Title:

"Influence of El Niño Events on Erosion and Sediment Transport Using the SWAT-T Model and Multi-Objective Calibration: Case Study of the Jequetepeque Basin"

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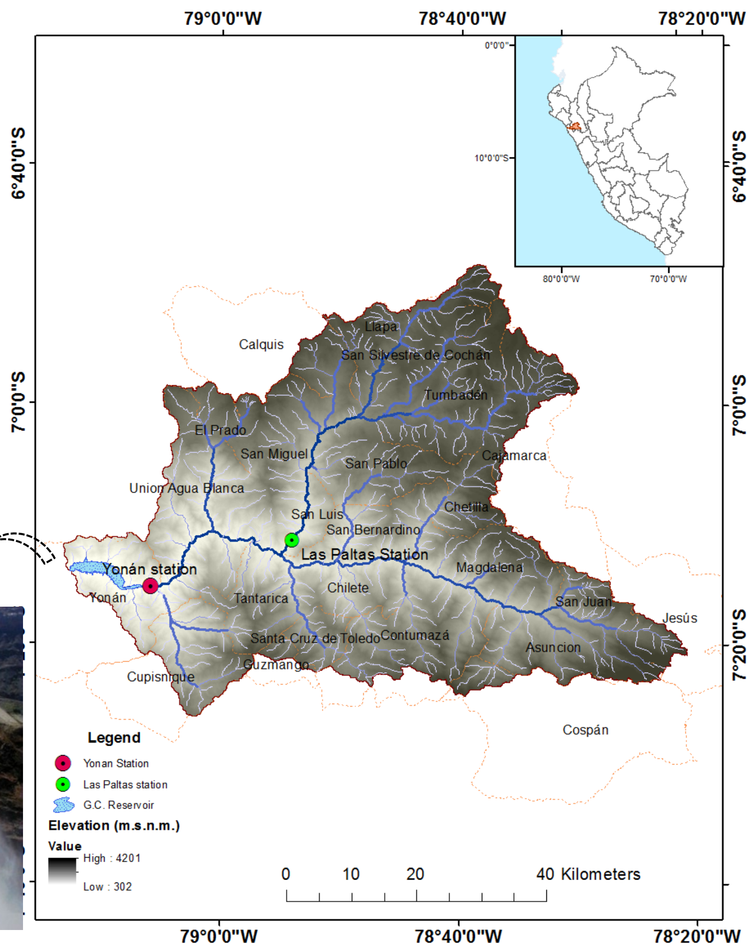
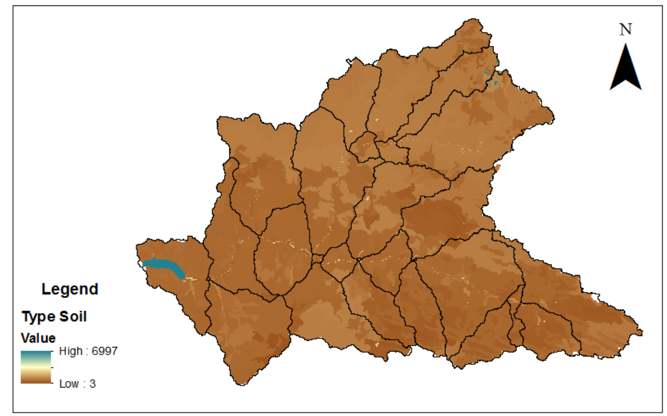
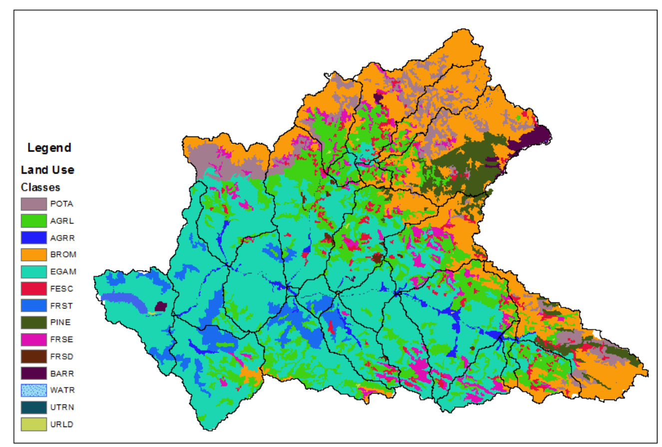
Study Area

