

Stormwater Impacts to Guam's Aquatic Resources: Why We Need to Protect Streams, Wetlands, and Reefs

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Presentation outline

- Guam's aquatic resources
- Why should we care?
- Geology of Guam
- What is a watershed?
- Northern Guam Stormwater Scenarios
- Southern Guam Stormwater Scenarios



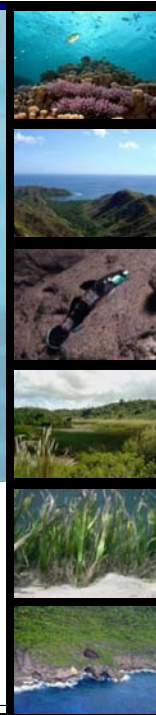
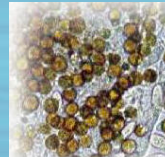
Introduction to Guam's aquatic resources

- Drinking water
- Cave systems
- Wetlands
- Nearshore coral reef ecosystem
 - ~42 sq. mi. of shallow reef
 - Different reef types
 - Thousands of marine species



What is a coral reef ecosystem?

- Diverse collection of species that interact with each other and with the physical environment
- Corals+ form the "foundation"
- Large structures formed through partnership with single-celled algae partners
- Provide habitat for thousands of species
- Linked to seagrasses, sand flats, mangroves, other marine/intertidal habitats



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Requirements for healthy reefs

- Clean water
- Low nutrient levels
- Adequate temperature range
- Healthy reef fish populations

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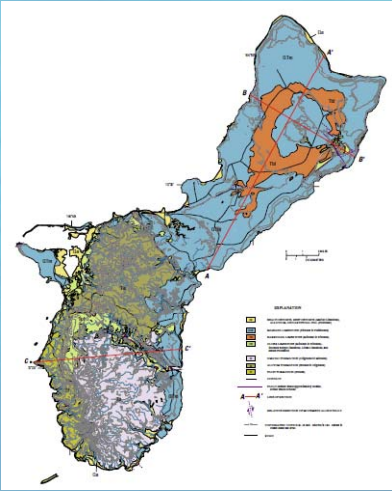
Why should we care?

Healthy People, Healthy Environment, Healthy Economy

- Drinking water – “no brainer”
- Cave systems – cultural value, unique ecosystem/species
- Wetlands – mitigate flooding, clean water, wildlife habitat
- Rivers – drinking water, unique ecosystem/species, harvest, cultural value
- Coral reefs – Guam’s reefs valued at ~\$127 million/yr
 - Tourism
 - Cultural value
 - Coastal protection
 - Fisheries
 - Recreational/
 - Research/Education
 - Bioprospecting
 - Aesthetics

Geology of Guam

- Island divided into 2 parts:
 - Northern limestone plateau
 - Karst topography
 - Aquifer
 - Southern mountains
 - Volcanic
 - Surface water
 - Highly erodible soils



