1. Site Description and Installations

The Cariri Experimental Basins, consisting of the Experimental Basin of Sumé (EBS – 7.67^0 S, 37.0^0 W) and the Experimental Basin of São João do Cariri (EBSJC – 7.42^0 S, 36.5^0 W), are located in the typically semiarid region of the north-east of Brazil, known as Cariri in the state of Paraíba. They were installed to verify and monitor the diverse hydrological processes involved in the generation of runoff and soil erosion in different scales ranging from plots of 1 m^2 to small sub basins of 0.32 km^2 and 0.59 km^2. The ongoing research program aims to measure the runoff generated and the quantity of eroded soil in individual experimental units to permit reliable estimates of parameters involved in modeling the runoff-erosion process on an event by event basis. The EBS was installed in 1982 under a joint program of technical cooperation between the Superintendency for the Development of the north-east of Brazil (SUDENE) and the then Overseas Cooperation Agency of France, ORSTOM (now, Institut de Recherche pour le Développement- IRD). The operation and further expansion was passed on to the Hydrology Research Group of the Federal University of Paraiba (UFPB) in the Campus of Campina Grande. The research team of the now, Federal University of Campina Grande (UFCG) operated the EBS till 1991, when it had to be closed due to administrative problems. At the time of closure, EBS had 9 erosion plots of 100m^2 with different types of management, 2 micro basins of about 0.5 ha, cleared bare, and two micro basins of 0.62ha and 1.07ha with undisturbed natural vegetation. The need for a clear understanding of the influences of land cover and management practices on water yield has been well expounded by Bosch and Hewlett (1982).

In order to continue the research initiated in EBS and to further the knowledge of the hydrological processes involved in runoff and erosion processes, the EBSJC, located about 65 km to the north, near the town of São João do Cariri and in the same hydrological area as of EBS, was initiated in 1998 with the installation of two erosion plots of $100m^2$. The EBSJC is located within the catchment of the rivulet Riacho Namorados (13.6 km^2) and had been equipped with a full scale meteorological station in 1985. In the following years two small sub basins of 59ha and 32ha were instrumented for runoff measurement. This field installation meant for teaching and research was carried out with the technical cooperation and funding by GTZ, the German Agency for Technical cooperation. Subsequent to the operation of the erosion plots in 1999, progressively, 3 micro basins for measuring runoff and erosion were installed. The first one with an area of 0.18ha was in bare soil, while the other two with an area of 0.16ha and 1.63ha respectively were nested basins and had the natural vegetation cover partly modified by farm animals. The physical characteristics of the experimental units are given in Table 1.

The region, in which EBS and EBSJC lie, has a wavy and undulating topography, fairly thin soil layer underlain by bedrock, with some notable rocky outcrops and the altitude varying from 450 m to 790 m. The very thin surface layer of the soil is highly vulnerable to erosion that, if not properly conserved, may lead to desertification. The climate in the region is typically semiarid, with the concentration of rains in one single period of about 3 months between February and May. The annual precipitation varies from about 400 to 600 mm and the mean annual temperature is around 25^0C and the mean daily tank evaporation rate is about 5.5 mm, being highest in November (9.0 mm/day) and lowest in June (2.4 mm/day). The vegetal cover of the region is composed of native brush known as “caatinga” (about 75%), cultivated areas in which are raised corn and beans mostly during the rainy season, and some reforested areas with trees of “algaroba” which is a midsized tree with good leafy area. The soil depth is relatively small in the region and the subsoil is derived from the underlying rock. The most common soil types found in the basin are: Brown non-calcic vertic soils, Verticsoils and Litolic soils with the predominance of the Brown non Calcic vertic type. The area is well drained and most of the water courses are seasonal and ephemeral.

2. Methods and data collection

In both the EBS and EBSJC, the main objective was to obtain reliable measurements of the surface runoff and the resulting amount of soil erosion daily or for each individual event. Precipitation was obtained from the several rain gauges installed in and around the experimental basins. Recording rain gauges provided information about the intensity and duration of the events. Except for the recording units like water level recorder, the data collection was carried out by technical personnel stationed in the basins. The sample plots of 1 m^2 in EBS were operated only under simulated rainfall for a limited period and are not included in the Cariri Catchments Data set.

