Climate Change Vulnerability Assessment

Maryland Coastal Bays Program

Overview

- CCMP relevance & EPA requirement
- Being Prepared for Climate Change - A Workbook for Developing Risk-Based Adaptation Plans
- Partner input

Relevance

- CE 2.2.6 MCBP will pursue the designation of the Coastal Bays as an EPA **Climate Ready Estuary** and incorporate strategies in all planning activities and projects…
- CCMP Chapter 6: Coastal Resiliency
- The current CCMP has 44 actions directly related to climate change

Tools

- Being Prepared for Climate Change - A Workbook for Developing Risk-Based Adaptation Plans
  - http://www2.epa.gov/cre/being-prepared-climate-change-workbook-developing-risk-based-adaptation-plans
- Required by EPA for Climate Ready Estuary
- This workbook came out Aug. 2014, after the new CCMP was created

From MD Coastal Bays Final Program Evaluation Letter

- IV. Challenges
- **Climate Change**
- To ensure the viability of CCMP goals in the face of climate change, EPA recommends that the MCBP systematically assess how climate change will affect the organization's work. We encourage the MCBP to consider the **Climate Ready Estuaries *Being Prepared for Climate Change* workbook** as a resource for conduction that assessment. In FY 2015 and beyond, EPA plans to provide technical and financial resources to assist with such an effort.

Vulnerability Assessment

- **Step 1—Communication and Consultation**
- **Step 2—Establishing the Context for the Vulnerability Assessment = 14 CCMP Goals**
- Step 3—Risk Identification
- Step 4—Risk Analysis
- Step 5—Risk Evaluation: Comparing Risks

Step 2 – Establishing the Context

The organization is the center of attention, and the reasons why it exists (i.e., its purpose, mission, goals or objectives) are the base units of the vulnerability assessment.

= CCMP

Step 3 – Risk Identification

Generating a **broad list** of **reasonably foreseeable ways** that climate stressors could **keep your organization from achieving its goals**

Climate Stressors (from EPA)

- Warmer summers (overall climate)
- warmer winters (overall climate)
- Warmer water
- Increasing drought
- Increasing storminess
- Sea Level Rise
- Ocean Acidification

Generating Risks in Step 3: Brainstorm!

The Risk develops along the pathway between the cause (Stressor) and the effect (not reaching the Goal)

Ex: Stressor X could __________ and the result is we might not attain Goal Y

Example (from EPA)

- Sea Level Rise (stressor) will lead to more beach erosion (pathway) and we might not be able to maintain the endangered bird species nesting sites (goal).

Remember…

- Don’t dismiss any risks in this step
  - This is a brainstorming session
  - Step 4 will determine how important each risk is
- Risks are not inevitable
  - Likelihood is analyzed in Step 4
  - Stressors and Goals are mostly locked in
  - The Risk is the problem to be managed by lowering likelihood and consequence (ID’ed in Step 4)

Warmer Summers

- **WQ 1: Decrease nutrient loading**

- Negative impact on cool season grasses
- Increase irrigation and need for turf renovation and fertilizers
- Increase in cyanobacteria
- Vegetation range shifts and shift to southern species, favoring new plants with more (or fewer) nutrient reqmts
- Infrastructure strained from more visitors due to longer "shoulder season"
- Longer warm season could increase value of ag land AND residential land, meaning fewer opportunities for conservation

Warmer Summers

- **WQ 2: Decr toxic contaminants**
- Wildfire could increase contamination from fire retardants/suppressants

Warmer Summers

- **WQ 3: Implement TMDL Strategy**

- Heat stress increases irrigation needs
- Materials costs increase
- Increase in cyanobacteria, shift to southern species
- Competing resource mgmt. needs could reduce focus on TMDL

Warmer Winters: WQ 1

- Incr cost due to duration of maintenance
- Incr P inputs assoc with turf establishment
- Ground softness deterring access for maintenance, encouraging turf damage
- Longer growing season with higher winter nutrients
- More concentration of pollutant loads
- Seasonal residents stay longer and contribute more loads (incl pet waste)

Warmer Winters: WQ 2

- Increased winter residents/visitors contribute to higher volume of sewage with a variety of personal care products and other contaminants
- Increase length in the season pesticides are used.

Warmer Winters: WQ 3

- Longer growing season can lead to more lawn maintenance with fertilizers and pesticides
- Loss of melting winter snows may reduce spring or summer flow volume, and raise pollutant concentration in receiving waters
- longer growing season with high winter nutrients (most permits are written for no discharge during growing season)
- nutrient reductions in winter will be needed (tertiary WWTP methods not active in winter).

