

传统：‘建设’基础设施

- **Controlled disruption** of ecosystem by building man-made structures
- **Examples:** pipes, levees, dams, flood walls, gutters

- 通过建造人工结构对生态系统进行有控制的扰动
- 示例：管道、堤坝、水坝、防洪墙、排水沟

NBS: 'NATURAL' INFRASTRUCTURE /

NBS: '自然' 基础设施

- Natural solutions include **regenerating, protecting and creating ecosystems**
- Newer and **not as well-tested** as built infrastructure, but can be more **cost-effective** in some cases
- **Examples:** mangroves, wetlands, floodplains, upland forests

- 自然解决方案包括再生、保护和创建生态系统
- 相较于已建成的基础设施，这些解决方案较为新型且尚未经过充分验证，但在某些情况下可能更具成本效益
- 示例：红树林、湿地、洪泛平原、山地森林

MANY TERMS FOR “NATURE-BASED SOLUTIONS” / “基于自然的解决方案” 的多种表述



Source: Cohen-Shacham et al. 2016; UNEP et al. 2014; EC 2015; Lo 2016; WWF 2017; USACE n.d.; EcoShape 2018; WBCSD 2017



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THINKING ABOUT NBS AS INFRASTRUCTURE /

将NBS视为基础设施

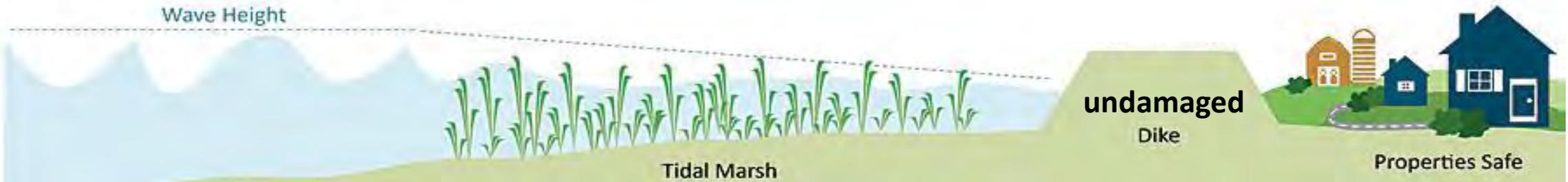
	Nature-based Solutions (NBS) / 基于自然的解决方案 (NBS)	
Built / 建造	Hybrid / 混合	Natural / 自然
Hard, gray, engineered structures built to address development objectives / 坚硬、灰色的工程结构，专门设计用于实现发展目标。	Combination of ecosystem elements and hard engineering interventions for addressing development objectives / 生态系统要素与硬工程干预措施的结合，以实现发展目标	Creation, protection or restoration of only ecosystem elements for addressing development objectives / 仅通过创建、保护或恢复生态系统要素来实现发展目标。

NBS: 'HYBRID' INFRASTRUCTURE / 国家统计局: '混合' 基础设施

- Natural solutions alone are **often insufficient** to meet all needs / 仅靠自然解决方案通常不足以满足所有需求。
- **'Hybrid' solutions integrate and enhance** the benefits of natural and built solutions / “混合” 解决方案整合并提升自然解决方案与人工解决方案的优势。

- **Examples:** permeable pavements, constructed wetlands, removable sea walls, green roof / 示例: 透水铺装、人工湿地、可移动海堤、绿色屋顶

Wave attenuation with a healthy tidal marsh.



Wave attenuation with a degraded tidal marsh.



TYPES AND TYPOLOGIES OF NATURE-BASED SOLUTIONS / 自然基底解决方案的类型与分类



ADDITIONAL 'CO-BENEFITS' OF NATURAL AND HYBRID SOLUTIONS / 自然与混合解决方案的额外“协同效益” 解决方案

Provide a **wealth of co-benefits**, including:

- Sustaining livelihoods
- Improving food security
- Carbon sequestration
- Improving water quality
- Protecting biodiversity and habitats

提供丰富的协同效益，包括：

- 维持生计
- 改善粮食安全
- 碳封存
- 改善水质
- 保护生物多样性和栖息地

WORDS OF CAUTION / 注意事项

- **Effective use of NBS is highly context-specific**, requiring careful evaluation, planning and design
- **Some NBS have natural variability and uncertainty that must be accounted for.**

