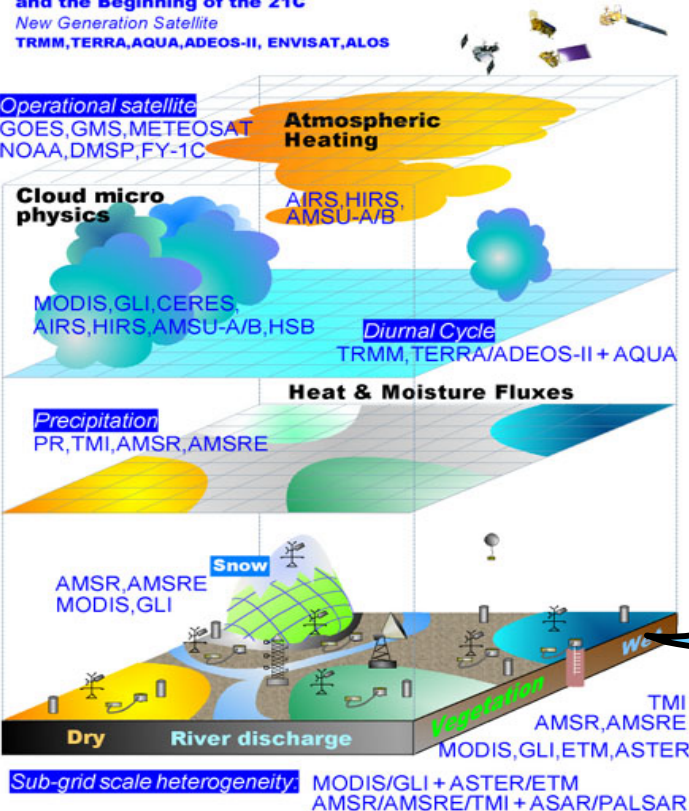


2.3 CEOP Watershed Hydrology Component

Integrated Data Approach

The 1st Opportunity for Global and Comprehensive Data Sets and the Beginning of the 21C

New Generation Satellite
TRMM, TERRA, AQUA, ADEOS-II, ENVISAT, ALOS



Reference Sites and Model Coverage



CEOP Configuration

CEOP Hydrology Reference Sites

Princeton University/University of Washington are attempting to augment the CEOP tower flux sites with a small set of hydrological reference sites that will fulfill the following purposes:

- To serve as validation sites for the land surface parameterizations in coupled land-atmosphere-ocean models, essentially at a point or small area scale;
- To serve as "tie points" or ground truth reference sites for remote sensing products

<http://hydrology.princeton.edu/>

The web site summarizes some attributes of a set of global sites that have been identified as the candidates for official CEOP hydrology reference sites, and that meet most, if not all, of the above criteria.

CEOP Hydrology Reference Sites

Sites should meet the following criteria:

- Stream gauge information should be available for a catchment within which other (e.g., tower) observations lie. Catchment drainage area should ideally be in the range 100-1000 km², recognizing that for some sites drainage areas as small as 10 km² and as large as 10,000 km² may be acceptable;
- Precipitation data, either from gauges or radar, sufficient to resolve the major modes of spatial variability;
- Tower flux observations available for at least one site within the catchment, and land cover, soil and other ancillary data sufficient to support flux transfer methods which could provide spatial interpolation of tower evapotranspiration estimates;
- Ideally, multiple year time series of the major water and energy balance terms.

CEOP Hydrology Reference Sites

The current sites include:

- Kyeamba Creek, NSW Australia
- Sleeven Polder, lower Feale River basin, County Kerry, Ireland
- Walnut Gulch, Arizona, USA
- Igarape Asu, Central Amazonia, Brazil
- Zwalm river basin, Belgium
- Volta river basin, Ghana
- Wolf creek, Canada
- Naqu river basin, China

Brief summaries are accessible from the web for each of the sites, as is a data entry form for entering summary information for new sites.

What is this?

Candidate Sites

- > Kyeamba Creek (Australia)
- > Sleeve Polder (Ireland)
- > Walnut Gulch (US)
- > Igarape Asu (Brazil)
- > Zwalm River (Belgium)
- > Volta River (Ghana)
- > Wolf Creek (Canada)
- > Naqu River (China)