Warmer Water: WQ 1

- Longer duration for eutrophication of receiving waters
- Low bottom oxygen may lead to incr release of P from sediment
- Increased algae blooms (longer season too) and die off, leads to fish and other marine life die off
- Prolonged dead zones
- Increased disease and parasites, decreasing health of bivalves and reducing filtration

Warmer Water: WQ 2

- May increase volatility of some products
- Does LD_{50} change?
- Increase in toxicity with warmer water temps
- Potential for incr solubility of contaminants

Warmer Water: WQ 3 (1 of 2)

- Higher solubility could mean higher concentration of pollutants
- Higher surf temps may lead to stratification
- Greater algae growth
- Greater survival of parasites and bacteria, for transmission

Warmer Water: WQ 3 cont.

- Temp criteria for discharges may be exceeded (thermal poll’n)
- Warmer temps could mean increased toxicity
- Low bottom oxygen could mean release of P from sediments
- TMDL strategic focus could be shifted to bacteria, algae, fish impacts, etc.

Increasing Drought: WQ 1 (1 of 2)

- Incr use of irrigation
- Could incr wind erosion on well-drained sandy soils
- Drought stresses cool season turf creating greater turf loss during active playing seasons which necessitate maximum nutrient inputs to maintain vigor in season and to perform repairs afterwards

Increasing Drought: WQ 1 cont.

- Decreased freshwater inputs will lead to longer residence times with shifts to smaller phytoplankton and pico-cyanobacteria in low turbulence high nutrient environment with high N:P ratio or dinoflagellates if N:P ratio is low (diatoms will sink)
- increase concentration of pollutants w/ less volume
- Vegetation dieback will cause nutrient loads to increase
- Drought may decrease the survival of newly implemented BMPs (i.e. saplings/tree plantings).

Increasing Drought: WQ 2

- More dangerous air borne particulate matter exposed on land surfaces and available for distribution
- increase concentration of pollutants w/ less volume
- less water to transport contaminants, less to dilute contaminants.

Increasing Drought: WQ 3 (1 of 2)

- Poll’n build-up on land followed by hi-intensity flushes
- Critical low-flow criteria for discharging may not be met
- Pollutant concentrations could increase
- Larger reliance on irrigation and managing fertility at the top end of legal limits will become the norm

Increasing Drought: WQ 3 cont.

- Damage to cool season grasses may require increased fertility inputs to repair
- Decreased freshwater inputs will lead to longer residence times with shifts to smaller phytoplankton and pico-cyanobacteria in low turbulence high nutrient environment with high N:P ratio or dinoflagellates if N:P ratio is low (diatoms will sink)
- Water conservation measures may take precedence over water quality.

Increasing Storminess: WQ 1 (1 of 2)

- Flashy high volume events may increase nutrient and sediment loading; BMPs are overrun
- Heavy rainfall increases mower and user damage which increases nutrient inputs for repairs
- Free moisture and humidity equals turf disease pressure which could require nutrient inputs to 'grow out' damage after chemical application.

Increasing Storminess: WQ 1 cont.

- Greater resuspension may increase nutrient resuspension and decrease light.
- Possible CSO or septic failure
- Urban areas with inadequate stormwater infrastructure will flood more and larger amounts of untreated runoff will enter the Bays

Increasing Storminess: WQ 2

- Heavy rain induced flooding may inundate storage buildings causing loss of product
- Increase in heavy rainfall events could cause more rapid leaching of toxic contaminants--such as from landfill, agricultural fields, etc.
- re-suspension of contaminated sediments
- contaminated debris from storm damaged structures & facilities washes into bay
- Floods may cause dam failures releasing accumulated toxins.

Increasing Storminess: WQ 3 (1 of 2)

- Streams may see greater scour and erosion
- Urban areas may be subject to more floods
- Flood control (e.g. detention basins, manure management) may be inadequate
- High rainfall may cause septic systems to fail and CSOs to occur - Treatment plants may go offline during intense floods.

Increasing Storminess: WQ 3 cont.

- Field closures and turf damage increase
- Greater resuspension may increase nutrient resuspension and decrease light.
- may impact monitoring efforts.
- Resources from partners may be needed to deal with emergencies and may not be available for TMDL or CCMP actions.

Sea Level Rise: WQ 1 (1 of 2)

- Coastal storm events may overwhelm septic tanks, drain fields and municipal WWTP's and create more runoff
- Tidal flooding combined with long durations of rainfall retard drainage and create anaerobic conditions on site which increases nutrient inputs for site repairs
- High risk to treatment infrastructure

SLR: WQ 1 cont.

- loss of wetlands reduces the amount of nutrients removed via natural processes
- increase erosion, leads to increased nutrient loading
- In coastal areas tidal flooding will exacerbate stormwater flooding (untreated volume higher)
- Inland areas will experience higher water tables and fertilizers may have direct contact with water rather than soil barrier.

SLR: WQ 2

- Vehicles caught in flooding could discharge fluids
- Storage facilities (oil, gasoline, fertilizer etc.) could be overwhelmed and leak product
- flooding of streets and parking lots
- incursion onto upland could flood containment sites
- Sewage overflows may lead to more toxic contaminants.