The Jequetepeque river basin is in northern Peru, between parallels 06° 50' and 7° 30' South Latitude and meridians 78° 20' and 79° 40' West Longitude of the Greenwich meridian, between the departments of Cajamarca and La Libertad. The basin measures 4,377 km2, the water network, whose main river is the Jequetepeque, is 161 km long and the study area covers 3,447.6 km2. The study area has an altitudinal range of 300 to 4200m.a.s.l.







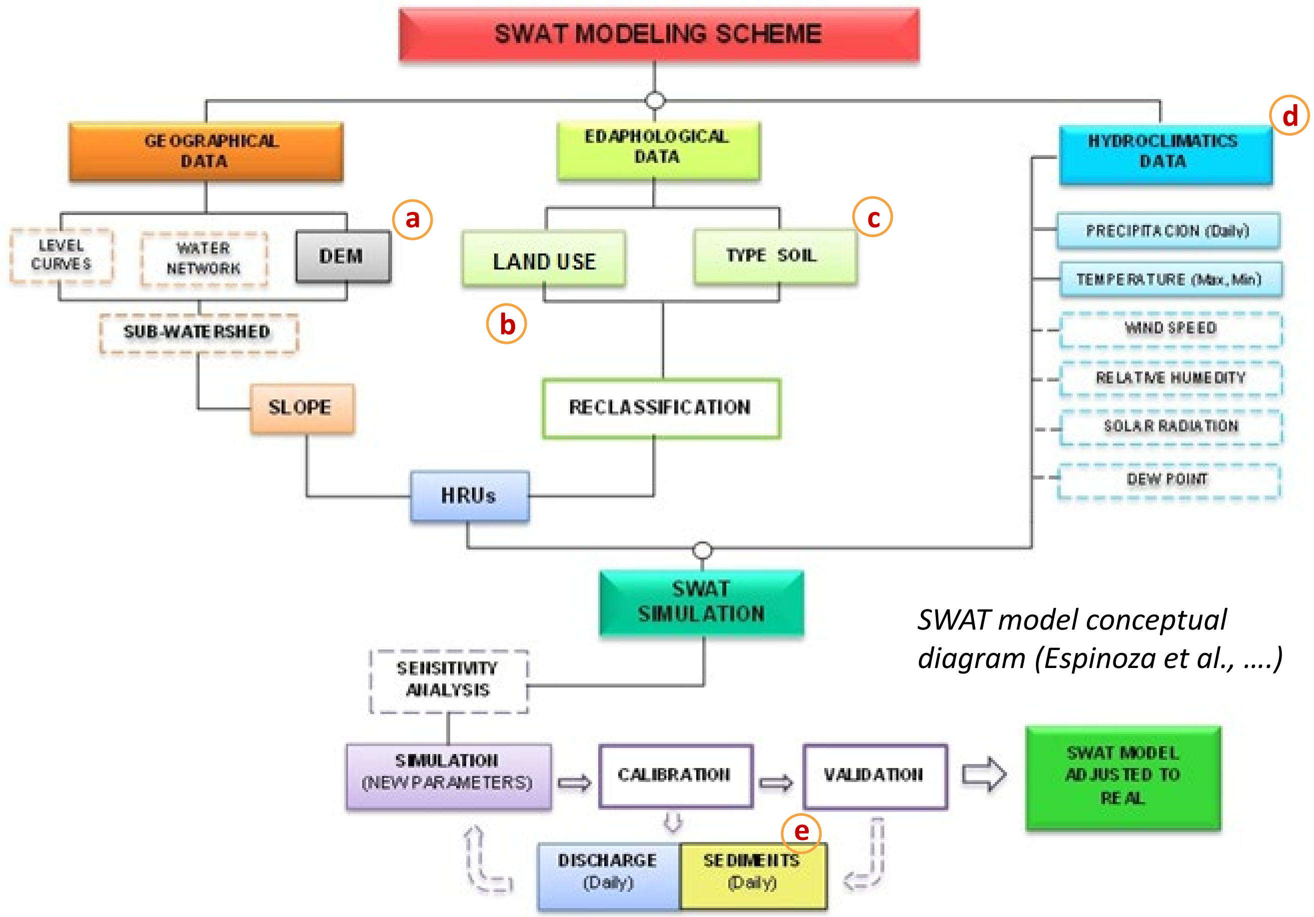
Materials and Methods

SWAT-T, a modified version based on SWAT 2012 – Rev.627, which improved the vegetation growth module by simulating the seasonal growth dynamics of trees and perennial plants in the tropics. (Taddesi et al., 2017, Fernandez-Palomino et al., 2021)