Northern Guam: Aquifer

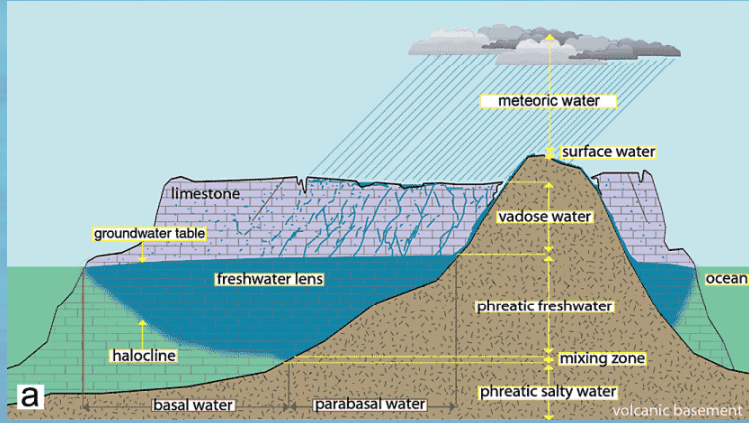
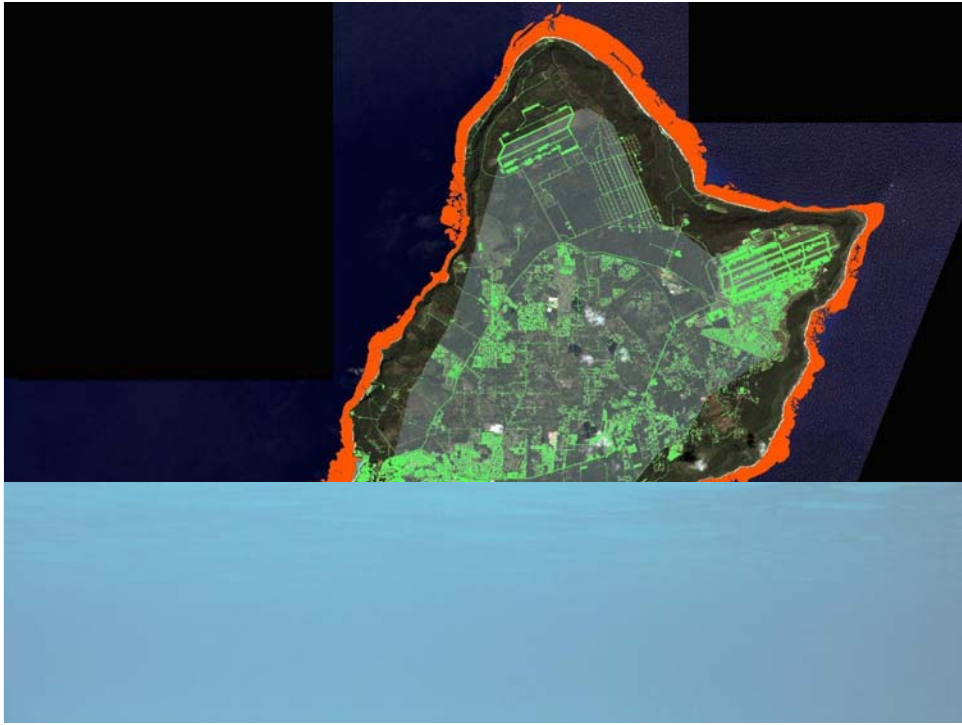


Figure from Taborosi et al., 2003

<http://www.speleogenesis.info>











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Southern Guam: Rivers

- Most rainfall in volcanic areas in southern Guam enters stream valleys
- Around 100 streams
- Range in length from less than 1 km to more than 5 km




