CLIMATE CHANGE IMPACTS ON THE HYDROLOGY OF A TROPICAL DRAINAGE BASIN

Work in Progress

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AGENDA

1. INTRODUCTION

2. METODOLOGY

3. HYDROLOGIC NUMERIC MODEL

4. MODEL CONCEPTUALIZATION

5. FUTURE WORK

INTRODUCTION

- General Circulation Models (GCMs) reveal an increasing potential for climate change during the next 50 years

- Impacts in regional water resources are expected as the result of the climate change (Shelton and Fridirici, 2001)

- Little information is available on the relative importance of the various components of the hydrologic cycle under different climate change scenarios in the tropical regions.

- Puerto Rico → Water related problems are reported every year
  - Water supply
  - Surface and groundwater pollution
  - Reservoir sedimentation

- Expected response of the hydrology to climate change conditions

- This study will be a first attempt to carry out:
  - Gross preliminary regional estimation of the water budget for a tropical watershed (located in Puerto Rico)
  - Using a numerical, physically-based, integrated hydrologic model
  - Evaluate the potential effect of climate change on the components of the hydrologic cycle.

SIMILAR STUDIES

- Said et al. (2005) used an integrated hydrologic surface and groundwater model (FHM) to estimate the annual total water budget in the Big Lost River Basin in Idaho (3,730 km2).

- Integrated hydrologic modeling study applying Mike She coupled with the Mike 11 (Thompson et al., 2004) reproduced the highly seasonal nature of both ground water and ditch water level in a lowland wet grassland in England.

- Integrated hydrological modeling for the Sjaelland Island (7330 km2) in Denmark. Could be used to investigate the impact of climate changes on water resources availability (Henriksen et al., 2003).

SIMILAR STUDIES (cont.)

- Bouraoui et al. (1999) used ANSWERS (Bouraoui et al. 1997) to predict possible impacts of CO_2 doubling on ground water resources for an agricultural catchment in France.
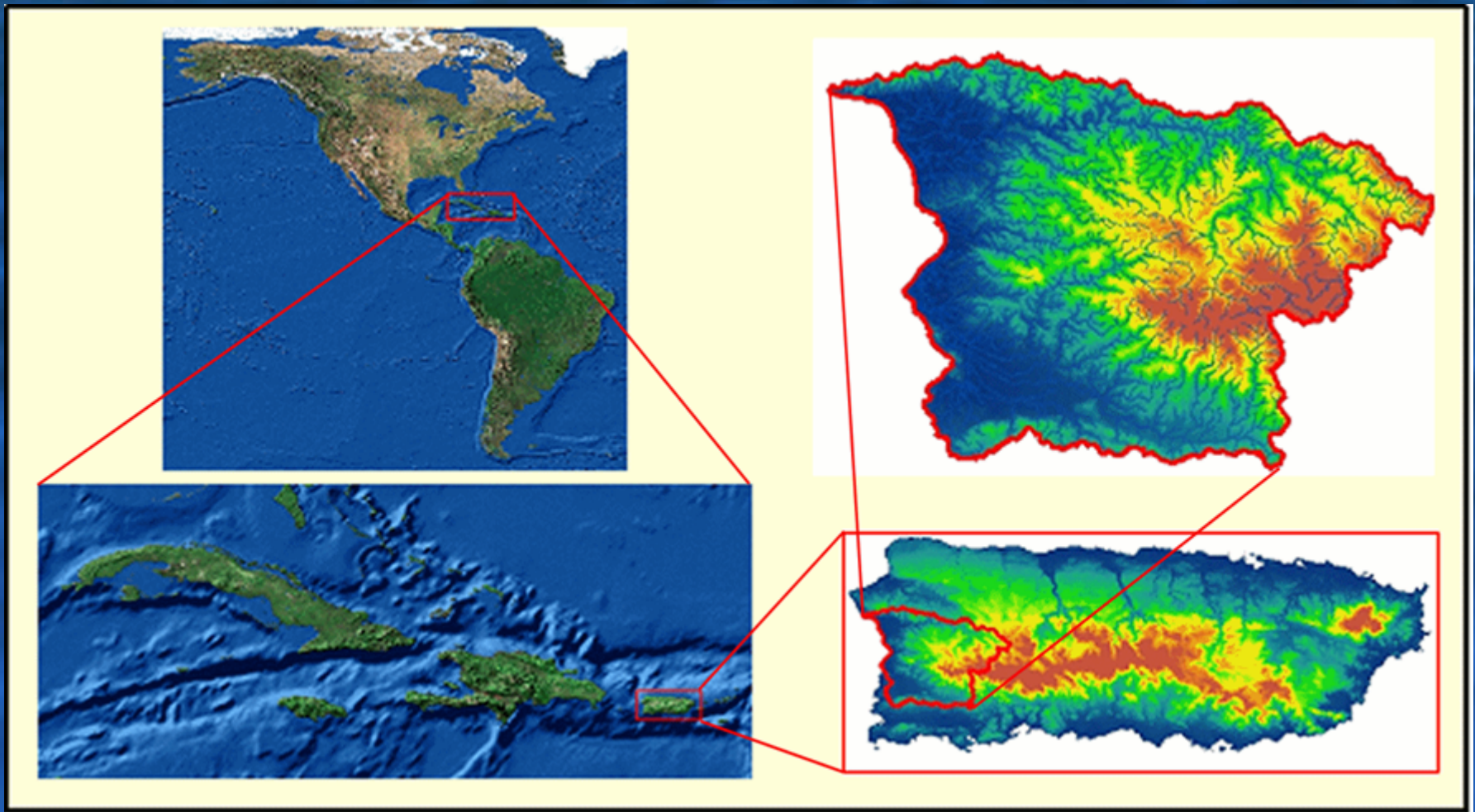
STUDY AREA