Submit Your Site

Current Entries

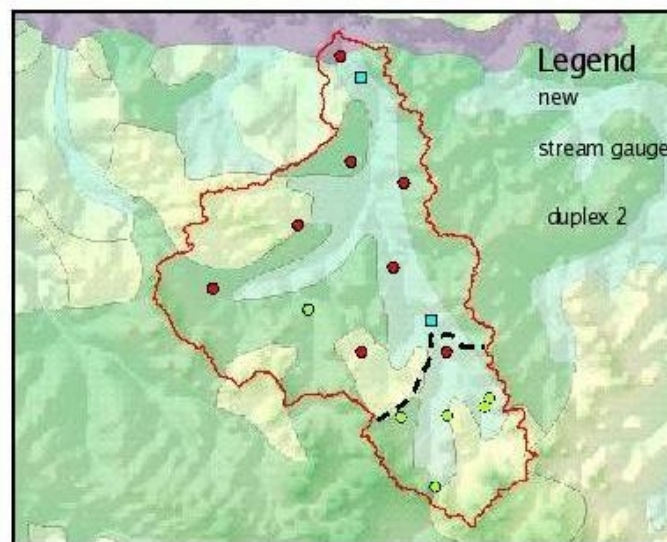
Kyeamba Creek, NSW Australia

Site Summary

The Murrumbidgee watershed (drainage area about 100,000 km²) lies in the eastern headwaters of the Murray–Darling Basin (drainage area about 1,000,000 km²). Although the basin lies within about 100 km of Australia's east coast, it lies to the west of the coastal divide and drains generally westward. Most of the catchment is mixed rangeland and forest, with mean annual precipitation ranging from over 1000 mm/yr in the east, reducing to 200 mm/yr in the far west.

Management of dryland agriculture, and particularly soil salinity problems, are major issues in the basin, as elsewhere in the MDB. There are also irrigation areas at several points along the river. Kyeamba Creek (approx. 500 km², 700 mm/yr rainfall) is a research catchment within the Murrumbidgee at which relatively long-term data exist. Kyeamba Creek is gauged at two locations, hence providing the opportunity for nested catchment studies.

Various University of Melbourne (UoM) research projects have installed, in addition to stream gauges and a precipitation gage network, a transect of 9 soil moisture monitoring sites across the whole Murrumbidgee, as well as 14 sites within Kyeamba Creek. Microgravity sensors and piezometers are also installed at these sites. In addition to the UoM instrumentation, some research sites run by other groups have collected various data from shorter periods across the Murrumbidgee. At present there is a flux tower at Tumbarumba, approximately 100 km east of Kyeamba and in a much wetter climate. There are plans to install a flux tower within Kyeamba Creek however funding is yet to be secured.



Data Summary

Drainage area to outlet: ~530km² (Ladysmith), 145km² (Book Book)

Basin outlet latitude-longitude: 35.19S 147.51E (Ladysmith); 35.35S, 147.55E (Book Book)

Stream gauge period of record: 1975 to 1986 and 2001–ongoing (Ladysmith); 1985 to present (Book Book)

Precipitation gauges: 5 within Kyeamba (2001–ongoing); BoM station at Wagga Wagga 15km from Kyeamba Creek (an AMS and AMO site with 30 mm data – i.e. highest level of BoM sites) 30 min. data since late 1990 and daily data from ~1900. There are many other daily rain stations in the area

Micrometeorological data: from Wagga Wagga – incoming shortwave, screen temperature, specific humidity, wind speed and direction, sunshine hours, cloud cover. From these data 30 min forcing data for rainfall, incoming shortwave, temperature, specific humidity and wind speed have been derived from Jan 2001 – present (see report below).

Turbulent flux measurements: None at present, fluxes tower planned for 2004, subject to funding

Other measurements: In situ TDR at 9 sites along transect across the whole Murrumbidgee; 14 sites within the Kyeamba

What is this?

Candidate Sites

- > Kyeamba Creek (Australia)
- > Sleeven Polder (Ireland)
- > Walnut Gulch (US)
- > **Igarape Asu (Brazil)**
- > Zwalm River (Belgium)
- > Volta River (Ghana)
- > Wolf Creek (Canada)
- > Naqu River (China)