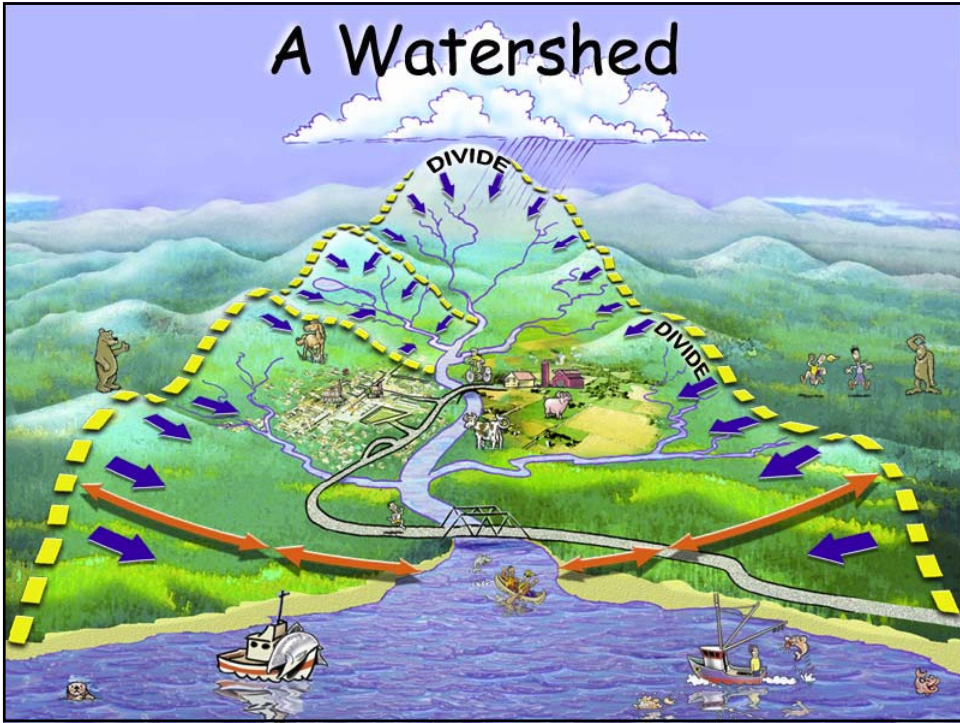


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What is a Watershed?

- “An area or region of land drained by a river, river system, or other body of water”
- “An area of land where all of the water that is under it or drains off of it goes into the same place”





Guam's watersheds

- **Aquifer**
 - Can be divided into sub-basins
- **Southern watersheds**
 - 16 watersheds, can be divided into sub-watersheds