- Tropical Watershed   819 Km^2

- Wide diversity physical and hydrological features (e.g., geology, topography, climate, and land use)

STUDY AREA (cont.)

- Data gathering
    - Topography
    - Soils
    - Land use
    - Hydrogeology

    - Climate data
    - Mean daily flow rate
      at river stations
    - Well water level data

- Model Conceptualization
    - Translating the entire physical system into one that can be modeled numerically

- Calibration
    - Mean daily flow rate
    - Regional trends of well water level

- Simulation
    - Climate change conditions

- MIKE SHE

  – Physically-based, spatially-distributed, integrated surface water and groundwater model.

  – MIKE SHE coupled with MIKE 11 is capable of modeling the main processes in the land phase of the hydrological cycle
    - Interception
    - Evapotranspiration
    - River / Open channel flow
    - Overland flow
    - Unsaturated soil flow
    - Groundwater flow

- Graphic user interface (GUI) with comprehensive pre- and post-processing capabilities, and GIS compatible.

- GIS developed for the study area
  - Geographic information compiled from different sources
  - Layers resulting from the analysis
  - Inputs of the numeric model

- Topography
  - Elevation data for Puerto Rico from the USGS National Elevation Data (NED)
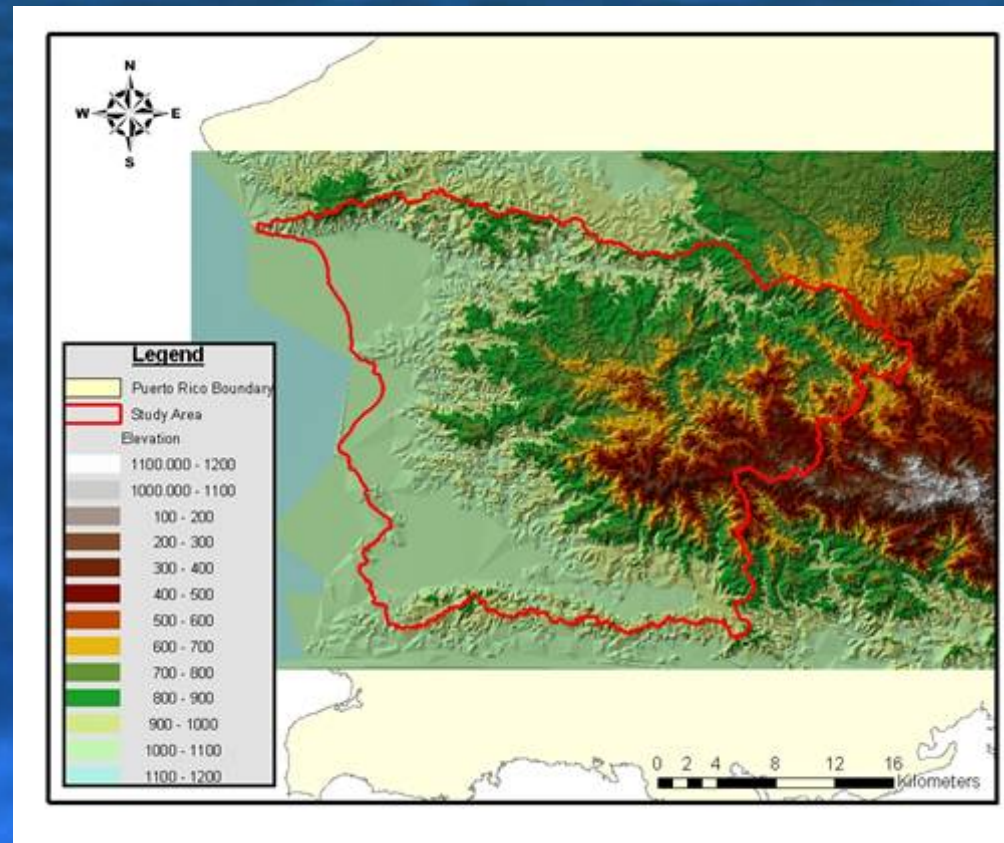
Topography of the study area