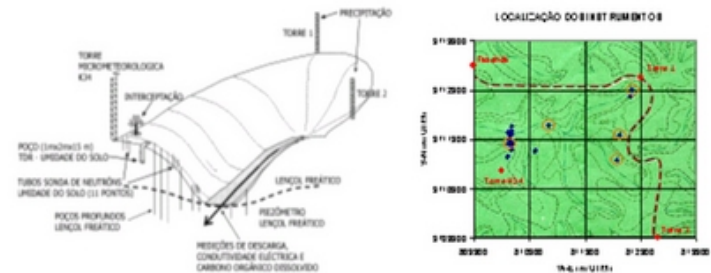
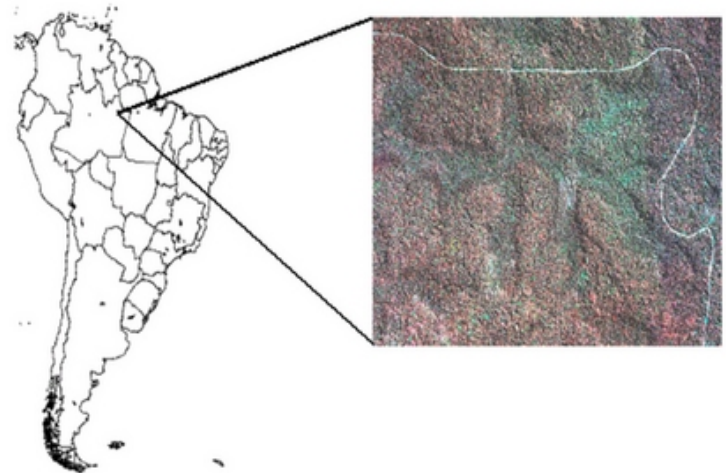
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Current Entries

Igarape Asu, Central Amazonia, Brazil

Site Summary

The Asu catchment is located at approximated 40 km NNW of Manaus, at 3.08°S, 60.07°W. The catchment, with a drainage area of a 6.37 km², collects the discharge of five first order streams, encompassing the most common landscape forms that occur in the region. The regional basal geology are Precambrian cristaline rocks. The plateaus are usually gentle, generally flat, with altitude varying between 90 to 120 m. The plateaus are surrounded by broad flat valleys at an altitude ranging from 45–55 m, which are periodically flooded during the wet season. Vegetation at the Asu Catchment is a dense humid evergreen tropical forest, with marked spatial variability depending on the position on the landscape. The canopy height of this forest types varies between 12 to 15 m. Over the slopes, where the "podzólicos" occur, the forest is classified as "Mata arenícola", with canopy height up to 25 m. The tree density is high, about 2500 trees with diameter greater than 5 cm. The climate of the region is Af_i according to Koppen classification, with average annual temperature of 26C (minimum 19C and maximum 39C). Annual rainfall varies from 1800 to 2800 mm, with a rainy season going from December to May. In March and April, the monthly rain exceeds, on average, 300 mm.



Data Summary

Drainage area to outlet: 6.37 km²

Basin outlet latitude–longitude: 2°36'6.8"S, 60°12'25.7" W

Stream gauge/water level recorder period of record: December 2001 to present(half-hourly).

Precipitation gauges: Apart from the flux tower raingauge, rainfall is monitored at four locations: 2° 36' 32.68" S; 60° 11' 8.42" W; 2° 37' 45.36" S, 60° 10' 51.93" W; 2° 35' 19.17" S; –60° 13' 17.63" W; and 2° 35'32.58" S;60° 12' 51.13" W. Rainfall is recorded on half an hour interval, and records began in February, 2002. The record has several interruptions due to rain gauges malfunctions.

Water level gages: About 13 dipwells are used to monitoring the water table, most of which are located on the



What is this?

Candidate Sites

- > Kyeamba Creek (Australia)
- > Sleeven Polder (Ireland)
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- > Volta River (Ghana)
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- > Naqu River (China)

Submit Your Site

Current Entries

Naqu river basin, China

Site Summary

The energy and water cycle over the Tibetan Plateau play an important role in the Asian monsoon system, which in turn is a major component of both the energy and water cycles of the global climate system. The intensive observation period and long-term observation of the CEOP (coordinated enhanced observing period) Asia–Australia monsoon project (CAMP) on the Tibetan Plateau (CAMP/Tibet, 2001–2005) and GEWEX Asian Monsoon Experiment on the Tibetan Plateau (GAME/Tibet, 1996–2000) have been done successfully in the past six years. A large amount of data has been collected, which is the best data set so far for the study of energy and water cycle over the Tibetan Plateau.

The objectives of CAMP/Tibet are: (1) Quantitative understanding of an entire seasonal hydro-meteorological cycle including winter processes by solving surface energy "imbalance" problems in the Tibetan Plateau; (2) Observation of local circulation and evaluation of its impact on plateau scale water and energy cycle; and (3) establishment of quantitative observational methods for entire water and energy cycle between land surface and atmosphere by using satellites. To achieve the scientific objectives of CAMP/Tibet, a meso-scale observational network (150×250 km², 91–92.50°E, 30.7–33.30°N) were implemented and will be set up in the central plateau (Fig. 1).