The DEM(**a**) was characterized from the STRM product of 30m x 30m grid, The information on land use and soil type was obtained from available cartographic information, a thematic map at a scale of 1/50,000, prepared based on the INRENA study and provided by PEJEZA (INRENA, 2004).

Precipitation information was obtained from 10 meteorological stations with historical data, the daily hydrometric record has a period of 36 years (1982-2017), Temperature was obtained from PISCOtpm gridded data and finally the daily record of suspended sediment concentration for 19 years (1999-2017). (**e**).

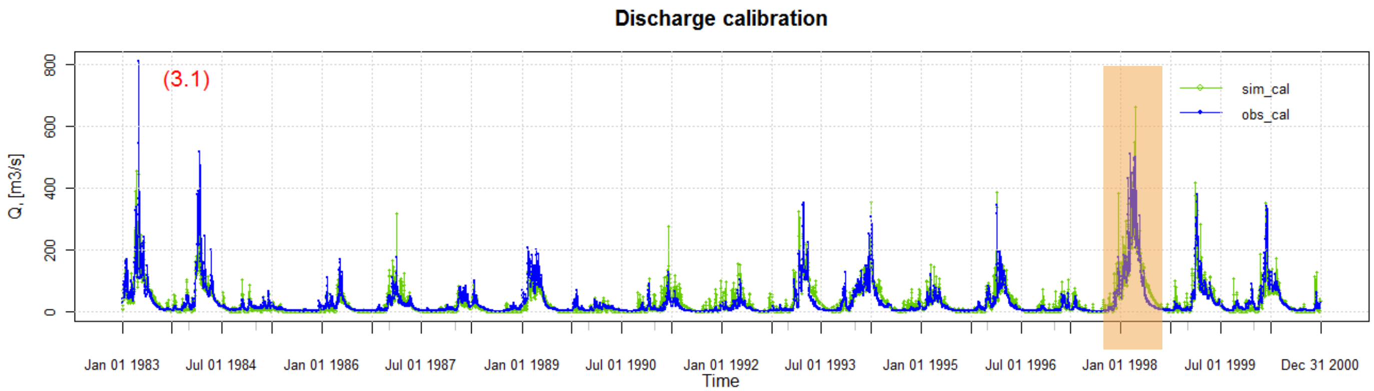
The hydrological simulation process considered the calculation of the surface runoff volume using the SCS curve number, the potential evapotranspiration (PET) was calculated by the Hargreaves method and the flow routing through the channel will be calculated by the Muskingum method.