Aquifer system

- Hydrogeology related studies

- Geohydrologic and lithological well data

- USGS GIS Information

- Surface to the bottom of the relative impermeable bedrock

- Geological units

Legend

	Puerto Rico Boundary
	Study Area

Aquifer name

	Alluvial-valley aquifer
	Coastal embayments aquifers
	Confining unit
	Kingshill aquifer
	North Coast Limestone aquifer system lower aquifer
	North Coast Limestone aquifer system upper aquifer
	South coast aquifer
	Volcaniclastic-, igneous-, and sedimentary-rock aquifers
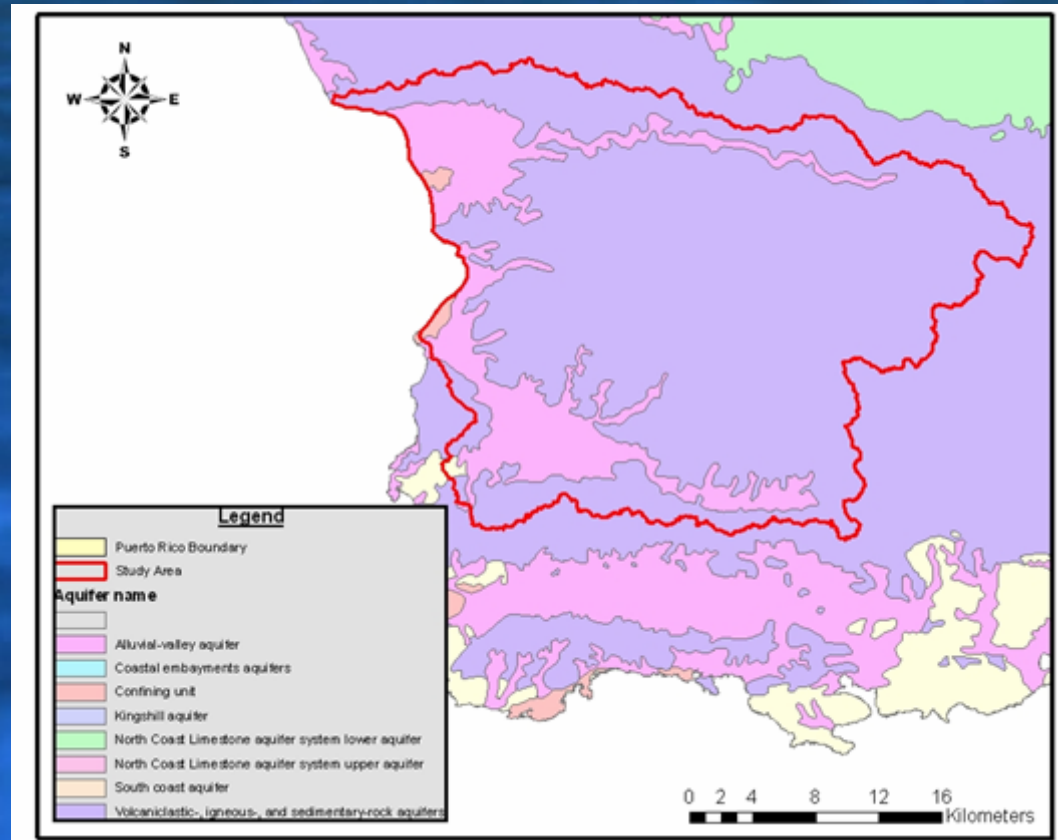
Geographic distribution of the aquifers in Puerto Rico and Virgin islands. (Source: Renken et al., 2002)

Aquifer system (cont.)

