Santee Experimental Forest Watersheds Metadata Report (SNT)

Charleston, South Carolina

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Research Area Information

Santee Experimental Forest Watersheds

Research Area Information

Harvest URL -Option 2

http://www.srs.fs.usda.gov/charleston/data/santee_hydrodb.csv

Site URL

http://www.srs.fs.usda.gov/charleston/santee.html

Site north bounding coordinate (decimal degree) N-33.14999, W-79.77688

Site west bounding coordinate (decimal degree) N-33.13837, W-79.76318

Site south bounding coordinate (decimal degree) N-33.13837, W-79.77076

Site east bounding coordinate (decimal degree) N-33.13788, W-79.78143

Site Climate URL

http://www.srs.fs.fed.us/charleston/hydrology.html

Site Watershed URL

http://www.srs.fs.fed.us/charleston

Experimental Design

Many different experiments have been conducted on the Santee Experimental forest since measurements began in 1946, the most notable research on the study site involved prescribed fire, pine siliviculture, nutrient cycling and water quality. During 1976, stream gauges were installed at the outflow of the paired watersheds under the direction of C. Ennis Young and were used to evaluate the effects of prescribed fires on stream water quality and nutrient cycling. The treatment watershed was divided into 20 pine management compartments, each 7.1 ha, with 20 m wide buffer strips left bordering the stream channels. During the winters of 1976-77, 1977-78, and 1978-79, a total of 12 compartments were burned, four each year. Three summer burns were also conducted during 1976-77. Stream nutrient outputs from the treatment and control watershed were compared before and after prescribed burning. The nutrient outputs from the treatment watershed reflected the response of an operational forest, and illustrated that periodic prescribed fires in the southeaster coastal plain pine forests are not likely to have an appreciable effect on the quality of ground or stream waters. On September 22, 1989, the eye of Hurricane Hugo passed through the Francis Marion National Forest and the forest was badly damaged by the hurricane. Subsequently, the treatment watershed (#77), but not the control watershed (#80), was salvage logged (Personal Communication, William Harms, Research Forester, Southern Research Station). Water Samples were collected immediately after the hurricane and have been collected regularly since. The watershed gauges, which had been deactivated in 1981, were reactivated in January 1990 (Bill Harms, Personal Communication). In 1964, water level monitoring wells were placed in Watershed #77. The measurement of these wells

stopped in 1971. In 1992, a new set of wells was placed in both watersheds. When these wells were installed, a soil particle size analysis was run at the well sites. These wells were manually measured until 1996. In 1996, the manual measurements were replaced with electronic measurements by placing continuously recoding well monitors on three of the wells, and creating prediction equations for the rest of the wells using the 1992-1995 data. Manual weather measurements (rain and temperature) started at the Santee Headquarters in 1946 and today there are four weather measuring devices on the experimental forest. Three stations measure rain and temperature: the Lottie Road station started taking measurements in 1971, the rain gauge on Watershed #77 started taking rain measurements in 1963 and temperature measurements in 1996, and the rain gauge on Watershed # 80 started taking rain measurements in 1990 and temperature measurements in 1996. An electronically recording weather station was erected at the Santee Headquarters in 1996, and currently measures temperature, rainfall, wind speed, and solar radiation. During the fall of 1994, as a part of a larger study on the recovery of the forest from Hurricane Hugo by Chuck Gresham et. al. (1994), permanent plots were located on Watershed #80. On each plot, they conducted an inventory of trees, advanced regeneration, coarse woody debris (standing and down) and canopy density and frequency. In addition, wells to monitor the depth of the water table were installed in each plot. One of the preliminary conclusions from these studies was that the regeneration forest was not of the species composition of the pre-hurricane community, and that the large amount of coarse woody debris is releasing large amounts of carbon and nutrients to the ecosystems (Gresham et al. 1994). In 1998, a long term study of vegetation dynamics was initiated in the watersheds (Burke 1998). Four 0.1 ha plots were located in each of the watersheds, and the ecological importance of herbaceous and woody vegetation (density, cover or basal area, species diversity) and dimensions of trees (diameter, breast height, and height) were measured (Bailey, in prep).