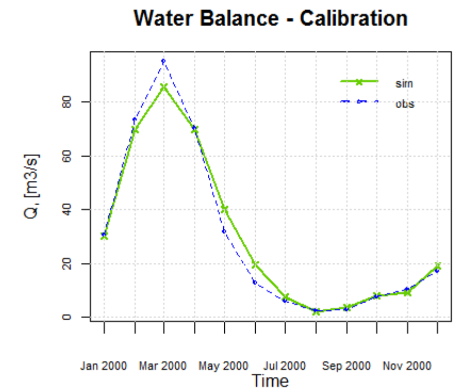


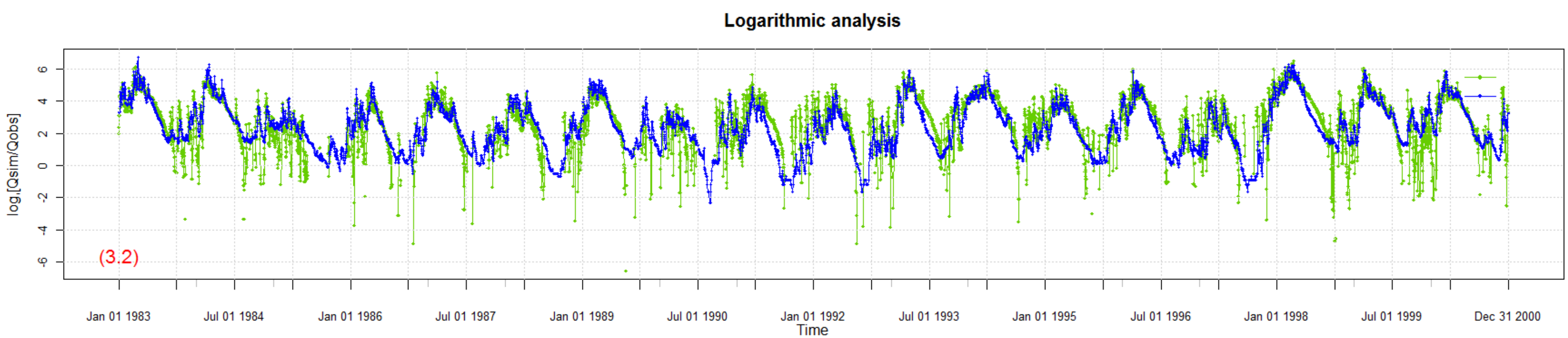
SWAT model conceptual diagram (Espinoza et al., ….)

Results

The modeling phase began on January 1, 1981 and ended on December 31, 2017. A warm-up period (January 1, 1981-December 31, 1982), an eighteen-year calibration period (January 1, 1983-December 31, 2000), and a seventeen-year validation period (January 1, 2001-December 31, 2017).