- Literature reported information of depth to the relatively impermeable bedrock (Colón-Dieppa and Quiñones-Márquez, 1985)

- Literature reported seismic profiles data (Díaz and Jordan, 1987)

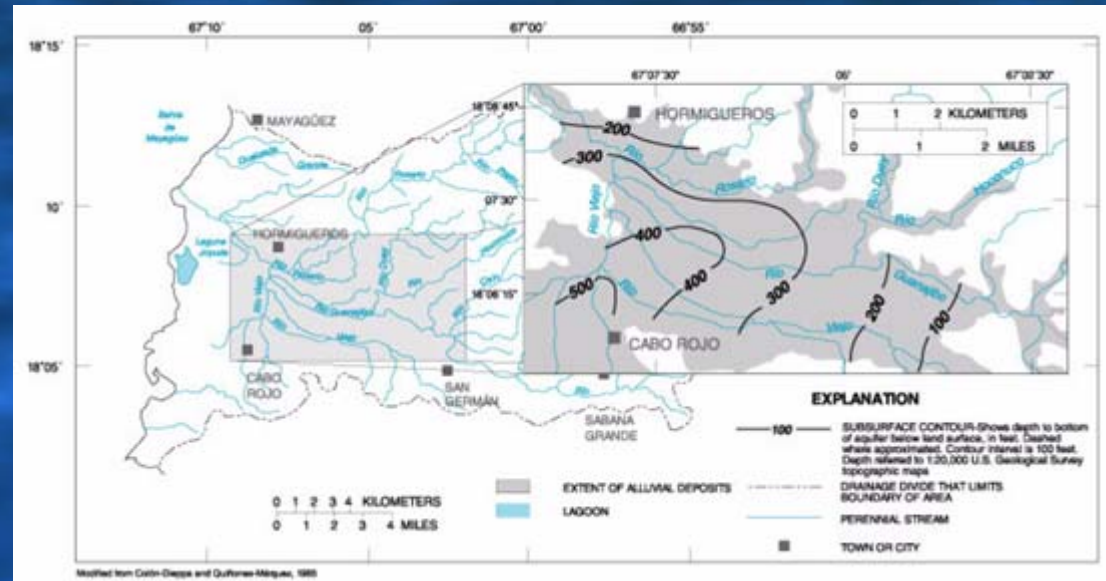- Lithologic well data (Driller company)
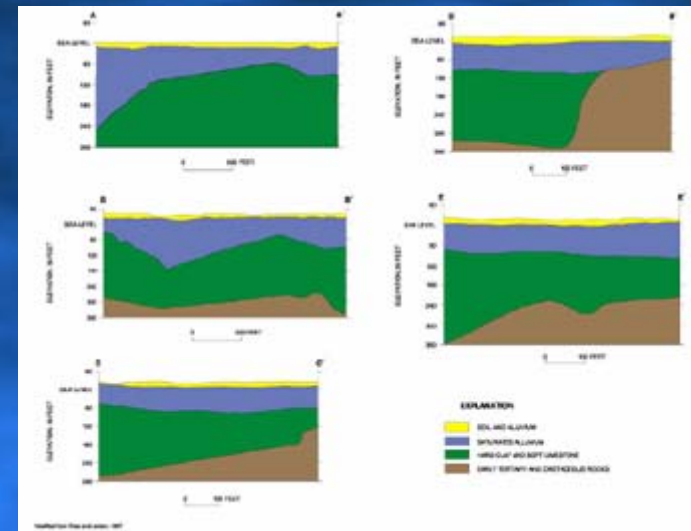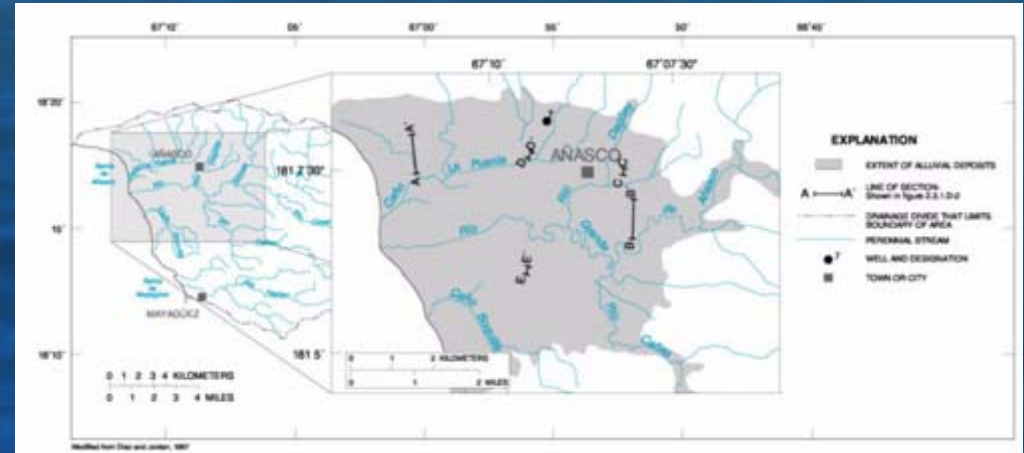
Seismic profiles information. (Source: Veve and Taggart, 1996)

