# URBAN CLIMATE CHANGE ADAPTATION CURRICULUM

## Contents

**1) Planning tools and mapping** are essential for climate change adaptation initiatives. There are classical tools for planning but cities have typically not integrated them into an overall vision and strategy that increases a city's capacity to adapt to climate change. Cities such as Cartagena are starting to integrate these tools. The following list includes new and classical:

- **Regional planning and cooperative trans-boundary planning**: Climate change is a global phenomenon without regard to political boundaries and conflicts ad requires . regional-scale and cooperative, trans-boundary planning.
- **Urban coastal vs. inland vs. watershed planning:** Different urban morphologies must be recognized and planned for in a way that addresses their unique characteristics.
- **Strategic planning**: in contrast to comprehensive or master planning, this planning concentrates on only a few high-impact interventions. For example, strategic infrastructure planning, prioritizes adaptive investments and retrofits to key institutional buildings, energy networks, connectivity infrastructure (roads and bridges) to ensure smooth delivery of key logistics and services
- **Hazards mapping**: Based on a city's spatial features, such as topography and proximity to water features, this type of mapping identifies the various physical risks in each part of the city. Steep areas may be susceptible to landslides, for instance, while coastal areas may be suffer storm surges.
    - **Vulnerability mapping:** Vulnerability mapping plots areas of the city that are most susceptible to hazards due to socioeconomic factors, such as poverty and poor quality housing
    - **Prediction projections mapping**: climate change projections vary in certainty and extent of a given impact; so these maps plot the various possible impacts of climate change based on
    - **Adaptive capacity mapping**: Similar to strategic planning in that adaptive capacity mapping prioritizes high-impact initiatives to adapt to climate change. ACM is the result of an adaptive capacity strategy that reduces risk by reducing exposure and vulnerability, and enabling social capital for change.
- **Integrated water management**: looks at hydrological resources and their relationship to other spaces, resources, and hazards within the city and region.
- **Integrated urban flood planning**: a component of IWRM dealing specifically with floods. Flood planning is often the first step of IWRM, or the top priority for cities with limited budgets.
- **Participatory planning**: This type of planning emphasizes empowerment of the community for whom the plan is being prepared. The targeted community is included within the planning process, and their inputs shape the final strategy. In the case of climate change adaptation, participatory planning can give insights into vulnerable populations' needs and build consensus towards interventions such as relocations or retrofit programs.

## 2) Design Principles

- **Prioritize disaster risk reduction and climate change adaptation actions:** Include risk reduction and climate change adaptation in the ordinary planning municipal exercise. (The complexity of adaptation and disaster management activities. complement many spatial and economic development planning.)
- **Allow systems to flow naturally:** An overarching principle of reducing exposure is to partner with nature, rather to fight against it. In other words, rather than controlling environmental hazards, cities should seek to effectively manage them, and minimize their impact on various systems. A key example of this relates to water management: rather than capturing and directing water through hard infrastructure like armored drains or seawalls, green infrastructure technologies can mimic ecological controls, working with – and not against – nature while still pursuing development and adaptation objectives.
- **Evaluate sites for potential environmental hazards and ability to accommodate soft engineering: Site analysis highlights** the risks to which a site is susceptible guides the design process and minimizes the likelihood of future disasters. In many cases green engineering can reduce hazards exacerbated by conventional development.
- **Build buffers and settle above low-lying areas:** Encouraging settlement above low-lying areas proactively places space between the built environment and hazards like flooding, storm surges, and mass flows. Expanding buffer zones puts space between existing buildings and hazards.
- **Increase density but reduce building footprints:** Expanding the urbanized area increases storm runoff, increases ambient temperatures, damages ecology, and typically encroaches upon environmentally sensitive land. Maximizing livable density promotes growth in safe areas while reducing negative impacts of sprawl.
- **Increase infiltration and calculate/reduce impermeable surfaces:** Allowing water to infiltrate into the ground naturally minimizes runoff that aggravates erosion and overflows rivers.
- **Deliver land and services for the most at-risk populations:** Providing the poor with safe land, reasonable quality housing, and basic services increases their ability to reduce their exposure and vulnerability in the face of risks, Prioritze sewage ad portable water.
- **Disaster resilient building component in high risk areas:** In cases when relocation of infrastructure is impossible or impractical, incorporating disaster resilient retrofits will help buildings withstand hazardous events.
- **Concentrate in producing safe serviced land for the poor so that it reduces exposure, and vulnerability.** Exercise all land instruments available in a municipality to fund ad cross finance land development
- **Design retrofits with climate change adaptation strategies to integrate solutions.**
- **Measure and project the impact of proposed impermeable surfaces on channel width**
- **Prioritize climate change adaptation retrofitting in settlement.**