The erosion plots of 100 m^2 had the runoff and the eroded sediments directed into a1000 l (1 m^3) capacity collection tank with a calibrated bucket inside to collect the small flows. For large runoff when the tank might get full, the overflow was led into a second tank that would accumulate only a ninth fraction of the outflow from the first with the remainder spilled over. Thus for any event, the total runoff was obtained by adding to the full capacity of the first tank, nine times the volume collected in the second. All the tanks were pre-calibrated. The amount of soil eroded was determined by weight utilizing the mean sediment concentration in the outflow. This was established by collecting several samples of the water sediment mixture and subsequent processing in a lab. In the case of micro-basins, all of them were equipped with sediment and runoff collectors of 2300 l capacity terminating with a 90^0 triangular weir designed to handle the maximum expected discharge of 270 l/s. Water level recorders were used to register the level of water in the collectors and the head over the weir (Fig.1). Sediments passing with the flow over the weir were sampled by means of a siphon mechanism at three points located at intervals of 10 cm starting from the crest level of the weir. The siphoned sediment water mixture was collected in closed auxiliary cans and the sediment concentration of the outflow of the weir was determined by sampling the accumulated mixture. The amount of sediment retained in the collectors was determined by sampling during several stages of the depletion and clearance of the collectors at the end of each event. The total runoff volume was established from the hydrograph generated and the soil erosion determined by the product of the mean sediment concentration and the flow volume. Further details about the equipment and data collection in EBS are given by Srinivasan and Galvão (2003).

In the case of EBSJC, the measurement of runoff and erosion in the erosion plots as well as the micro-basins was exactly the same as described before. With two sub basins (Fig.2), however, there was no attempt to measure the sediment yield and the principle objective was to establish the runoff hydrograph in a reliable manner. The large variations in precipitation result in runoff ranging from very small to quite large flows. Standardized weirs were used for this purpose with a broad crested, wide angled V shaped weir in sub-basin 1 (Fig.3), and a combination of sharp crested 900 V notch with a rectangular weir in sub-basin 2 (Fig.4). Both the weirs were equipped with continuous water level recorders to enable the calculation of the discharge over the weir for generating the hydrographs. All other data regarding the precipitation, evaporation, air temperature etc. were available from the meteorological station.

3. Applications and results

The data collected so far, has amply served to recommend management practices for land use and in the process of modelling runoff and soil erosion. The protective influence of the sparse native vegetation was, indeed, impressive. On March 25, 1989 a precipitation of 34.5 mm occurred in EBS that resulted in stark differences of runoff and erosion in the micro-basins as well as erosion plots (Table 1). For example, micro-basin 2 with natural vegetation generated a runoff of 0.014 mm and a soil erosion of 0.334 kg/ha, while the micro-basin 4 that was cleared bare generated a runoff and soil erosion of 15.54 mm and 7785 kg/ha respectively, highlighting the risks involved in land clearance (Srinivasan, Santos & Galvão,2003). The runoff erosion model WESP (Lopes, 1987), found to be particularly efficient in event simulations of very small catchments, has been calibrated and validated (Srinivasan & Galvão, 1995). A procedure for optimization of the model parameters has been proposed by Santos, Srinivasan, Suzuki and Watanabe (2003). The regional validity of the model parameters has been suggested by Srinivasan and Paiva (2009). Soil erosion is a serious environmental problem that requires the help of simulation tools (Juez, Tena, Fernandez-Pato, Batalla & Garcia-Navarro, 2018).

Parameterization of simulation models can be best achieved with data from experimental basins. Govender and Everson (2005) found that to assess the hydrological processes and predict the impact of land use changes, the model SWAT provides an adequate means. The model SWAT was parameterized with data from EBSJC and the Namorados catchment (13.6km^2) was simulated in daily time steps for various alternatives of land use. The results showed that reforestation was the best alternative for soil conservation and promoting infiltration (Srinivasan, Carvalho Neto & Rufino, 2013). This is in conformity with the findings of Bosch and Hewlett (1982). There is plenty of scope to probe into other aspects like: scale effects, water quality of runoff associated with land use and climate change impacts.

4. Data Availability

All the processed data from the Cariri Catchments (EBS & EBSJC) are available for students and research scientists. A booklet containing complete details of installations, methods of data collection and the processed data from the Experimental Basin of Sumé (EBS) was released in 2003 and its location for access is given under references (Srinivasan & Galvão, 2003). The processed data collected from the Experimental Basin of São João do Cariri (EBSJC) as well as EBS are now being made available at the repository by accessing:

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The data bank will be updated as and when newly processed data from EBSJC becomes available. To obtain any additional information or clarifications, please contact: carlos.galvao@ufcg.edu.br or vajapeyam@yahoo.com.