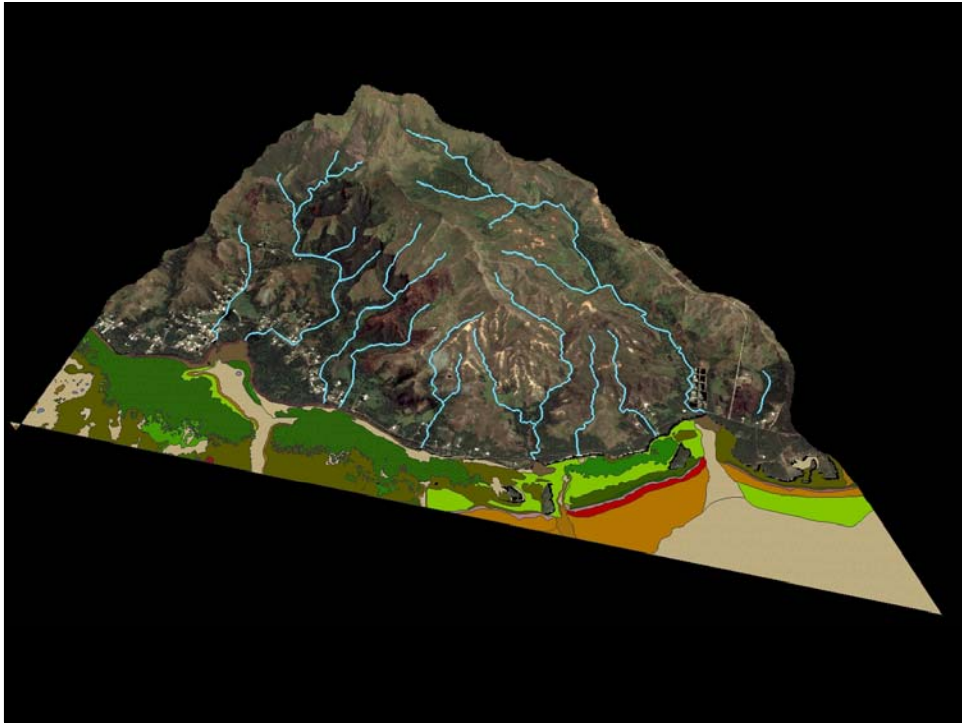


The "Ridge-to-Reef" Concept

- **Land, rivers, reef....It is all connected!**





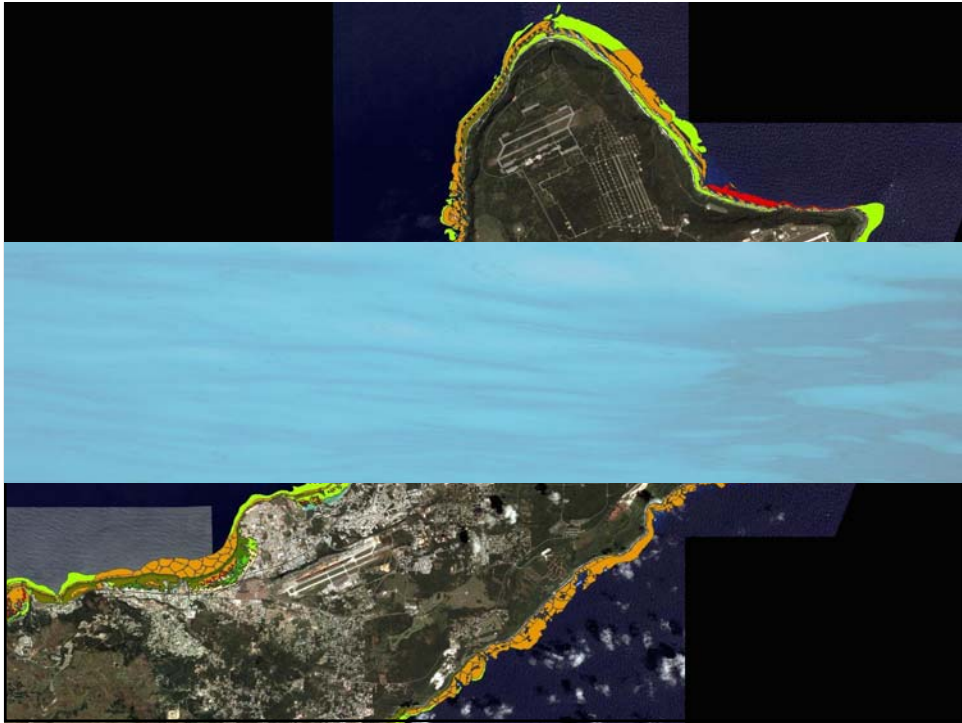


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Northern Guam Aquatic Resources

- Drinking water
- Cave systems
- Nearshore coral reef ecosystem

The collage features a large central image of a diverse coral reef with various colors and textures. To its left is a smaller image of a cave system with stalactites and a dark opening. On the right, a vertical strip contains six smaller images: a coastline with a blue sky, a diver in the water, a green field, reeds in a pond, and a shoreline with a blue sky.



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Where does the water go?

Northern Watersheds and Stormwater

- **3 scenarios:**
 - Natural system - vegetated land over the aquifer (no impervious surfaces)
 - Stormwater diverted to sink/stormwater infrastructure
 - Effective stormwater management in area with impervious surfaces mixed with vegetation


A vertical strip of six small images on the right side of the slide. From top to bottom: 1. A close-up of coral and sea anemones underwater. 2. A landscape view of rolling green hills under a blue sky. 3. A close-up of a person's legs and feet on a rocky, reddish-brown terrain. 4. A view of a green field with a small pond or stream. 5. A close-up of green grass and reeds. 6. A view of a rocky coastline with waves crashing against the shore.

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Where does the water go?

Northern Watersheds and Stormwater

- Scenario 1: Natural system
 - Fate of water in vegetated areas on the northern plateau:
 - Absorption by vegetation
 - Overland flow slowed by vegetation
 - Slower, more disperse movement of water through environment into aquifer
 - No pollutants – cleaner water




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Where does the water go?

Northern Watersheds and Stormwater

- Scenario 1: Natural system
 - Impact on resource:
 - Drinking water
 - Cave systems
 - Nearshore reefs
 - What is a reef?
 - Requirements for healthy reefs – clean water, low nutrients, etc.




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Where does the water go?

Northern Watersheds and Stormwater

- **Scenario 2: Harmon Sink**
 - **Fate of water in areas with high impervious surface cover, diverted to sink/pond**
 - Water moves faster
 - Pollutants in stormwater
 - Where it goes
 - Transfer rate (to reef)




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Where does the water go?

Northern Watersheds and Stormwater

- **Scenario 2: Harmon Sink**
 - **Resources affected**
 - **Reefs**
 - **Nutrients – algal growth, bacteria (human health and coral disease)**
 - **Pollutants (including freshwater)**




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Where does the water go?