Publications

List of Publications and references used in this study: Amatya, D.M., G. Sun, C.C. Trettin, and R.W. Skaggs. 2003a. Long-term Forest Hydrologic Monitoring in Coastal Carolinas. In Proc. Renard, Kenneth G., McElroy, Stephen A., Gburek, William J., Canfield, H. Evan and Scott, Russell L., eds., First Interagency Conference on Research in the Watersheds, October 27-30, 2003. U.S. Department of Agriculture, Agricultural Research Service, pp:279-285. Lotti, T. 1958. A special fire plan for the Santee Experimental Forest. Amatya, D.M., G. Sun, R.W. Skaggs, and C.C. Trettin. 2003b. Testing of DRAINMOD for Forested Watersheds with Non-Pattern Drainage. ASAE Meeting Paper # 032046, St. Joseph, MI. Binstock, D.A. 1978. Effects of a prescribed winter burn on anion nutrient budgets in the Santee Experimental Forest watershed ecosystem. Ph.D. Dissertation. Duke University, Durham, NC. 184pp. Harms, W.R., D.D. Richter and C.W. Ralston. 1982. Prescribed Fire: Effects on Water Quality and Forest Nutrient Cycling. Science (215):661-663. Miwa, M., D.L. Gartner, C.S. Bunton, R. Humphreys, and C.C. Trettin. 2003. Characterization of Headwater Stream Hydrology in the Southeastern Lower Coastal Plain. Project Report to US EPA, USDA Forest Service, Charleston, SC. Richter, D.D., C.W. Ralston and W.R. Harms. 1983. Chemical composition and spatial variation of bulk precipitation at a coastal plain watershed in South Carolina. Water Resources

Research. 19:134-140. Richter, D. deBaucherville. 1980. Prescribed fire: Effects on water quality and nutrient cycling in forested watersheds of the Santee Experimental Forest in South Carolina. Dissertation. Duke University, Durham, NC. 194 pp. Romancier, R.M. and W.P. LeGrande. 1962. Glaze damage on the Santee Experimental Forest. Southern Lumberman. Dec. Sun, G., J. Lu, D. Gartner, M. Miwa, and C.C. Trettin. 2000b. Water Budgets of Two Forested Watersheds in South Carolina. In: Proc. Of the Spring Spec. Conf., Amer. Wat. Res. Assoc., 2000. Young, C.E. and R.A. Klawitter. 1968. Hydrology Of Wetland Forest Watersheds. pp. 29-38. USDA Forest Service Report No. 4. Southeastern Forest Experiment Station, Ashville, NC. Young, C, E., Jr. 1967. Streamflow - An important factor in forest management in the coastal plain. South. Lumberman Christmas Issue. 215(2680):109-110. Young, C.E. 1966. Water balance on a forested watershed in the flatwoods. Annual Southeast Section Meeting of the American Society of Agricultural Engineers, Jackson, Miss. Feb. 7-9, 1966.

USGS Harvest URL

http://gce-lter.marsci.uga.edu/harvest/usgs/snt_lter.txt

Meteorlogical Stations

Santee Meteorologic Station

Meteorological Station

Photo URL

http://www.srs.fs.fed.us/charleston/hydrology.html

Lottie Road

Meteorological Station

Latitude (decimal degrees) N-33.14707
Longitude (decimal degrees) W-79.78971
Elevation (meters; a.m.s.l.) ..... 8.5 m above mean sea level
Exposure (degrees) ..... 45 degrees
Wind Exposure (degrees azimuth) ..... 45 degrees
Begin Date 02/13/1964

Topography

very shallow slope (less than 2%) leading to 1st order stream for watershed 77

Surface

grass

Area Description

50 meters of open grassy field leading into pine forest.

History

Rainfall measurement was begun on 02/13/1964. Temperature measurement was begun on 09/09/1971. There is a Temperature data gap from 02/04/1973 to 05/24/1973. There is a Rainfall data gap from 10/31/1969 to 11/23/1971. During the early years (pre 1966), the weather station data was manually recorded. The rain gauge was usually read only after rain had fallen. However, if rain fell on a week-end, the rain gauge was not read until the next work week. This site uses an Onset/ Hobo temp gauge and an Onset/Hobo tipping rain gauge

Photo URL

http://www.srs.fs.fed.us/charleston/hydrology.html

Air Temperature

Begin Date..... 02/13/1964
End Date..... Present
Data Logger Sampling Interval..... 15 min
Summary Interval .....Daily
Data Accuracy (degree celsius) .....Accuracy +/- 0.25
Instrument Height (meters) 1.5m
Instrumentation Description

Each HOBO H8 logger has an internal temperature sensor on a 4 inch wire which is mounted on the circuit board inside the snap lid case. Typically, the sensor is left inside the case and measures ambient air temperature over the operating range of the logger with a time constant of about 15 minutes in still air. The internal sensor can be placed outside the case when a shorter time constant is needed (less than 1 minute in air and about 2 seconds in water).