- 自然基于解决方案的有效应用具有高度的场景依赖性，需要进行仔细评估、规划和设计
- 部分自然基于解决方案存在自然变异性和不确定性，必须予以充分考虑。

CLIMATE HAZARDS: URBAN HEAT / 气候灾害：城市热岛效应

Hazards: Extreme urban heat

Contributing factors:

- Densification of cities
- Impervious and dark surfaces
- Loss of green cover
- Changing weather patterns
- Natural disasters

危险： 极端城市热浪

影响因素：

- 城市密度增加
- 不透水和深色表面
- 绿地覆盖减少
- 气候模式变化
- 自然灾害

- 500,000 premature deaths per year from extreme heat
- 1.6 billion people in >1000 cities will be exposed to extreme urban heat by 2050
- Urban heat impacts economic productivity: 1.5-2% annual GDP losses globally

- 每年有50万人因极端高温而过早死亡
- 到2050年，全球将有16亿人生活在超过1000个城市中，面临极端城市高温的威胁
- 城市高温对经济生产力造成影响：全球每年国内生产总值（GDP）损失1.5%至2%



NBS FOR EXTREME URBAN HEAT /

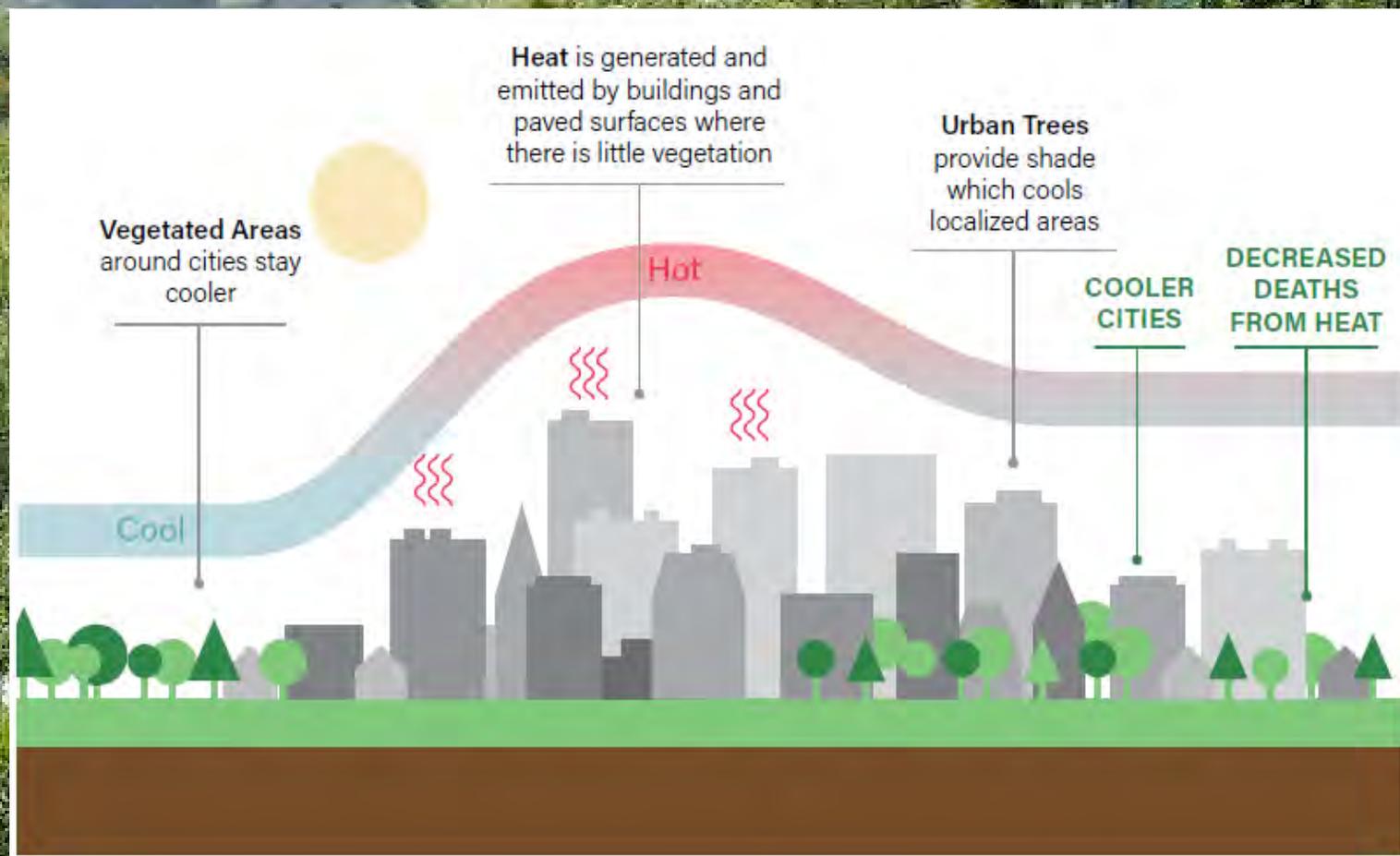
NBS 专为极端城市高温设计

The solutions:

- Green roofs/walls
- Tree cover
- Gardens
- Reduce impervious cover
- Green corridors
- Restore/daylight wetlands and water bodies

解决方案:

- 绿色屋顶/墙体
- 树木覆盖
- 花园
- 减少不透水覆盖物
- 绿色廊道
- 恢复/开阔湿地和水体



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NBS INTERVENTIONS FOR URBAN HEAT / NBS干预措施在城市热岛效应中的应用

LIGHTEN IT



Green roofs generally have higher albedo than their grey infrastructure counterparts.

COVER IT



Trees are an important source of shade in cities, helping mitigate the urban heat island effect.

ACCESS IT



Greenways help connect humans and nature, and enable interaction with shade-creating elements such as trees.

COOL IT



Forests carry out evapotranspiration, consuming heat and helping cool cities.



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CASE EXAMPLE: MEDELLIN'S GREEN CORRIDORS /

案例分析：麦德林的绿色走廊



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CLIMATE HAZARDS: URBAN STORMWATER FLOODING /

气候灾害：城市暴雨洪水

Urban flooding hazards: stormwater pollution, landslides

城市洪水灾害：
雨水污染、山体滑坡

Contributing factors:

- Urbanization
- Lack of drainage
- Insufficient water infrastructure
- Climate change

影响因素：

- 城市化
- 排水系统不完善
- 供水基础设施不足
- 气候变化

- Urban flooding occurs when water flows faster than it can be absorbed or transported away
- **By 2030, global urban population will increase by another 1 billion.**

- 城市洪水是指水流速度超过其被吸收或排走的能力
- **到2030年，全球城市人口将再增加10亿。**

NBS FOR URBAN FLOODING AND STORMWATER HAZARDS / NBS 城市洪水与暴雨排水灾害解决方案

The solutions:

- Open spaces
- Constructed wetlands
- Bioretention areas
- Green roofs
- Permeable pavement

解决方案:

- 开放空间
- 人工湿地
- 生物滞留区
- 绿色屋顶

RANGE OF RISK REDUCTION AND ADDITIONAL BENEFITS: URBAN FLOODING AND STORMWATER HAZARDS /

风险降低范围及额外效益：城市洪水及雨水灾害

Constructed wetland

- Filters pollutants; captures sediments; reduces stormwater runoff that can damage built infrastructure

Additional benefits

- Biodiversity; freshwater storage; recreation, tourism, and education

人工湿地

- 过滤污染物；捕获沉积物；减少可能损坏建筑基础设施的雨水径流

额外好处

- 生物多样性；淡水储存；休闲、旅游和教育

Bioretention areas

- Reduce runoff of sediments and pollutants into river; increase groundwater recharge

Additional benefits

- Protect streamside properties; recreation and tourism

生物滞留区

- 减少泥沙和污染物进入河流；增加地下水补给

额外效益

- 保护河岸地带的财产；促进休闲和旅游业

CASE EXAMPLE: DISASTER RISK MANAGEMENT WITH CONSTRUCTED WETLANDS IN KATHMANDU VALLEY, NEPAL /

案例研究：尼泊尔加德满都谷地人工湿地灾害风险管理

- Poor **wastewater management**
 - Small-scale, decentralized, **wetland system**
 - **Community support** essential
 - Highly effective, **low cost** pollutant removal: **US\$290/yr** to treat wastewater from **80 households**
-
- 废水管理不善
 - 小型分散式**湿地系统**
 - 社区支持至关重要
 - 高效且**低成本**的污染物去除：处理**80户家庭**的废水每年仅需**US\$290**



HAZARDS FOR COASTAL FLOODING AND EROSION /

沿海洪水和侵蚀的危害

Hazards: Flooding, erosion

Contributing factors:

- Development decisions
- Ecosystem degradation
- Sea level rise
- Changing weather patterns
- Natural disasters

危险：洪水、侵蚀

影响因素：

- 开发决策
- 生态系统退化
- 海平面上升
- 气候模式变化
- 自然灾害

The world's coasts

- 9% of global land area
- 28% of the global population (1.9 billion people)
- 42% of global GDP production site