Northern Watersheds and Stormwater

- Scenario 2.5: East Agana Drainage
 - Fate of water in areas with high impervious surface cover, diverted to stormwater infrastructure
 - Water moves faster
 - Pollutants in stormwater
 - Where it goes
 - Transfer rate (to reef)




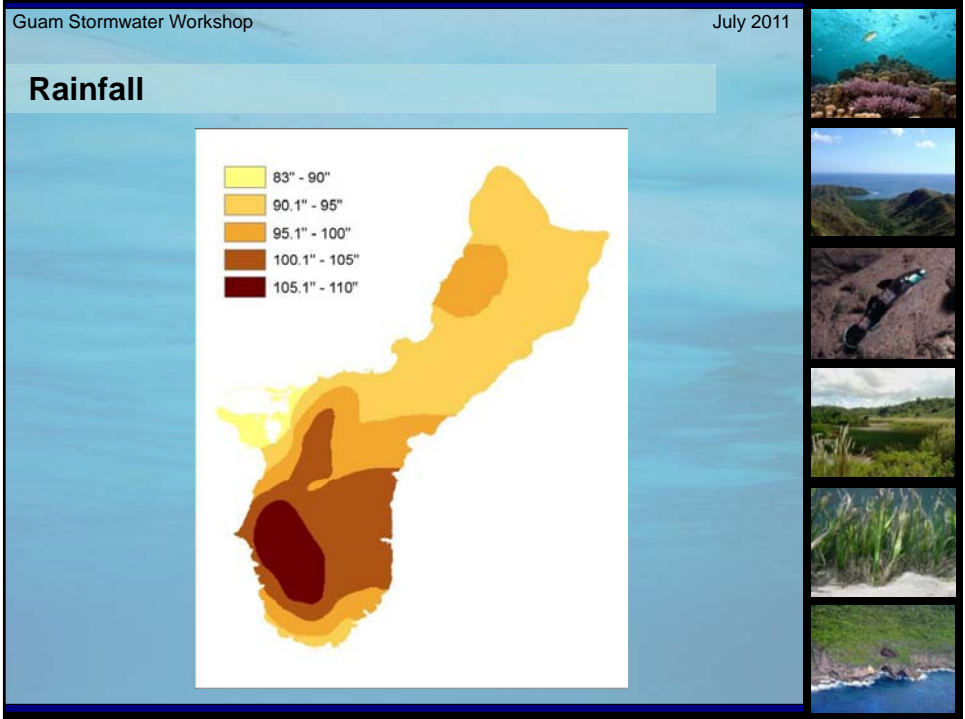
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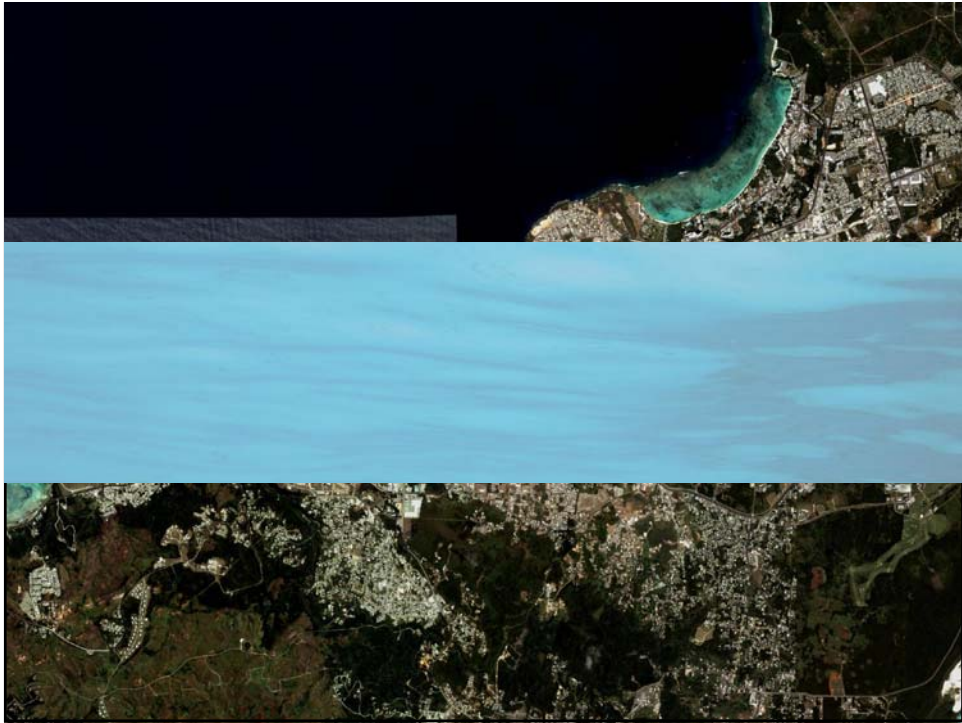
Where does the water go?