Aquifer system (cont.)

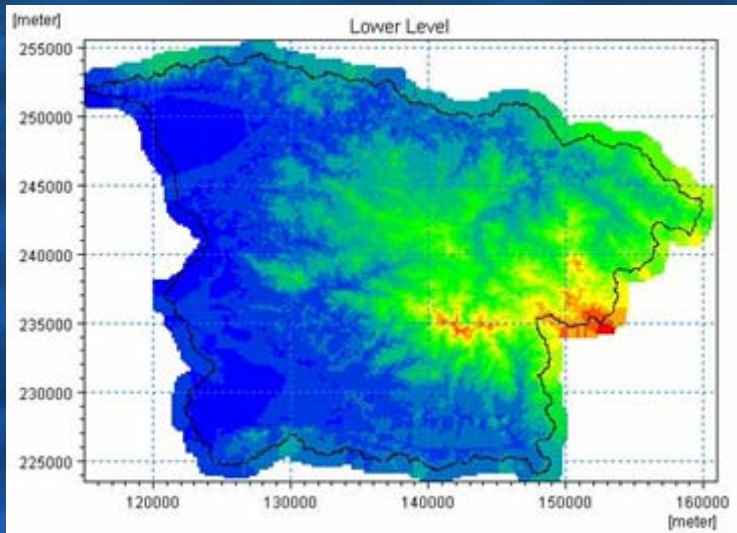- Geohydrologic data of wells located in the area provided by the USGS Caribbean Water Science

- Land topography

Approximate depth to the relatively impermeable bedrock in the central Guanajibo valley. (Source: Veve and Taggart, 1996).

Aquifer system (cont.)

Surface to the bottom of the relative impermeable bedrock (conceptualization)

Spatial distribution of the geologic units (conceptualization)

Legend
- Puerto Rico Boundary
- Study Area
- Alluvial-Upper valley aquifer
- Añasco Alluvial-Lower valley aquifer
- Guanajibo Alluvial-Central and lower valley aquifer
- Volcaniclastic-, igneous-, and sedimentary-rock aquifer
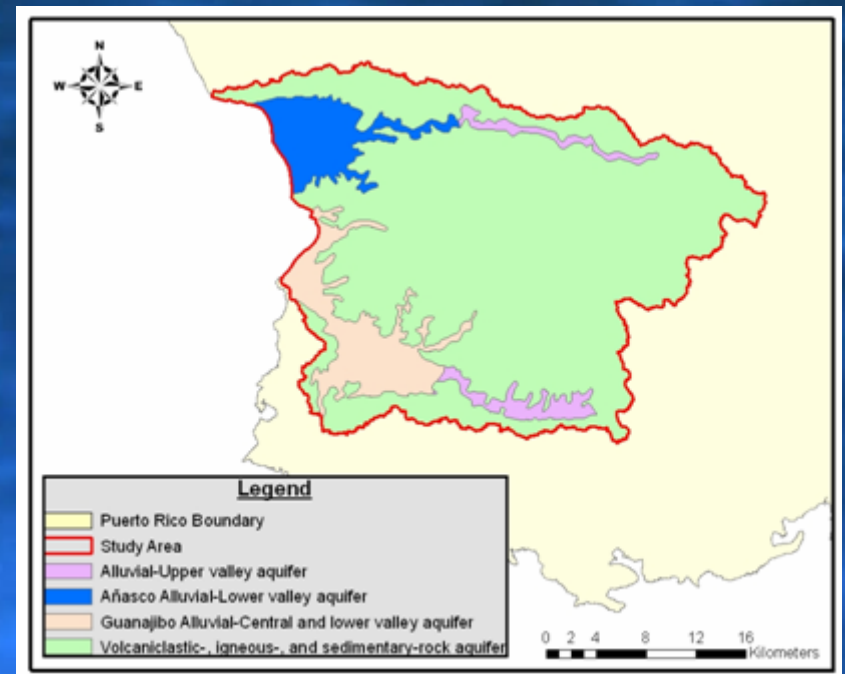
Vadose zone