Methods Description

Data is downloaded every 1-2 months to a laptop using the Boxcar Pro 4.0 program. The data is brought to Charleston and reconfigured into an Excel spreadsheet by Jim Weeg. A log is kept for each time the data is downloaded.

Sensor History

06/27/01 equipment switched from Omnidata 800 to Onset/HOBO Rain Gauge

Calibration History

Equipment calibrated at installation (06/27/01). Recalibration recommended annually

Minimum QC Threshold (degree celsius) .....-20 degrees
Maximum QC Threshold (degree celsius) .....70 degrees

Precipitation

Begin Date..... 02/13/1964
End Date..... present
Data Logger Sampling Interval..... 15 min
Summary Interval .....Daily
Data Accuracy (millimeters) .....accuracy - 4%
Instrument Height (meters) .....0.5 m
Instrumentation Description

The Onset Data Logging Rain Gauge consists of two major components, a tipping bucket type rainfall collector and a HOBO Event data logger. The collector consists of a black anodized aluminum collector ring with a knife-edge and a funnel that diverts the water to a tipping-bucket mechanism. The mechanism is designed such that one tip of the bucket occurs for each 0.01 inch or 0.25 mm of rainfall. Bucket tips are detected when a magnet attached to the tipping bucket actuates a magnetic switch as the bucket tips, thus affecting a momentary switch closure for each tip of

the bucket. The spent water drains out of the bottom of the housing. The switch is connected to a HOBO Event data logger which records the time of each tip. The aluminum housing is coated with a white baked enamel surface to withstand years of exposure to the environment.

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Sensor History

06/27/01 equipment switched from Omnidata 800 to Onset/HOBO Rain Guage.

Calibration History

Equipment calibrated at installation (06/27/01). Recalibration recommended annually.

Minimum QC Threshold (millimeters) .....0.25 mm

Maximum QC Threshold (millimeters) ..... unlimited

Meteorologic Station #5

Meteorological Station

Latitude (decimal degrees) N-33.14162

Longitude (decimal degrees) W-7978836

Elevation (meters; a.m.s.l.) .....4.4 m above mean sea level

Exposure (degrees) .....25 degrees

Wind Exposure (degrees azimuth) .....35 degrees

Begin Date..... 12/13/1963

Topography

High ground of the drainage basin for the 1st order stream

Surface

grass

Area Description

Met station is located in a flat grassy field that leads into primarily pine forest 100m away from the met station.

History

Data was collected at a weekly interval from 12/13/1963 until 10/19/1966. There is a data gap from 10/19/1966 until 11/15/1989. During the early years (pre 1966), the weather station data was manually recorded. The rain gauge was usually read only after rain had fallen. However, if rain fell on a weekend, the rain gauge was not read

until the next work week. This site uses an Onset/Hobo temp gauge and an Onset/ Hobo tipping rain gauge.

Photo URL

http://www.srs.fs.fed.us/charleston/hydrology.html

Air Temperature

Begin Date..... 12/13/1963

Data Logger Sampling Interval..... 15 min

Summary Interval ..... daily

Data Accuracy (degree celsius) ..... +/- 0.25

Instrument Height (meters) 1.5m

Instrumentation Description

Each HOBO H8 logger has an internal temperature sensor on a 4 inch wire which is mounted on the circuit board inside the snap lid case. Typically, the sensor is left inside the case and measures ambient air temperature over the operating range of the logger with a time constant of about 15 minutes in still air. The internal sensor can be placed outside the case when a shorter time constant is needed (less than 1 minute in air and about 2 seconds in water).

Methods Description

Data is downloaded every 1-2 months to a laptop using the Boxcar Pro 4.0 program. The data is brought to Charleston and reconfigured into an Excel spreadsheet by Jim Weeg. A log is kept for each time the data is downloaded.

Sensor History

06/27/01 equipment switched from Omnidata 800 to Onset/HOBO Rain Guage.

Calibration History

Equipment calibrated at installation (06/27/01). Recalibration recommended annually.