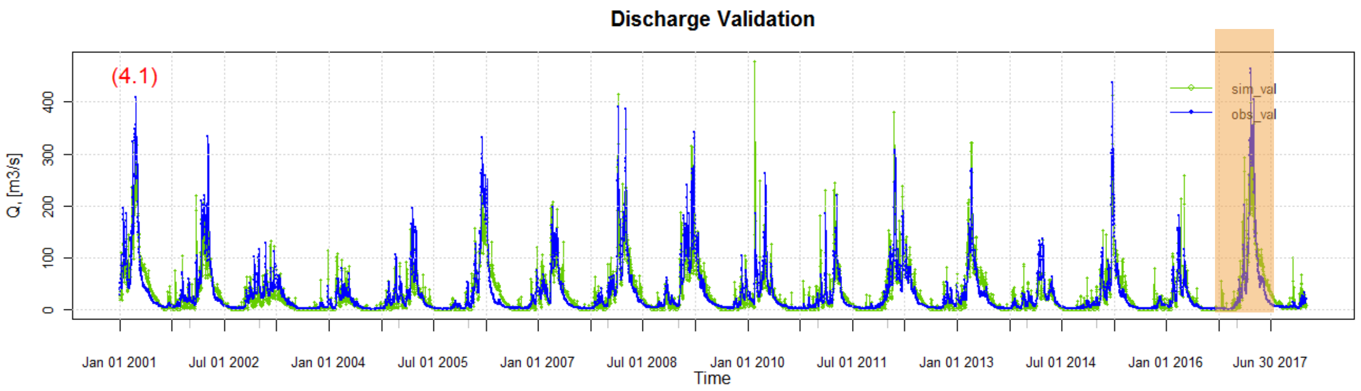


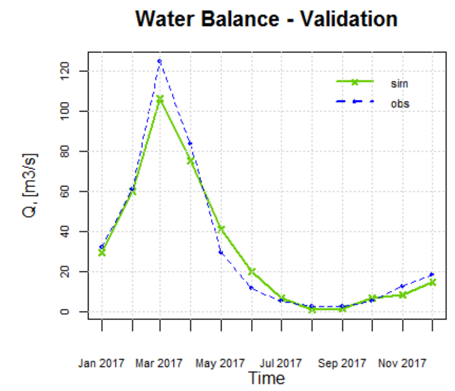


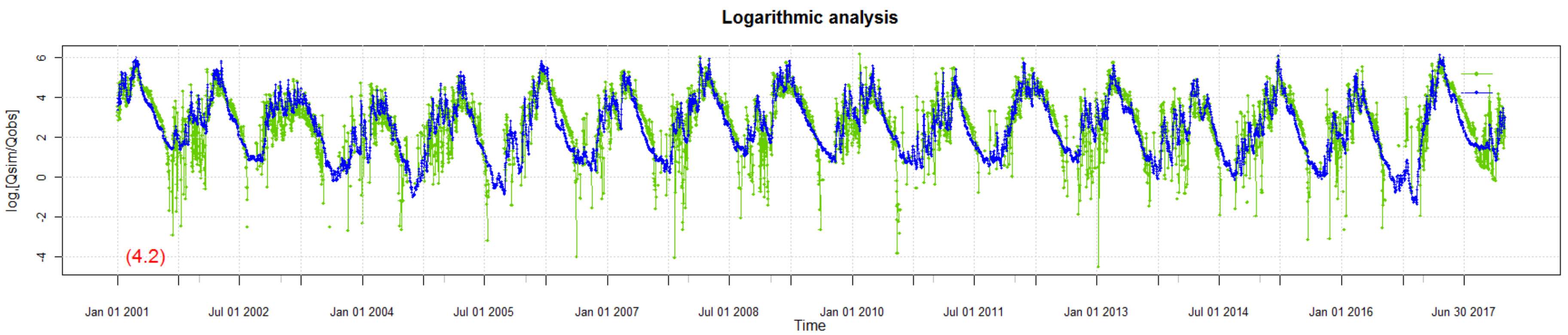
flow calibration, statistical achievement that classifies the model as "good" at a daily rate (NSE = 0.7, KGE = 0.82, PBIAS = 1.4), and at a monthly rate it manages to be "very good" (NSE = 0.92, KGE = 0.91, PBIAS = 1.3).

Results

The modeling phase began on January 1, 1981 and ended on December 31, 2017. A warm-up period (January 1, 1981-December 31, 1982), an eighteen-year calibration period (January 1, 1983-December 31, 2000), and a seventeen-year validation period (January 1, 2001-December 31, 2017).