- Soils present in the study area were reclassified → (6) categories according with their texture
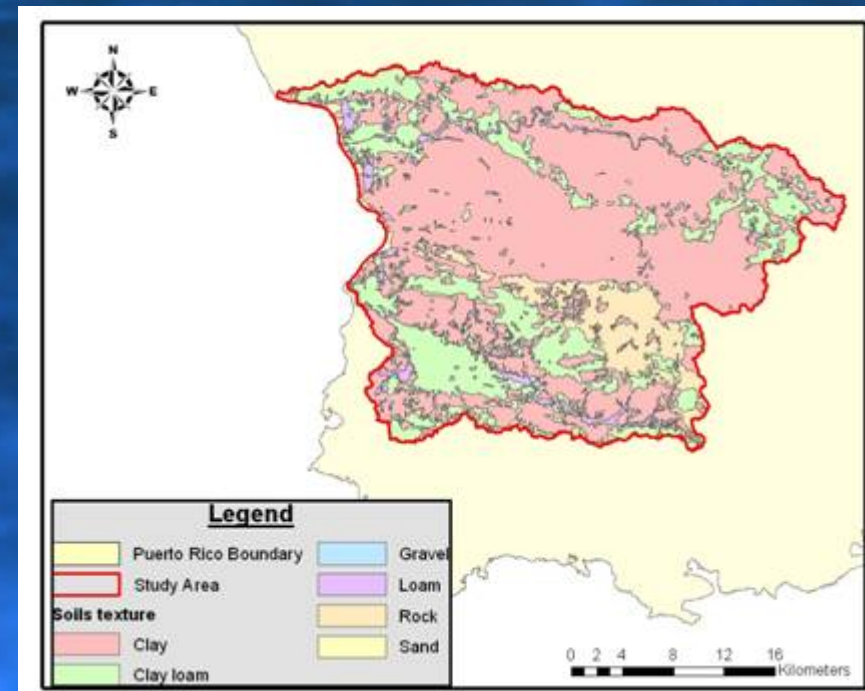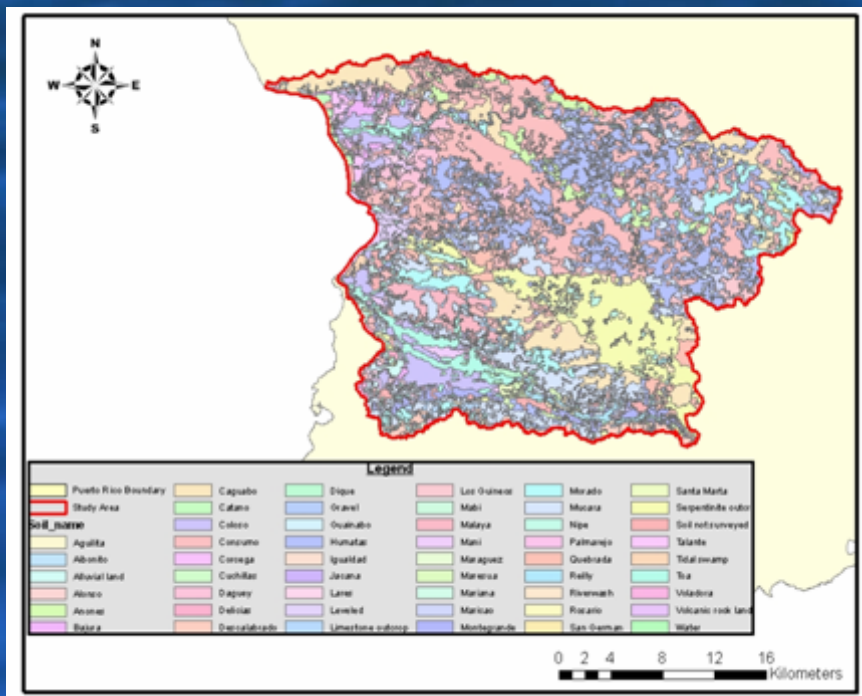
Soils present in the study area (Source: Soil Survey Geographic (SSURGO) NRCS)
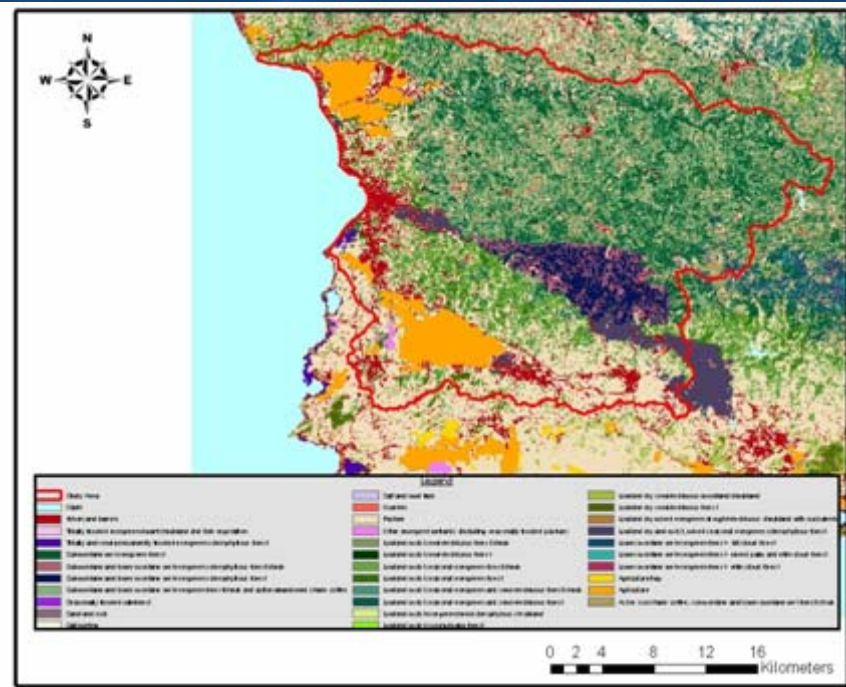
Reclassification of soils (Texture)