Minimum QC Threshold (degree celsius) .....-20 degrees

Maximum QC Threshold (degree celsius) .....70 degrees

Precipitation

Begin Date..... 12/13/1963

End Date..... present

Data Logger Sampling Interval..... 15 minutes

Summary Interval ..... daily

Data Accuracy (millimeters) accuracy-4%

Instrument Height (meters) 0.25m

Instrumentation Description

The Onset Data Logging Rain Gauge consists of two major components, a tipping bucket type rainfall collector and a HOBO Event data logger. The collector consists of a black anodized aluminum collector ring with a knife-edge and a funnel that diverts the water to a tipping-bucket mechanism. The mechanism is designed such that one tip of the bucket occurs for each 0.01 inch or 0.25 mm of rainfall. Bucket tips are detected when a magnet attached to the tipping bucket actuates a magnetic switch as the bucket tips, thus affecting a momentary switch closure for each tip of the bucket. The spent water drains out of the bottom of the housing. The switch is connected to a HOBO Event data logger which records the time of each tip. The aluminum housing is coated with a white baked enamel surface to withstand years of exposure to the environment.

Methods Description

Data is downloaded every 1-2 months to a laptop using the Boxcar Pro 4.0 program. The data is brought to Charleston and reconfigured into an Excel spreadsheet by Jim Weeg. A log is kept for each time the data is downloaded

Sensor History

06/27/01 equipment switched from Omnidata 800 to Onset/HOBO Rain Guage.

Calibration History

Equipment calibrated at installation (06/27/01). Recalibration recommended annually.

Minimum QC Threshold (millimeters) 0.25

Maximum QC Threshold (millimeters) ..... unlimited

Meteorologic Station #25

Meteorological Station

Latitude (decimal degrees) N-33.13598

Longitude (decimal degrees) W-79.77910

Elevation (meters; a.m.s.l.) .....8.8 m above mean sea level

Exposure (degrees) .....36 degrees

Wind Exposure (degrees azimuth) .....24 degrees

Begin Date..... 03/23/1990

Topography

Level area on high ground above 1st order stream for the watershed.

Surface

Grass

Area Description

Met station is located in a flat grassy field that leads into primarily pine forest 100m

away from the met station.

History

Rainfall measurements were begun on 03/23/1990. Temperature measurements were begun on 02/09/1996. This site uses an Onset/Hobo temp gauge and an Onset/Hobo tipping rain gauge.

Photo URL

http://www.srs.fs.fed.us/charleston/hydrology.html

Air Temperature

Begin Date..... 03/23/1990

End Date..... Present

Data Logger Sampling Interval..... 15 min

Summary Interval .....Daily

Data Accuracy (degree celsius) .....Accuracy +/- 0.25

Instrument Height (meters) .....1.5m above ground

Instrumentation Description

Each HOBO H8 logger has an internal temperature sensor on a 4 inch wire which is mounted on the circuit board inside the snap lid case. Typically, the sensor is left inside the case and measures ambient air temperature over the operating range of the logger with a time constant of about 15 minutes in still air. The internal sensor can be placed outside the case when a shorter time constant is needed (less than 1 minute in air and about 2 seconds in water).

Methods Description

Data is downloaded every 1-2 months to a laptop using the Boxcar Pro 4.0 program. The data is brought to Charleston and reconfigured into an Excel spreadsheet by Jim Weeg. A log is kept for each time the data is downloaded.

Sensor History

Equipment calibrated at installation (06/27/01). Recalibration recommended annually

Calibration History

Equipment calibrated at installation (06/27/01). Recalibration recommended annually.

Minimum QC Threshold (degree celsius) .....-20 degrees

Maximum QC Threshold (degree celsius) .....70 degrees

Precipitation

Begin Date..... 03/23/1990

End Date..... present

Data Logger Sampling Interval..... 15 min

Summary Interval .....Daily

Data Accuracy (millimeters) accuracy-4%

Instrument Height (meters) 0.5m

Instrumentation Description

The Onset Data Logging Rain Gauge consists of two major components, a tipping bucket type rainfall collector and a HOBO Event data logger. The collector consists of a black anodized aluminum collector ring with a knife-edge and a funnel that diverts the water to a tipping-bucket mechanism. The mechanism is designed such that one tip of the bucket occurs for each 0.01 inch or 0.25 mm of rainfall. Bucket tips are detected when a magnet attached to the tipping bucket actuates a magnetic switch as the bucket tips, thus affecting a momentary switch closure for each tip of the bucket. The spent water drains out of the bottom of the housing. The switch is connected to a HOBO Event data logger which records the time of each tip. The aluminum housing is coated with a white baked enamel surface to withstand years of exposure to the environment.