Northern Watersheds and Stormwater

- Scenarios 2.5: East Agana Drainage
 - Resources affected
 - Reefs
 - Nutrients – algal growth, bacteria (human health and coral disease)
 - Pollutants (including freshwater)
 - Sediment








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Where does the water go?

Northern Watersheds and Stormwater

- **Scenario 3: Effective stormwater management**
 - **Fate of water in areas with mixed vegetation/impervious surfaces and effective SW controls**
 - Use of vegetation to mitigate impacts (e.g., vegetated drainages)
 - Oil/pollutant catch systems
 - Systems to reduce water speed (e.g, baffling systems)
 - Phased building (and not leaving site in mid-phase)




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Where does the water go?

Northern Watersheds and Stormwater




- **Scenario 3: Effective stormwater management**
 - **Benefits to resources**
 - Slows water flow
 - Reduces nutrients/pollutants
 - Decreases turbidity




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Southern Guam Aquatic Resources

- Drinking water
- Wetlands/Mangroves
- Cave systems
- Rivers
- Nearshore coral reef ecosystem








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Where does the water go?

Southern Watersheds and Stormwater

- Differences from Northern Guam/aquifer
 - Surface water runoff (little infiltration)
 - Steep slopes
 - Highly erodible soils
- 3 scenarios:
 - Natural system - vegetated land
 - Worst-case scenario – Agat-Umatac road
 - Effective stormwater management in area with impervious surfaces mixed with vegetation




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Where does the water go?

Southern Watersheds and Stormwater

- Scenario 1: Natural system
 - Forested (as opposed to extensive savannah, “badlands”)
 - Resources affected
 - Streams
 - Nearshore reefs




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Where does the water go?

Southern Watersheds and Stormwater

- **Scenario 1.5: More realistic “Natural” system**
 - Forest, savannah, “badlands”
 - **Resources affected**
 - **Streams**
 - Sediment, nutrients, organic matter
 - **Nearshore reefs**
 - Sediment, nutrients, organic matter






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Where does the water go?

Southern Watersheds and Stormwater

- **Scenario 2: Agat-Umatac Road**
 - Prior to road project --- Cetti Bay, other reef areas more “pristine”
 - Lack of stormwater controls resulted in large-scale sedimentation of large stretch of reef



Where does the water go?

Southern Watersheds and Stormwater

- Scenario 2: Agat-Umatac Road
 - Continued stormwater impacts
 - Streams
 - Increased stream flow
 - Increased velocity
 - Streambank erosion
 - Loss of habitat (fish, snails, shrimp)
 - Reefs
 - Increased sedimentation
 - Increased pollutants



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Where does the water go?

Southern Watersheds and Stormwater

- **Scenario 3: Towards balance**
 - Appropriate SW management for areas with mixed vegetation/impervious surface cover

Design:

- Vegetation
- Sedimentation ponds
- Natural streambank stabilization



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Where does the water go?

Southern Watersheds and Stormwater

- **Scenario 3: Towards balance**

During construction:

 - Proper use of sediment controls
 - Silt curtains
 - Fiber mats and borders
 - Vegetation



It's ultimately about the people of Guam...



<http://www.more4kids.info/347/toddlers-and-water/>



Photo courtesy of Guam DAWR