## 3) Decision-making levels and uncertainty:[1]

Decision-makers planning adaptation investments and activities face a number of uncertainties, especially in regards to determining the magnitude of climate change's urban impacts. A number of management tools account for the uncertainty in predicting these impacts.

- **Adaptive management:** Develops a strategy that can be modified over time in light of new information or circumstances.
- **Scenario Planning:** Looks at a range of climate change projections scenarios, and develops responses to each. Alternative policies are compared and vetted to determine the advantages and tradeoffs of each.
- **Robust/resilient:** Looks at a range of climate change projections scenarios, and develops a response that performs well in each scenario.

## 4) Examples of Policies:[2]

- **Green infrastructure and protection of informal settlements:**
    - Efforts to raise awareness of risks proportionate to structural and nonstructural flood control measures
    - Convert reclaimed land back to its natural state
    - Focusing on release of water rather than containment
    - Optimization of open space and preservation of natural resources
    - Neighborhood scale of storm management
    - Zoning to manage floodplain development
    - Nonstructural flood control systems such as land use regulations, administration management, and economic levers
    - Reduce stormwater speed and pollutant loads
    - Identify stormwater hot spots and prevent increased overbank flooding

- **Protecting the built environment:**
    - Measure and project the effects of proposed impermeable surfaces
    - Septic systems and landfills must not compromise groundwater quality during floods
    - Convey extreme floods, increased peak flows and bankfull flows away from exposed areas
    - Protect urban streams and enlarge as watershed's impermeable area exceeds 10%
    - Expand micro-insurance policies to maximize built area security

- **Integrated water management**
    - Integrate coastal zone management, watershed management and urban land use management

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[1] http://climate-adapt.eea.europa.eu/uncertainty-guidance/topic2

[2] Adapted from [cite IPCC 2013 or 2012, I2UD 2013]

- Adopt integrated water resource management plan for adaptation and reduced health risks
- Set and monitor air and water quality regulations
- Design stormwater plan, anticipate impermeable surface area growth
- Design water capture, storage, and release plans

- **Relocation** (China case)
  - Abandon the most vulnerable place
  - Encourage relocation with a supportive policy, action plan, and resources.
  - Larger compensation for families who voluntary relocate; smaller amount for families who stay
  - For relocated families compensation covers material and money costs of housing. Compensation could be a blend of cash grants, government loan guarantees, or building materials
  - Recovery efforts restore and improve the post-disaster affected areas
  - Relocation takes place as close to the original site as possible
  - Voluntary buyout programs to purchase damage properties in flood-prone areas to encourage relocation

- **Retrofitting:** (see design principals)
  - Identification, retrofitting, and maintenance of construction vulnerabilities in settlements
  - Elevating structures to flood proof them
  - Planning evacuation routes and programs

## 5) Case Studies (see "Annex II – Selected Case Studies Reviewed")

1. Rainwater Catchment and Hurricane Protection in Bermuda
2. Flood Monitoring in Philippines Slum
3. Resettlement program in the Yangtze River Basin Flood affected areas.
4. Curitiba integrated flood management
5. Land Value Capture in USME
6. Reblocking in Langrug, Western Cape