Methods Description

Data is downloaded every 1-2 months to a laptop using the Boxcar Pro 4.0 program. The data is brought to Charleston and reconfigured into an Excel spreadsheet by Jim Weeg. A log is kept for each time the data is downloaded

Sensor History

06/27/01 equipment switched from Omnidata 800 to Onset/HOBO Rain Guage.

Calibration History

Equipment calibrated at installation (06/27/01). Recalibration recommended annually.

Minimum QC Threshold (millimeters) .....0.25 mm

Maximum QC Threshold (millimeters) ..... unlimited

Watershed

Treatment Watershed

Watershed Spatial Characteristics

North bounding coordinate (decimal degrees) N-33.14999,W-79.7768
West bounding coordinate (decimal degrees) N-33.13837, W-79.76318
South bounding coordinate (decimal degrees) N-33.13286, W-79.77076
East bounding coordinate (decimal degrees) N-33.13788, W-79.78143
Area (hectares) .....160 ha
Aspect (degrees azmuth) ..... Southern half-45° , Northern half-225°.
Minimum watershed elevation (meters; a.m.s.l) . 0 m AMSL (Above Mean Sea Level)
Maximum watershed elevation (meters; a.m.s.l) .....10.5 m AMSL

Watershed Ecological Characteristics

Mean annual precipitation (millimeters) .....1350 mm (measured since 1963)
Slope (Percent) 3%
Slope description

The slope for both watersheds is less than 3%. (topographic map)

Channel length (meters) .....1260 m
Channel length description

Perennial. Because the maximum elevation of the channel is less than 10 m above sea level, it is doubtful that the hydraulic head can move much water as seepage flow through the clay-rich soil.

Drainage density (km/km2) .....1.260 km/1.6km2=0.7875 km/km2
Mean snowpack description

0 m

Watershed Descriptions

Pre-treatment vegetation

The forest is composed primarily of loblolly and longleaf pine with components of mixed hardwoods. The riparian zone consists predominantly of bottomland hardwoods. The over story on the watersheds was destroyed in 1989 because of hurricane Hugo: as a result, the current treatments on the paired first order watersheds consist of salvage vs. non salvage logging. The watersheds are also currently managed for red cockaded woodpecker habitat, which requires frequent prescribed fires.

Pre-treatment description

Stocking density is 6290 stems/ha (sampling area is 629 stems/.1 ha), the forest is composed primarily of loblolly and longleaf pine with components of mixed hardwoods. The riparian zone consists predominantly of bottomland hardwoods.

Soil description

WS-77 is made up of the following soil series: Goldsboro, Lynchburg, Rains, and Meggett. All of these are located in Berkely County, South Carolina. The Goldsboro series has a porosity of 8-12% at a depth of 0-0.3556m and 11-15% at a depth of 0.3556-1.905m. The Lynchburg series has a porosity of 9-13% at a depth of 0-0.3048m and 12-16% at a depth of 0.3048-1.651m. The Rains series has a porosity of 8-12% at a depth of 0-0.3048m and 10-15% at a depth of 0.3048-1.981m. The Meggett has a porosity of 15-20% at a depth of 0-0.1778m and 13-18% at a depth of 0.1778-1.600m.