Overlandflow

- Map of the forest type and land cover developed from a supervised classification approach using Lansat TM imagery (Helmer et al, 2002)
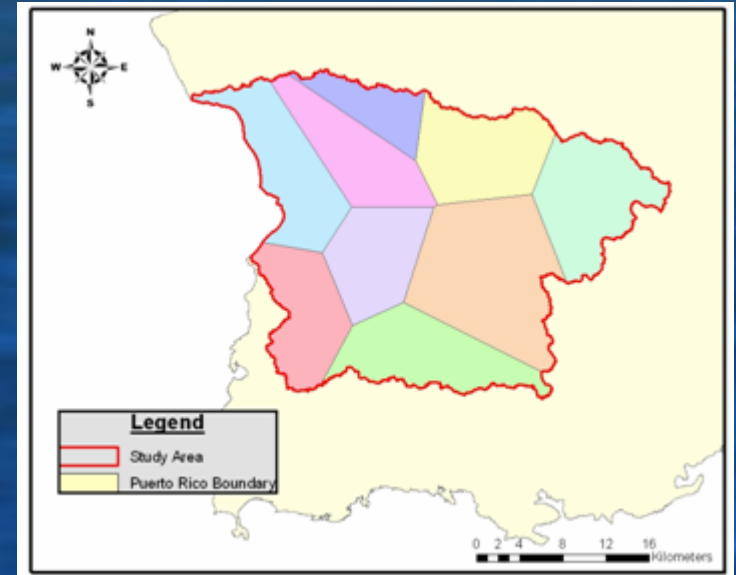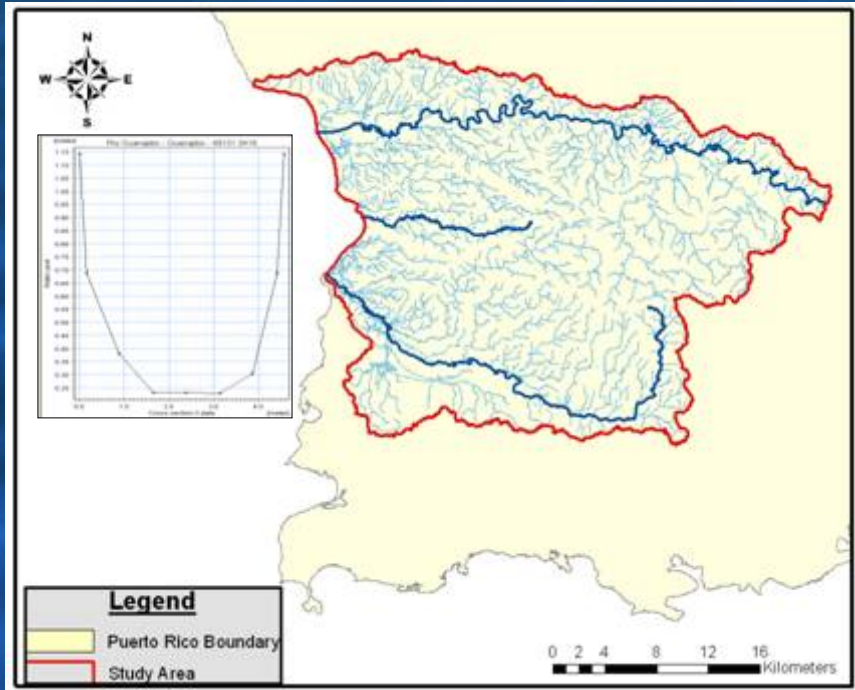