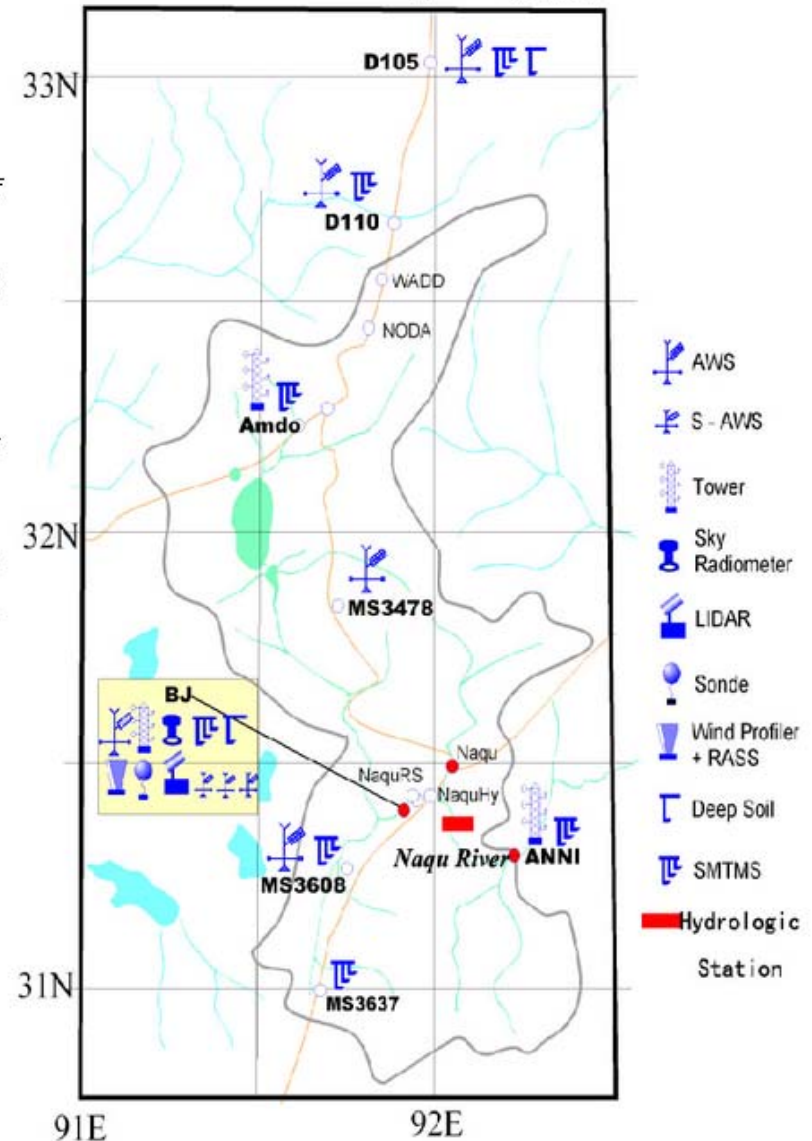
Data Summary

Drainage area to outlet: ~100 km²

Basin outlet latitude-longitude: Naqu:
91–92.50°E, 30.7–33.30°N

CAMP Meso Scale map

ver. 20021213



What is this?

Candidate Sites

- > Kyeamba Creek (Australia)
- > Sleeve Polder (Ireland)
- > Walnut Gulch (US)
- > Igarape Asu (Brazil)
- > Zwalm River (Belgium)
- > Volta River (Ghana)
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Current Entries