SLR: WQ 3

- Tidal flooding may extend to new areas, leading to additional sources of pollution
- Treatments plants may not be able to discharge via gravity at higher water levels; may be susceptible to flooding; Sewer pipes may have more inflow (floods) or infiltration (higher water table).
- Sewage may mix with seawater in combined sewer systems
- Contaminated sites may flood or have shoreline erosion
- inundation of septic drain fields
- Decrease in marshes may impact nutrient loading
- priority shift for resources mitigation vs water quality.

Ocean Acidif: WQ 1

- less DO in waters w/ change to pH
- Acidic waters may impact the health of bivalves, reducing filtration capabilities if bivalves put less energy towards growth and reproduction, and more energy towards shell building.

Ocean Acidif: WQ 2

- Lower pH will cause heavy metals such as cadmium, lead and chromium to dissolve more easily
- A more acidic ocean may cause more toxic contaminants to leach out of stable/inert state.

Ocean Acidif: WQ 3

- ocean vs estuarine research and implementation funding

Ocean Acidif: FW 1

- Decreases in shellfish that are unable to grow and reproduce due to reduced ability for shell (oysters, crabs, clams and scallops)- if that occurs there will be BIG changes in marine food chains
- negative impact on summer flounder reproduction and productivity and possibility others as well
- ecological disruption in predator-prey relationships as species become more mobile

Ocean Acidif: FW 2

- impacts to SAV?
- changing pH and water chemistry affects shellfish populations
- More staff and funding resources may be needed to track impacts to oysters and other mollusks

Ocean Acidif: FW 3

- Coastal shoreline interface with terrestrial upland will be dramatically different. Erosion of that shoreline area will be noticeable.

Ocean Acidif: FW 4

- Monitoring and data collection will be impacted by rapidly changing conditions affecting trends. Historic data will be less relevant

Ocean Acidif: RN 1

- Increased erosion of natural or constructed barriers can increase risk to vacation destinations from storm surge
- Recreational clamming may be impacted by ocean acidification. Food chains may be impacted reducing the availability of recreational fishing.

Ocean Acidif: RN 2

Ocean Acidif: RN 3

- new recommendations will be coming out to address issues that were not addressed before, i.e. island creation

Ocean Acidif: RN 4

- could have impacts to the chemical parameters of sediment chemistry; disposal options for use would be impacted.

Ocean Acidif: CE 1

- Negative impacts to aquaculture

Ocean Acidif: CE 2 & CE 3

Step 4—Risk Analysis

- One initial high level rating (low, medium, high) of:
  - Consequence
  - Likelihood
  - Spatial scale
  - Time horizon
  - Habitat type
- Smaller teams, one or two people, qualitative scale
- Document sources

Step 5—Risk Evaluation: Comparing Risks

- Develop a Consequences vs Probability Matrix
- Review it with Stakeholders
- Reach agreement on the overall assessment

FIGURE 5-1. An example consequence/probability matrix.

Likelihood (probability) of occurrence	Consequence of impact: Low	Consequence of impact: Medium	Consequence of impact: High
High	1. Warmer water may stress immobile biota 2. Warmer water may lead to changes in drinking water treatment processes n. ______________	1. Warmer water may hold less dissolved oxygen 2. Sea level rise may cause bulkheads, sea walls and revetments to become more widely adopted n. ______________	1. Shoreline erosion from sea level rise may lead to loss of beaches, wetlands and salt marshes 2. Combined sewer overflows may increase from more intense precipitation n. ______________
Medium	1. Increased wildfires from warmer summers may lead to soil erosion 2. Warmer winters may lead species that once migrated through to stop and stay n. ______________	1. Parasites and bacteria may have greater abundance, survival or transmission due to warmer water 2. Warmer summers may drive greater water demand n. ______________	1. More frequent drought may diminish freshwater flow in streams 2. More intense precipitation may cause more flooding n. ______________
Low	1. Warmer water may lead open seasons and fish to be misaligned 2. Warmer winters may lead to more freeze/thaw cycles that impact water infrastructure n. ______________	1. Warmer water may lead jellyfish to be more common 2. Ocean acidification may cause the recreational shellfish harvest to be lost n. ______________	1. Contaminated sites may flood from sea level rise 2. Warmer water may promote invasive species n. ______________

Action Plan

- Step 6—Establishing the Context for the Action Plan
- Step 7—Risk Evaluation: Deciding on a Course
- Step 8a—Finding Adaptation Actions
- Step 8b—Selecting Adaptation Actions
- Step 9—Preparing and Implementing an Action Plan
- Step 10—Monitoring and Review

Timeline

- **January 9th 2017** – Invitational Meeting (IC & others) –
  - Step 3 & 4 - Risk Identification & Risk Analysis
- **Jan – Mar** – Subcommittee conducts Step 4: Risk Analysis
  - March 13, Expert Team meets to review Step 4
- **March 30 & April 6**– public meetings to vet analysis
  - Step 5 – Risk Evaluation: Comparing Risks
- **Summer** – CCVA Stakeholder meeting to finalize results
  - Review of results
- **Early December** - CCVA Public report released