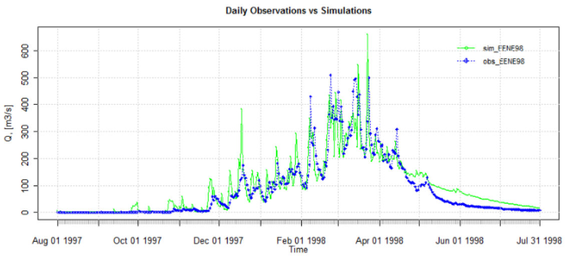


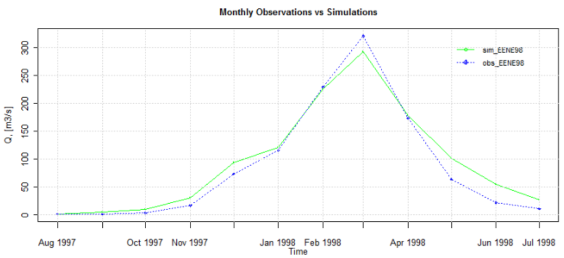


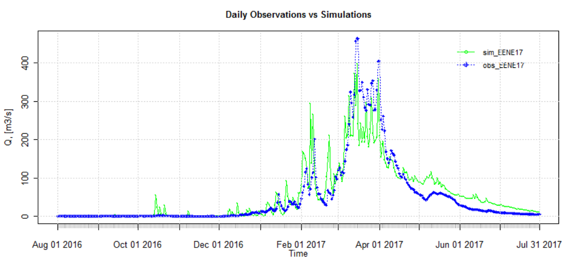


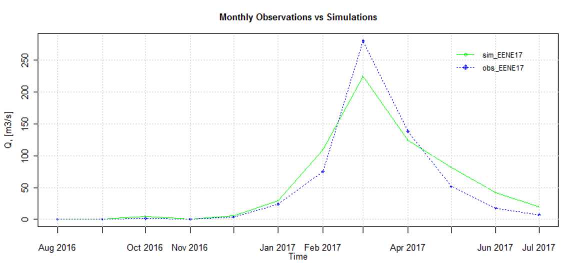
Flow validation, statistical achievement that classifies the model as "good" at a daily rate (NSE = 0.72, KGE = 0.83, PBIAS = -4.1), and at a monthly rate it manages to be "very good" (NSE = 0.92, KGE = 0.85, PBIAS = -4.6).