- 全球海岸线
- 9% 的全球陆地面积
- 28% 的全球人口（19亿人）
- 42% 的全球国内生产总值（GDP）生产基地

NBS FOR COASTAL RESILIENCE / NBS 用于沿海韧性

The solutions:

- Mangrove forests
- Coral reefs
- Oyster reefs
- Sandy beaches and dunes
- Salt marshes
- Seagrass

解决方案:

- 红树林
- 珊瑚礁
- 牡蛎礁
- 沙滩与沙丘
- 盐沼
- 海草

RANGE OF RISK REDUCTION AND ADDITIONAL BENEFITS: COASTAL RESILIENCE

Mangrove forests

- Reduce wave energy; stabilize and expand shoreline; elevate soil

Additional benefits

- Forest products; fisheries; water purification; carbon sequestration

Oyster reefs

- Reduce wave energy; stabilize shoreline; protect adjacent habitats

Additional benefits

- Carbon sequestration; fisheries; water purification

CASE EXAMPLE: RESTORING OYSTER REEFS IN THE GULF OF MEXICO / 案例示例：墨西哥湾牡蛎礁的修复

5.9 kilometers of restored oyster reefs in Mobile Bay, Alabama has:

- **Reduced wave height and energy:** The top 10% of waves by 76-99%
- **Produced marine food supply:** 3,460 kg of oyster (meat) harvest/yr
- **Purified water:** 1,888 kg of nitrogen/yr removed from nearshore waters

5.9公里的修复牡蛎礁在阿拉巴马州莫比尔湾:

- **降低波高和波能:** 前10%的波高减少76-99%
- **提供海洋食物供应:** 每年收获3,460公斤牡蛎(肉)
- **净化水质:** 每年从近岸水域去除1,888公斤氮

CONSIDERATIONS FOR POLICY FORMULATION / 政策制定的考量因素

- Implement **environmental monitoring** and **sustainable land use planning**
- Engage **all stakeholders**
- Facilitate **cross-sector coordination**
- Behavioral change through **knowledge sharing**
- Encourage **supportive policy signals**

- 实施**环境监测**和**可持续土地利用规划**
- 动员**所有利益相关方**
- 促进**跨部门协调**
- 通过**知识共享**促进**行为改变**
- 鼓励**支持性政策信号**

IMPLEMENTATION OF NBS / 自然基于解决方案（NBS）的实施

Steps To Guide NBS Project Cycle

1. Initial socio-ecological assessment
2. Risk and vulnerability assessment
3. Analyze costs, benefits, impacts and trade-offs
4. Design intervention, monitoring and evaluation framework
5. Develop financing strategy
6. Implement and construct intervention
7. Assess progress and effectiveness

NBS 项目周期指南

1. 初步社会生态评估
2. 风险与脆弱性评估
3. 分析成本、效益、影响及权衡
4. 设计干预措施、监测与评估框架
5. 制定融资策略
6. 实施并建设干预措施
7. 评估进展与成效

NBS IMPLEMENTATION CHALLENGES /

NBS实施面临的挑战

Need to better understand:

- Risk reduction performance of NBS
- Resilience-related benefits from local community to national levels
- Technical guidelines for NBS evaluation
- Integration of NBS with grey solutions

需要进一步了解:

- 基于自然的解决方案（NBS）的风险减缓效果
- 从社区到国家层面基于自然的解决方案（NBS）带来的韧性相关效益
- 基于自然的解决方案（NBS）评估的技术指南
- 基于自然的解决方案（NBS）与灰色解决方案的整合

WRAP UP AND HOW TO GET STARTED / 总结与入门指南

Understand local site context

- Biophysical traits and compatibility with hazard reduction target
- Social, policy, and financial enabling conditions
- Additional co-benefits benefits
- Variability in levels of performance

理解当地场地环境

- 生物物理特性与减灾目标的兼容性
- 社会、政策和财务支持条件
- 额外协同效益
- 性能水平的变异性

TO SUCCESSFULLY

成功地

- Leverage regenerative and adaptive traits of NBS for resilience
- Understand spatial and time scales to maximize benefits
- Integrate with current and future built infrastructure
- Inform implementation, management, and evaluation plans

- 利用自然基于解决方案（NBS）的再生和适应性特征提升韧性
- 理解空间和时间尺度以最大化效益
- 整合现有及未来建筑基础设施
- 指导实施、管理和评估计划