Wolf Creek, Yukon Territory, Canada

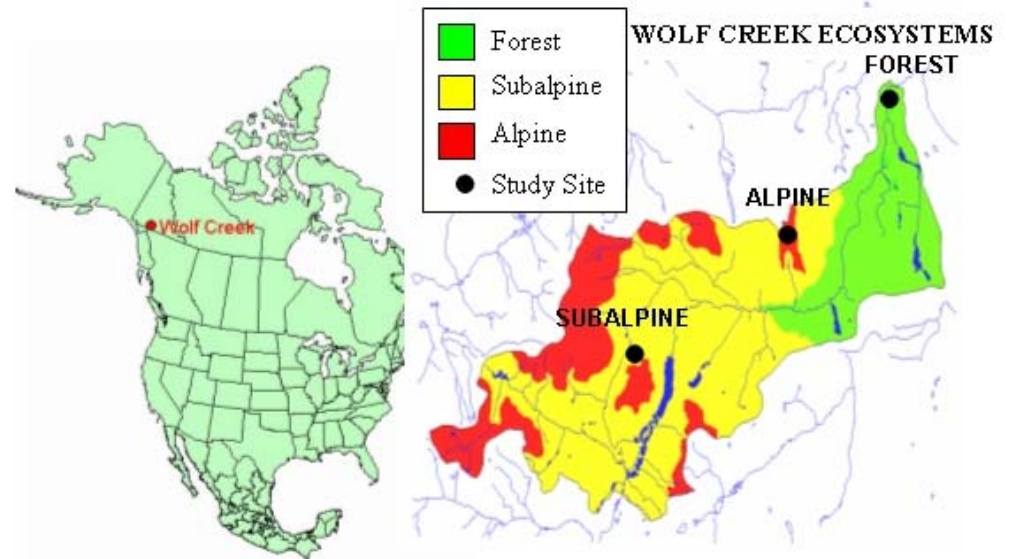
Site Summary

The Wolf Creek Research Basin (drainage area about 195 km²) lies in southern mountainous headwaters of the Yukon River Basin in the subarctic region of northwestern Canada (Figure 1). The sub-arctic continental climate is characterized by a large seasonal variation in temperature, low relative humidity and relatively low precipitation. Mean annual temperature is in the order of -3°C with summer and winter monthly ranges of 5o-15o, and -10o--20o C,

respectively. Summer and

winter extremes of 25o and -40o C are not uncommon. Mean annual precipitation is 300 to 400 mm per year with approximately 40 percent falling as snow. With a general northeasterly aspect, elevations range from 800 to 2250 m with the median elevation at 1325 m.

Wolf Creek is situated within the Boreal Cordillera ecozone (Environment Canada, 1995) and consists of three principle ecosystems, boreal forest, sub-alpine taiga (shrub-tundra) and alpine tundra with proportions of 22, 58 and 20% respectively of the total basin area. Permafrost is present in locations on north facing slopes and there is sporadic permafrost throughout the basin, with prevalence increasing with elevation. Study plots are located within each of the ecosystems at elevations of 750, 1250 and 1615 m respectively. The forest site is relatively level with gently undulating terrain consisting of an alternating hummock and hollow landscape. The canopy is dense, consisting primarily of white spruce to heights of approximately 20 m, with some poplar trees to approximately 15 m. The subalpine taiga site is located on an east facing moderate hillslope of approximately 15 degrees. The hillslope itself consists of undulating terrain with numerous hummocks and depressions. The site is vegetated with shrub alder and willow to heights of approximately 2 m. The alpine tundra site occupies a windswept ridge top plateau. Approximately 50% of the site is relatively level, with the balance sloping at approximately 15 degrees to the south. Vegetation is sparse consisting of mosses, some grasses and lichens with occasional patches of scrub willow no more than 0.2 m high.



What is this?

Candidate Sites

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Current Entries

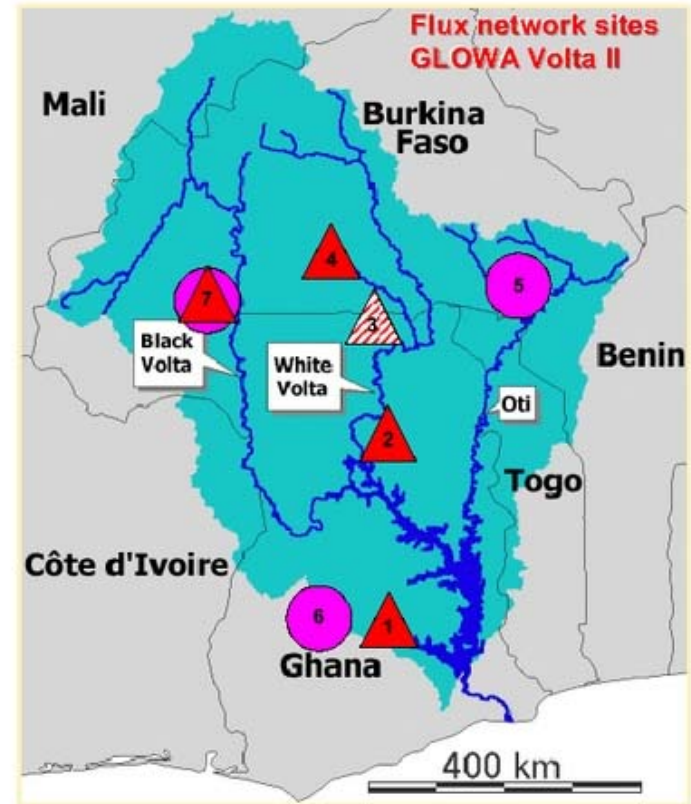
Volta River basin, Ghana

Site Summary

The Nodwua, Ejura and Novrongo experimental catchments were established in April 2001 as part of the GLOWA Volta Project (www.glowa-volta.de). They were chosen because they represent three different agro-ecological zones in the Ghanaian portion of the Volta River basin. The basins are located in a north to south transect, with the northern most being Novrongo (10.92° N, 1.03° W), then Nodwua (9.48° N, 0.92° E), and the most southern being Ejura (7.33° N, 1.27° W). The respective sizes of the experimental catchments are approximately 10, 20 and 15 km².