Results

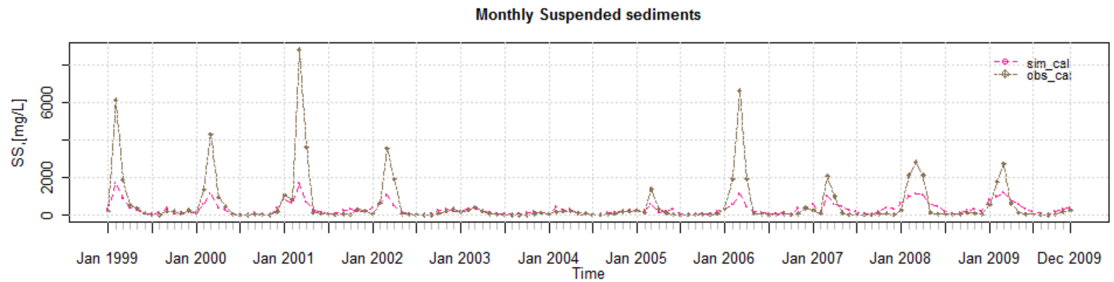


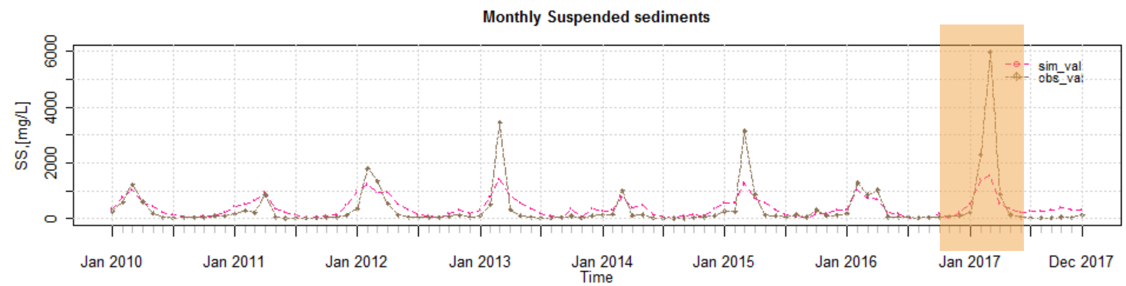






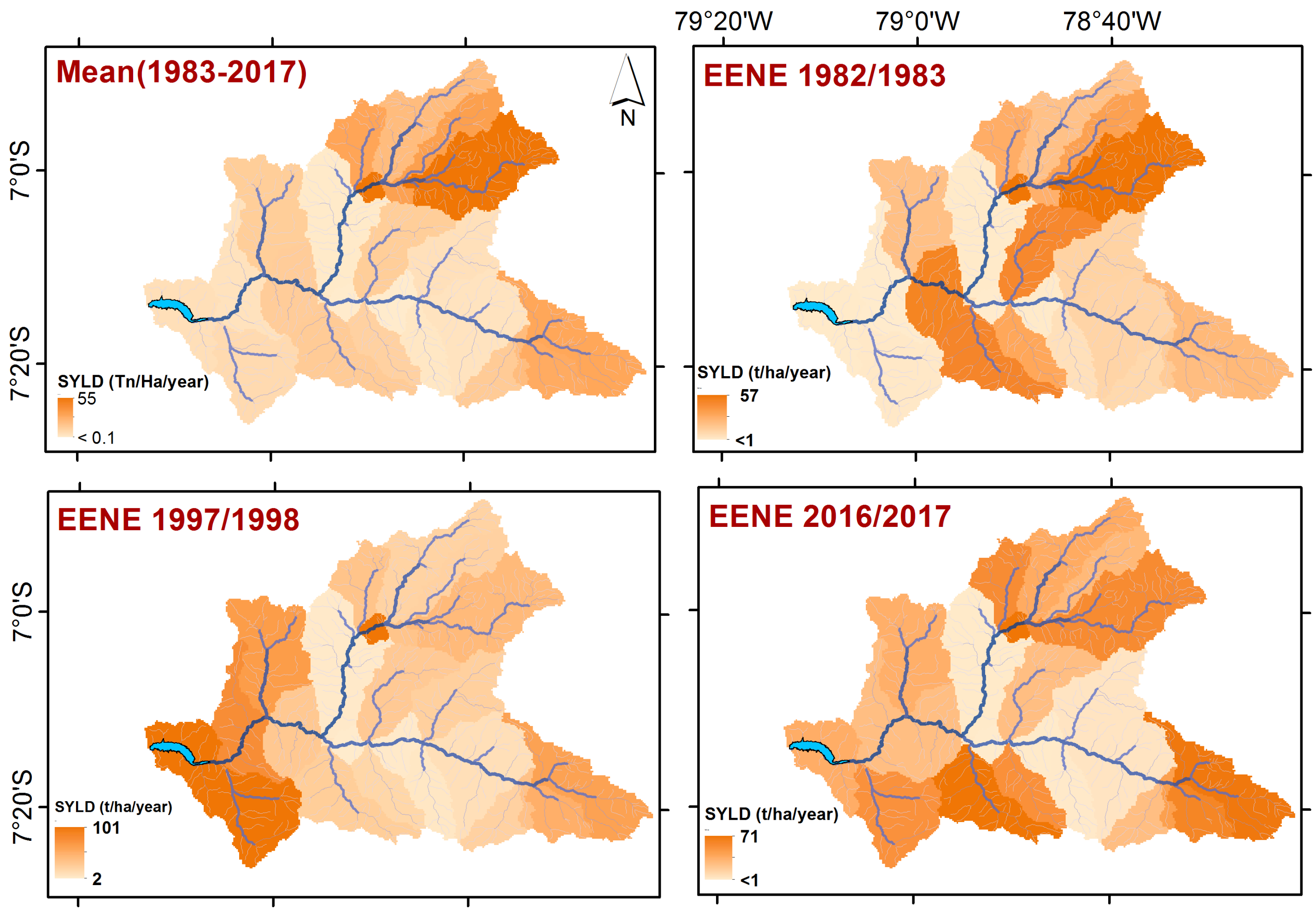
The model had a two-year warm-up period (January 1, 1981 - December 31, 1982), an eighteen-year calibration period (January 1, 1983 - December 31, 1994), and a sixteen-year validation period (January 1, 1995 - December 31 2012).





The sediment transport calibration process was carried out from January 1, 1999 to December 31, 2009, monthly, presenting statistics that classify the model response as “satisfactory” (NSE=0.51, R2=0.58 and PBIAS=16. 3); while the validation period was developed in the period January 01, 2010 until December 31, 2017, at monthly step, presenting statistics that catalog the model response in “satisfactory” condition (NSE=0.50, R2=0.58 and PBIAS=23.1).