Geology description

Lower Atlantic coastal plain on a marine terrace of the Pleistocene epoch

Treatment History

The most notable research on the study site involved prescribed fire, pine silviculture, nutrient cycling and water quality. During 1976, stream gauges were installed at the outlet of the paired watersheds under the direction of C. Ennis Young and the estimated outflow was used to evaluate the effects of prescribed fires on stream water quality and nutrient cycling. The treatment watershed was divided into 20 pine management compartments, each 7.1 ha, with 20 m wide buffer strips left bordering the stream channels. During the winters of 1976-77, 1977-78, and 1978-79, a total of 12 compartments were burned, four each year. Three summer burns were also conducted during 1976-77. Stream nutrient outputs from the treatment and control watershed were compared before and after prescribed burning. The nutrient outputs from the treatment watershed reflected the response of an operational forest, and illustrated that periodic prescribed fires in the southeaster coastal plain pine forests are not likely to have an appreciable effect on the quality of ground or stream waters. On September 22, 1989, the eye of Hurricane Hugo passed through the Francis Marion National Forest and the forest was badly damaged by the hurricane. Subsequently, the treatment watershed (#77), but not the control watershed (#80), was salvage logged (Personal Communication, William Harms, Research Forester, Southern Research Station). Water Samples were collected immediately after the hurricane and have been collected regularly since. The watershed gauges, which had been deactivated in 1981, were reactivated in January 1990 (Bill Harms, Personal Communication). In 1964, water level monitoring wells were placed in Watershed #77. The measurement of these wells stopped in 1971. In 1992, a new set of wells was placed in both watersheds. When these wells were installed, a soil particle size analysis was run at the well sites. These wells were manually measured until 1996. In 1996, the manual measurements were replaced with electronic measurements by placing continuously recording well monitors on three of the wells, and creating prediction equations for the rest of the wells using the 1992-1995 data. Manual weather measurements (rain and temperature) started at the Santee Headquarters in 1946 and today there are four weather measuring

devices on the experimental forest. Three stations measure rain and temperature: the Lottie Road station started taking measurements in 1971, the rain gauge on Watershed #77 started taking rain measurements in 1963 and temperature measurements in 1996, and the rain gauge on Watershed # 80 started taking rain measurements in 1990 and temperature measurements in 1996. An electronically recording weather station was erected at the Santee Headquarters in 1996, and currently measures temperature, rainfall, wind speed, and solar radiation. During the fall of 1994, as a part of a larger study on the recovery of the forest from Hurricane Hugo by Chuck Gresham et. al. (1994), permanent plots were located on Watershed #80. On each plot, they conducted an inventory of trees, advanced regeneration, coarse woody debris (standing and down) and canopy density and frequency. In addition, wells to monitor the depth of the water table were installed in each plot. One of the preliminary conclusions from these studies was that the regeneration forest was not of the species composition of the pre-hurricane community, and that the large amount of coarse woody debris is releasing large amounts of carbon and nutrients to the ecosystems. In 1998, a long term study of vegetation dynamics was initiated in the watersheds. Four 0.1 ha plots were located in each of the watersheds, and the ecological importance of herbaceous and woody vegetation (density, cover or basal area, species diversity) and dimensions of trees (diameter, breast height, and height) were measured.

Succession description

The forest stands on the watersheds were destroyed during Hurricane Hugo, in 1989. As a result, most of the mature trees were destroyed. The treatment watershed (#77) was salvage logged to remove downed stems; the control watershed (#80) was not salvaged. The regenerating forest is similar to the pre-disturbance stand.

Comparison description

The over story canopy on the control watershed (#77) was largely destroyed by Hurricane Hugo (1989). As a result, the regenerating forest consists of mixed pine-hardwood stands that are typical of the lower coastal plain.

Control Watershed

Watershed Spatial Characteristics

North bounding coordinate (decimal degrees) N-33.15931, W-79.78756
West bounding coordinate (decimal degrees) N-33.15219, W-79.77854
South bounding coordinate (decimal degrees) N-33.14220, W-79.79351
East bounding coordinate (decimal degrees) N-33.15241, W-79.80339
Area (hectares) .....200 ha
Aspect (degrees azmuth) ..... 225°

Minimum watershed elevation (meters; a.m.s.l) . 0 m AMSL (Above Mean Sea Level)
Maximum watershed elevation (meters; a.m.s.l) ..... 9.9 m AMSL

Watershed Ecological Characteristics

Mean annual precipitation (millimeters) ..... 1350 mm (measured since 1990)
Slope (Percent) 3%
Slope description

The slope for both watersheds is less than 3% (topographic map)

Channel length (meters) .....1375 m
Channel length description

Perennial. Because the maximum elevation of the channel is less than 10 m above sea level, it is doubtful that the hydraulic head can move much water as seepage flow through the clay-rich soil.

Drainage density (km/km2) .....1.375 km/2km2=.6875 km/km2
Mean snowpack description

0 m

Watershed Descriptions

Pre-treatment vegetation

The forest is composed primarily of loblolly and longleaf pine with components of mixed hardwoods. The riparian zone consists predominantly of bottomland hardwoods. The over story on the watersheds was destroyed in 1989 because of hurricane Hugo: as a result, the current treatments on the paired first order watersheds consist of salvage vs. non salvage logging. The watersheds are also currently managed for red cockaded woodpecker habitat, which requires frequent prescribed fires.