The climate is tropical savannah with a natural landcover of grassland and scrub forest. Precipitation in the region is characterized by summer convective storms, resulting in large variability, as expressed in periodic droughts. The precipitation in the region is heavily influenced by the location of the ITCZ. Interannual variability in river discharge is also high, with periods above and below the long term mean lasting many years to a decade.

The Glowa-Volta project is an integrated project designed to better understand the complex relationships between the water cycle, climate, landcover change and economic development. The project utilizes observations across a range of spatial scales, and includes measurement of surface meteorology, turbulent heat fluxes, runoff at experimental catchments, and land cover. Remote sensing is used to obtain information at the larger Volta basin scale. It is expected that four additional experimental areas (numbered 4 through 7 in figure 1) will be added during 2003 and 2004.



Legend:

- Volta Basin with major river network
- Scintillometer Station
- Eddy Correlation Station
- 1 Ejura (2001)
- 2 Nodwua (2001)
- 3 Navrongo (2001, scintillometer to 4 in 2004)
- 4 Boudtenga (2004)
- 5 Kompienga (2003, VinVal)
- 6 Mankranso (2003, VinVal)
- 7 Dano (2004, Dreyer)

What is this?

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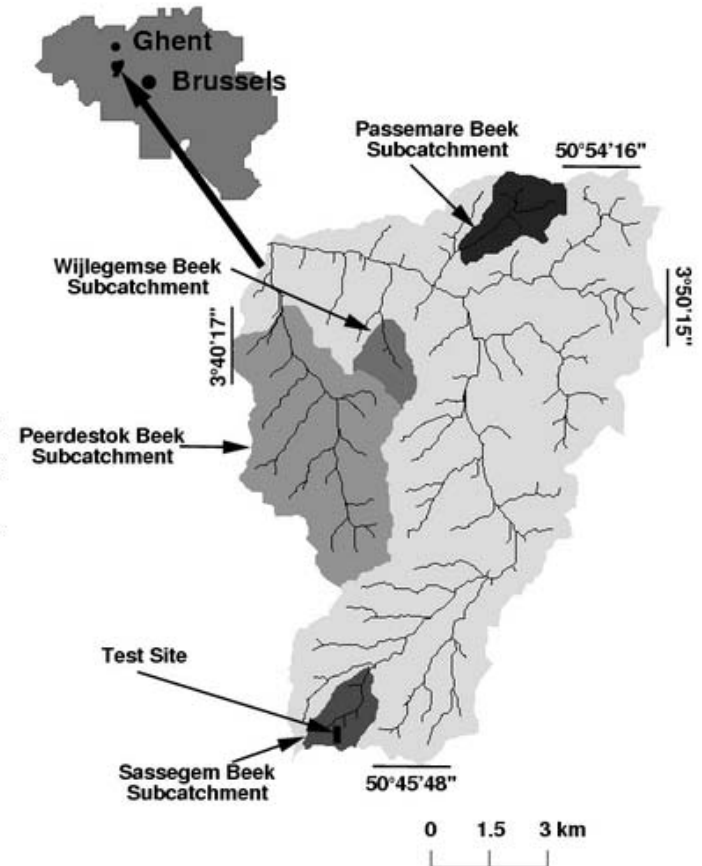
Zwalm River, Belgium

Site Summary

The Zwalm catchment, a subcatchment of the the Schelde River basin, is situated in the province of East-Flanders, Belgium at approximately 50.840N and 3.780 E, (see Figure) with the outlet of the basin south of Gent near the village Nederzwalm. The total drainage area is 114 km² and the total length of perennial streams is estimated from topographic maps, scale 1:10000, to be 177 km. Therefore, the drainage density is 1.55 km/km², a value characteristic for humid catchments. The topography of the basin is characterized by rolling hills and mild slopes. The maximum elevation difference in the basin is 150 m. The mean slope of first order streams (Strahler order) is 3.8%. The catchment is situated in the sandy-loam area of Flanders. Surface sampling has confirmed that most of the top layer of the soil profile has sandy loam texture, even though the Belgian soilmap surface to consist of deep loam soils (A-texture). The depth of the eolic cover is estimated to range between 0 and 10 m. Most of the land use is agriculture (arable crops and permanent pasture) but in the southern portion of the catchment it is forested (~50% Brakel-bos). The degree of urbanization is about 10% with urbanized areas mainly situated in the Northeast (Zottegem) and Southeast (Brakel).