Forest type and land cover (Source: USDA)

Reclassification of land cover
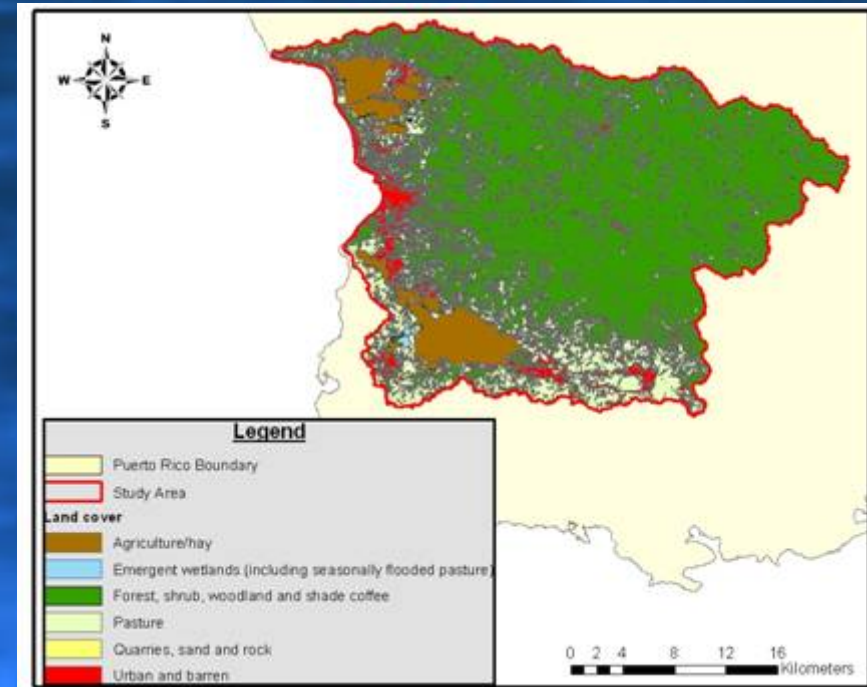
- Land cover classes were reclassified → 6 categories
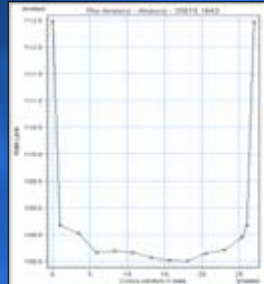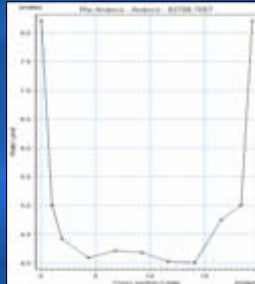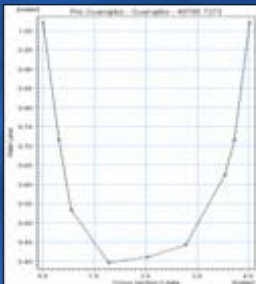
River Network

Thiessen polygons for the study area

Precipitation

- Rainfall data was obtained from the USGS stations located in the in the study area.

- Calibration
  - Surface water
    - Mean daily flow rate data from two USGS stations will be compared with modeled values.
  - Groundwater
    - Available historic ground water level data reported at wells
    - Regional trends of well water level

- Simulation
  - The impact in the water budget will be evaluated under Climate change conditions.

Questions ??