Pre-treatment description

Stocking density is 8090 stems/ha, (in sampling area, 809 stems/.1 ha), composed primarily of loblolly and longleaf pine with components of mixed hardwoods. The riparian zone consists predominantly of bottomland hardwoods.

Soil description

WS-80 is composed of the following soil series: Wahee, Duplin, Lenoir, and Meggett. All of these series are located in Berkely County, South Carolina. The Wahee series has a porosity of 15-20% at a depth of 0-0.1270m and 12-20% at a depth of 0.1270-1.854m. The Duplin series has a porosity of 10-15% at a depth of 0-0.1524m and 13-18% at a depth of 0.1524-2.032m. The Lenoir series has a porosity of 14-18% at a depth of 0-0.3810m and 13-15% at a depth of 0.3810-2.032m. The Meggett series has a porosity of 15-20% at a depth of 0-0.1778m and 13-18% at a depth of 0.1778-1.600m.

Geology description

Lower Atlantic coastal plain on a marine terrace of the Pleistocene epoch.

Treatment History

The most notable research on the study site involved prescribed fire, pine silviculture, nutrient cycling and water quality. During 1976, stream gauges were installed at the outlet of the paired watersheds under the direction of C. Ennis Young and the estimated outflow was used to evaluate the effects of prescribed fires on stream water quality and nutrient cycling. The treatment watershed was divided into 20 pine management compartments, each 7.1 ha, with 20 m wide buffer strips left bordering the stream channels. During the winters of 1976-77, 1977-78, and 1978-79, a total of 12 compartments were burned, four each year. Three summer burns were also conducted during 1976-77. Stream nutrient outputs from the treatment and control watershed were compared before and after prescribed burning. The nutrient outputs from the treatment watershed reflected the response of an operational forest, and illustrated that periodic prescribed fires in the southeaster coastal plain pine forests are not likely to have an appreciable effect on the quality of ground or stream waters. On September 22, 1989, the eye of Hurricane Hugo passed through the Francis Marion National Forest and the forest was badly damaged by the hurricane. Subsequently, the treatment watershed (#77), but not the control watershed (#80), was salvage logged (Personal Communication, William Harms, Research Forester, Southern Research Station). Water Samples were collected immediately after the hurricane and have been collected regularly since. The watershed gauges, which had been deactivated in 1981, were reactivated in January 1990 (Bill Harms, Personal Communication). In 1964, water level monitoring wells were placed in Watershed #77. The measurement of these wells stopped in 1971. In 1992, a new set of wells was placed in both watersheds. When these wells were installed, a soil particle size analysis was run at the well sites. These wells were manually measured until 1996. In 1996, the manual measurements were replaced with electronic measurements by placing continuously recording well monitors on three of the wells, and creating prediction equations for the rest of the wells using the 1992-1995 data. Manual weather measurements (rain and temperature) started at the Santee Headquarters in 1946 and today there are four weather measuring devices on the experimental forest. Three stations measure rain and temperature: the Lottie Road station started taking measurements in 1971, the rain gauge on Watershed #77 started taking rain measurements in 1963 and temperature measurements in 1996, and the rain gauge on Watershed # 80 started taking rain measurements in 1990 and temperature measurements in 1996. An electronically recording weather station was erected at the Santee Headquarters in 1996, and currently measures temperature, rainfall, wind speed, and solar radiation. During the fall of 1994, as a part of a larger study on the recovery of the forest from Hurricane Hugo by Chuck Gresham et. al. (1994), permanent plots were located on Watershed #80. On each plot, they conducted an inventory of trees, advanced regeneration, coarse woody debris (standing and down) and canopy density and frequency. In addition, wells to monitor the depth of the water table were installed in each plot. One of the preliminary conclusions from these studies was that the regeneration forest was not of the species composition of the pre-hurricane community, and that the large amount of coarse woody debris is releasing large amounts of carbon and nutrients to the ecosystems. In 1998, a long term study of vegetation dynamics was initiated

in the watersheds. Four 0.1 ha plots were located in each of the watersheds, and the ecological importance of herbaceous and woody vegetation (density, cover or basal area, species diversity) and dimensions of trees (diameter, breast height, and height) were measured.