Within the Zwalm are a number of gauged subcatchments, as shown in the figure. The Passemare Beek is a second order (Horton order) stream with a drainage area of 2.52 km², and a total channel length of 2.97 km. The average slope is around 5% (channel slope 4.8% and hill slope 5.6%). The Sassegem subcatchment, with a drainage area of 2.49 km² and a total channel length of 2.92 km, is situated in the extreme south of the Zwalm catchment. With average slopes of 8.5%, it is steeper than the Passemare.

Climatic conditions can be described as humid temperate. The mean annual rainfall is 775 mm and is distributed almost uniformly over the year. The average year temperature is 10 deg. C, with January the coldest month (mean temperature 3 deg. C) and July the warmest month (mean temperature 18 deg. C). The annual evaporation is approximately 450 mm.



What is this?

Candidate Sites

- > Kyeamba Creek (Australia)
- > Sleeve Polder (Ireland)
- > **Walnut Gulch (US)**
- > Igarape Asu (Brazil)
- > Zwalm River (Belgium)
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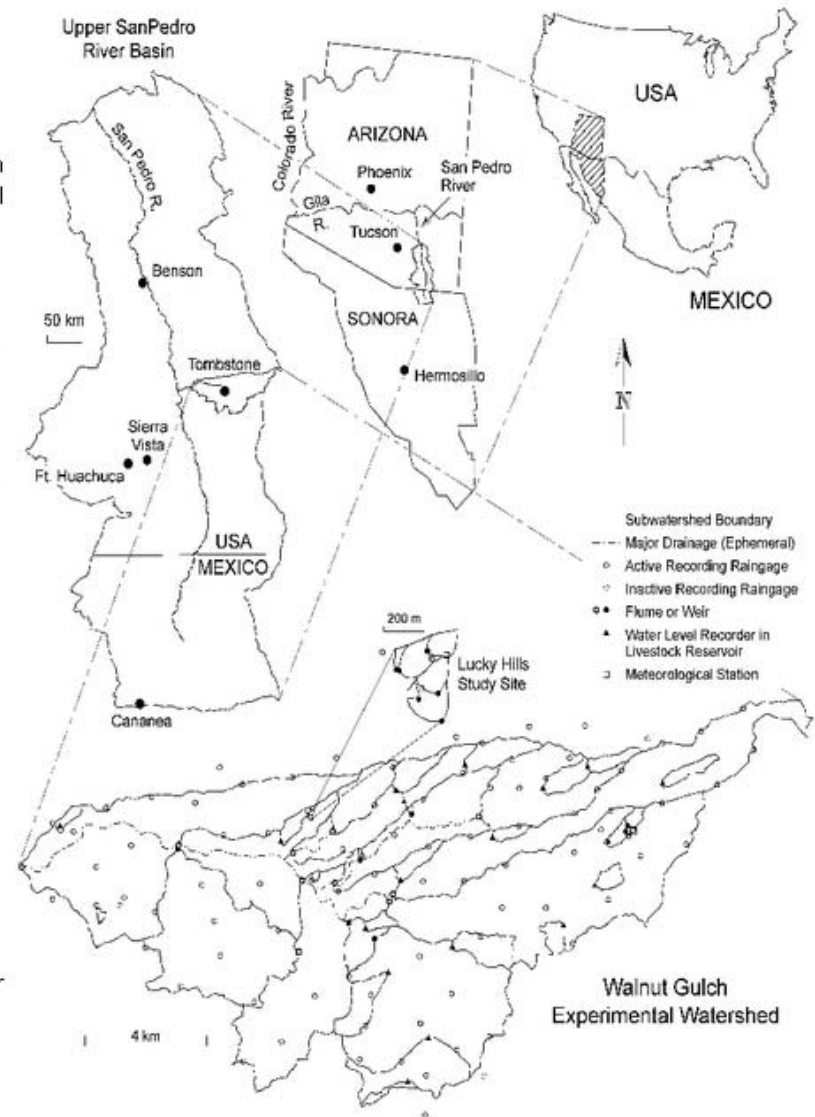
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Current Entries