## Supplement - Glossary

**EPA's Green Infrastructure List**

http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm

- **Land Conservation:** Preserving and protecting natural spaces near urban areas improve water quality and mitigating flooding. Sensitive areas such as wetlands and river banks should be prioritized.
- **Urban Tree Canopy:** Increasing tree coverage in cities can reduce the urban heat island effect by providing more shade. Additionally, trees slow and absorb rainwater, lessening the impacts of flooding.
- **Green Roofs:** Roofs covered with a growing medium and vegetation filter and store rainwater, reduce the urban heat island effect, and encourage transpiration of water. They are most cost effective on large buildings in order to offset stormwater management costs
- **Green Parking, streets, and alleys:** Due to streets and parking lots' large, hot, impermeable area, incorporating trees, bioswales, permeable pavements, and growing media like rain gardens reduces stormwater runoff and urban heat island.
- **Permeable Pavements:** Paved areas that allow water to infiltrate, or that store rainwater, near its source. Interlocking patterns and/or porous materials may be used.
- **Bioswales:** In contrast to typical gutters, bioswales are channels that incorporate vegetation to slow down, filter, and retain stormwater while transporting it.
- **Planter Boxes:** Planter boxes are raised garden beds that collect and retain runoff. The bottoms are either opened or closed. Planter boxes are ideal for areas with limited space.
- **Rain Gardens:** Rain gardens are vegetated cells that collect and retain rainwater and runoff. By imitating natural hydrology, rain gardens encourage infiltration and evapo-transpiration.
- **Downspout Disconnection:** Rather than diverting rainwater collected by roof gutters to sewers, downspout disconnection encourages capture and storage of water on-site in rain barrels, rain gardens, etc. This relieves other wastewater systems and reduces the water infiltrating the soil.
- **Rainwater Harvesting: Typically in the form of cisterns, rainwater harvesting systems collect rainwater and store in for future use.** In addition to reducing the water load in the soil, these systems provide water security in arid areas.

**USAID Coastal Wetlands Protection and Restoration Initiatives**

**Summary Coastal Instrument: from** http://transition.usaid.gov/our_work/cross-cutting_programs/water/docs/coastal_adaptation/adapting_to_coastal_climate_change.pdf

**Coastal wetlands protection** and restoration initiatives protect wetlands in order to continue benefiting from the services they provide, such as acting as a fish habitat, natural filter for water pollution, and buffer against storms and other hazards

- **Marine Conservation Agreements** are formal or informal agreements designed to achieve ocean or coastal conservation goals. These agreements usually involve actively managing hydrological resources or refraining from exploiting these resources.
- **Marine Protected Areas (MPAs)** are defined by the World Conservation Union (IUCN) as "any area of intertidal or subtidal terrain, together with its overlaying waters, and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part, or all, of the enclosed environment."
- **Payments for environmental services (PES):** these are various financial instruments which provide long-term funding specific polices and activities that benefit the environment. Either voluntary or mandatory, these payments compensate stewards of natural resources for the opportunity cost of not exploiting the resource.

**Beach and dune nourishment** adds more sand to the shoreline to compensate for coastal erosion. This practice is often complemented by the planting of vegetation to root the sand. Nourishment encourages the growth of protective dunes.

**Building standards** are construction requirements for buildings and other structures that promote safety of occupants and the public.

**A coastal development setback** is an area of land between the ocean and the land within which certain development restrictions apply. Development setbacks may be between the high-tide mark and the active foredune, for example.

**"Living shoreline"** is a way to reduce shoreline erosion by using vegetation to stabilize beach soils. Living shorelines absorb wave energy, prevent beach recession, and provides long-term protection for shores. This practice also helps accommodate the landward advance of wetlands due to sea-level rise.

Constructing **shoreline stabilization structures**, often referred to as shoreline hardening or armoring, is an approach taken to "defend" the shoreline from erosion or flooding.

**Other**

**Building Codes**

- **Freeboards:** In Maryland, raising freeboards by two feet can reduce annual flood insurance premiums by 50%: http://www.dnr.state.md.us/CoastSmart/pdfs/Freeboard_factsheet.pdf

**Infrastructure Design (i.e., stormwater codes)(Philadelphia)**

- **Stormwater Manual**

In Philadelphia, a stormwater fee is paid by building owners to the city to cover the cost of processing the rainwater that flows from properties to the city's wastewater treatment network. The fee is revenue-neutral. The previous stormwater fee was attached to the sewer service bill and did not charge a fee proportionate to the area of customers' property. The new charge reflects both property area and impermeable surface area. The new fee applies only to non-residential properties; residences pay a flat fee. The new charge is based on the following rates:

**Gross Area:** $0.526/500 square feet
**Impervious Area:** $4.145/500 square feet
**Monthly Billing:** $2.53 per account