Succession description

The forest stands on the watersheds were destroyed during Hurricane Hugo, in 1989. As a result, most of the mature trees were destroyed. The treatment watershed (#77) was salvage logged to remove downed stems; the control watershed (#80) was not salvaged. The regenerating forest is similar to the pre-disturbance stand.

Comparison description

The over story canopy on watershed (#80) was largely destroyed by Hurricane Hugo (1989). As a result, the regenerating forest consists of mixed pine-hardwood stands that are typical of the lower coastal plain.

Gauging Stations

Flume at Treatment Watershed

Hydrologic Gauging Station

Latitude (decimal degrees) N-33.14142

Longitude (decimal degrees) W-79.78409

Elevation (meters; a.m.s.l.) ..... 5.7 m AMSL (Above Mean Sea Level)

Begin Date 11/01/1989

Watershed Area (hectares) ..... 160 ha

Associated meteorological station

Met Station 5

Photo URL

http://www.srs.fs.fed.us/charleston/hydrology.html

History

The flow meters are downloaded monthly. Samples are taken based on flow, 1 sample every 250 pulses: 1 pulse = 1000 gallons. 1 bottle per sample event. Change bottles based on samples. Change bottle every 3 samples. Sample volume of 100ml - 300ml total. QA/QC: manual check of flow when flow rates are low enough.

Weir Description

ISCO Flow Meter 4210. The ISCO flow meter was installed by Jim Weeg and programmed by Johnson Inc. representative, Rodney Edwards. The initial programming was based on the existing weir design. The ISCO flow meter records flow rate/ GPM and water levels every 15 minutes.

Weir Calibration and Modification History

An ISCO 3210 portable sampler was installed in 1989, this was replaced in 2002 with an ISCO 4210 portable sampler. The ISCO portable samplers do not require calibration. All technical information for the samplers and flow meters is contained in the ISCO manuals, which are kept in office #105. The ISCO is used in conjuntion with a V-notch wier using the following formula: Q * A * H^2.5 Were Q = Flow rate, A = Constant for Gal/Min or L/Sec and H = Height

Stream Discharge

Data Logger Sampling Interval ..... daily

Summary Interval ..... 15 minute

Data Accuracy (liters per second) ... 1% of full scale over operating temperature range in still air

Minimum QC Threshold (liters per second) ..... 0 cfs
Maximum QC Threshold (liters per second) ..... 1700 cfs

Flume at Control Watershed

Hydrologic Gauging Station

Latitude (decimal degrees) N-33.14579
Longitude (decimal degrees) W-79.79123
Elevation (meters; a.m.s.l.) ..... 5 m AMSL (Above Mean Sea Level)
Begin Date 11/01/1989
Watershed Area (hectares) ..... 200 ha

Associated meteorological station

Met Station 25

Photo URL

http://www.srs.fs.fed.us/charleston/hydrology.html

History

The flow meters are downloaded monthly. Samples are taken based on flow, 1 sample every 250 pulses: 1 pulse = 1000 gallons. 1 bottle per sample event. Change bottles based on samples. Change bottle every 3 samples. Sample volume of 100ml - 300ml total. QA/QC: manual check of flow when flow rates are low enough.

Weir Description

ISCO Flow Meter 4210. The ISCO flow meters were installed by Todd Tompkins and programmed by Johnson Inc. representative, Rodney Edwards. The initial programming was based on the existing weir design. The ISCO flow meter records flow rate in cfs and water levels every 15 minutes.

Weir Calibration and Modification History

An ISCO 3210 portable sampler was installed in 1989, this was replaced in 1995 by an ISCO 4210 portable sampler.The ISCO portable samplers do not require calibration. All technical information for the samplers and flow meters is contained in the ISCO manuals, which are kept in office #105. The ISCO is used in conjuntion with a V-notch wier using the following formula: Q * A * H^2.5 Were Q = Flow rate, A = Constant for Gal/Min or L/Sec and H = Height

Stream Discharge

Data Logger Sampling Interval ..... daily
Summary Interval ..... 15 minute

Data Accuracy (liters per second) ... 1% of full scale over operating temperature range in still air

Minimum QC Threshold (liters per second) ..... 0 cfs

Maximum QC Threshold (liters per second) ..... 1600 cfs