Walnut Gulch, Arizona, USA

Site Summary

Walnut Gulch Experimental Watershed is operated by the United States Department of Agriculture, Agricultural Research Service, Southwest Watershed Research Center located in Tucson, Arizona. The Walnut Gulch Experimental Watershed encompasses the 150 square kilometers in southeastern Arizona, USA draining to the outlet gage at (31° 43' N, 110° 41' W) that surrounds the historical western town of Tombstone. The watershed is contained within the 7600 km² upper San Pedro River Basin flows north from Sonora, Mexico into Arizona. The watershed is representative of approximately 60 million hectares of brush and grass covered rangeland found throughout the semi-arid southwest and is a transition zone between the Chihuahuan and Sonoran Deserts. Elevation of the watershed ranges from 1250 m to 1585 m MSL. Cattle grazing is the primary land use. Annual precipitation is 350 mm; mean annual temperature is 17.7°C; potential ET is 2600mm. Walnut Gulch is an ephemeral tributary of the San Pedro River and is dry about 99% of the time. Hydrometeorological and soil erosion/sedimentation data are collected from 125 instrumented installations on WGEW. Precipitation is measured with a network of 88 weighing-type recording rain gauges arranged in a grid throughout the watershed. Various runoff measuring structures are used to monitor runoff from eight small subcatchments (< 40 ha). These structures include broad-crested V-notch weirs, H-flumes, and Santa Rita supercritical flow flumes. Runoff from watersheds greater than 40 ha is measured using either livestock watering ponds or large



What is this?

Candidate Sites

- > Kyeamba Creek (Australia)
- > **Sleeven Polder (Ireland)**
- > Walnut Gulch (US)
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- > Volta River (Ghana)
- > Wolf Creek (Canada)
- > Naqu River (China)

Submit Your Site

Current Entries

Sleeven Polder, lower Feale River basin, County Kerry, Ireland

Site Summary

The study area includes: the Sleeveen Polder (C2M), the polder next to it (Control Polder) and the upland area feeding the two polders. The Sleeveen and Control Polders are two of the 15 polders making up the lower Feale River catchment. The lower Feale River catchment is a low-lying flat peaty area of 300 km² situated in County Kerry in southwest Ireland. The Feale River runs through the town of Listowel, meanders along the lower Feale River catchment and flows into the sea at Ballybunnion beach. This river includes the Cashen Estuary, which is over 1 km wide at its widest point. Flooding from the tidal Feale River adjacent to the polders, which are used for agriculture, strongly affects this area. Each polder can be considered as hydraulically independent. The main purpose of the experiment supported by this site is to monitor and evaluate the effectiveness of pumping for eventual implementation in a flood mitigation strategy in the remaining part of the catchment.

The west coast of Ireland, where the study site is located, is influenced by a cool temperate oceanic climate. The Atlantic drift heavily affects the coast. Average annual temperature is about 9 °C. Mean annual wind speed varies between about 4 to 7 m/sec. Rainfall in the area generally averages between 1000 and 1250 mm per year.

The lower Feale River watershed is a low-lying area with poorly defined drainages. Therefore, the strategy for observing the local water



<p>SITE INFO</p>	<p>SITE NAME: Zwalm <i>Belgium</i></p> <p>SUMMARY:</p> <p>The total drainage area of the catchment is 114 sq. km and the total length of the perennial channels is 177 km. During the last glacial period (Wurm) the tertiary layers in the catchment were covered by eolic sandy-loam and loam soils. This cover is estimated to be between 0 and 10 m deep. The third soil type, clay, covers less than 5% of the total surface. The maximal elevation difference is 150 m. The average year temperature is 10 deg. C, with January the coldest month (mean temperature 3 deg. C) and July the warmest month (mean temperature 18 deg. C). The average yearly rainfall is 775 mm and is distributed evenly throughout the year. The annual evaporation is approximately 450 mm.</p> <p>AREA: 114.3 km² LAT: 50.88° LON: 3.68°</p>
<p>DATA</p>	<p>HYDROLOGICAL DATA: stream flow PERIOD: 1982– AVAILABILITY: digitized</p> <p>METEOROLOGICAL DATA: precip tair humid pres dew PERIOD: Feb. 2001– AVAILABILITY: digitized</p> <p>RADIATION DATA: Net Radiation PERIOD: Feb. 2001– AVAILABILITY: digitized Bowen Ratio PERIOD: Feb. 2001– AVAILABILITY: digitized</p> <p>OTHER DATA: Eddy correlation measurements are available from March through June 2002. TDR-based soil moisture measurements are available at the location of the weather station. From the Spring of 2004 on rain gauges and TDR instruments will be installed at four different locations in the catchments. Discharge measurements are available at the outlet in digitized format and four four subcatchments, till 2000 in digitized format and from 2000 on on hardcopies. These will be digitized in the near future.</p>
<p>CONTACT</p>	<p>NAME: Valentijn Pauwels PHONE: + 32 – 9 – 264 61 37 FAX: + 32 – 9 – 264 62 36 EMAIL: Valentijn.Pauwels@UGent.be</p>
<p>SUPPORTING DOCUMENT</p>	<p>zwalm_esa.eps (<i>application/eps 569545 Byte</i>)</p>

CEOP Hydrology Reference Sites

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