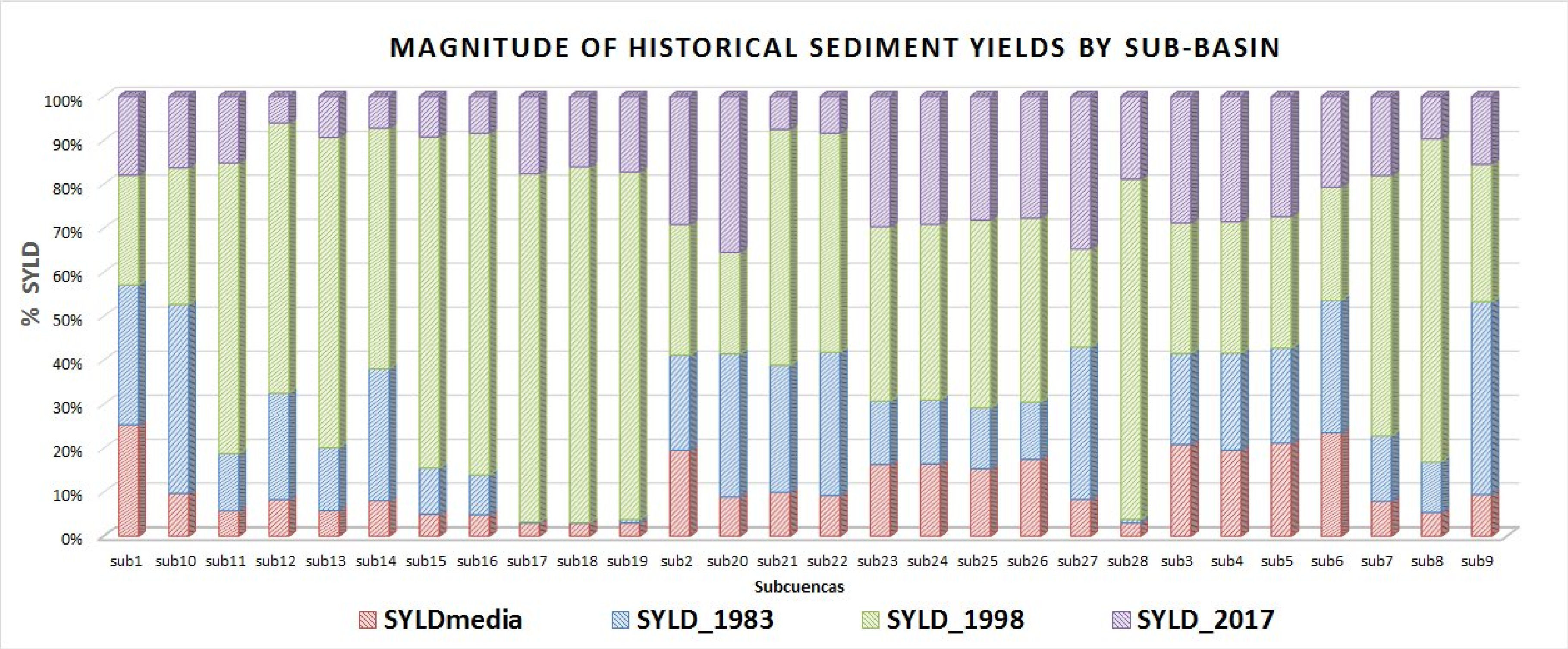
Results and Conclusions



Sediment yields in the Jequetepeque watershed were highest in the months of February (interannual average of 63 t/ha/year) and March (interannual average of 95 t/ha/year), but during the months of July (interannual average of 0.5 t/ha/year) and August (interannual average of 0.4 t/ha/year), the highest sediment yields were observed during the months of March (interannual average of 95 t/ha/year) and July (interannual average of 0.5 t/ha/year).

In extreme event scenario, the highest rate of sediment produced was observed during El Niño 1997/98, with a production range of 1 to 101 t/ha/yr; while the second highest production was observed during the coastal El Niño 2016/17 with a production range of between 0.3 to 71 t/ha/yr and finally during El Niño 1982/83 the sediment production range was between 0.1 to 57 t/ha/yr.

Results and Conclusions



The analysis of the last 3 extreme events in the Jequetepeque basin shows that the EENE 1997/98 had the greatest impact, with a magnitude 28 times higher than the interannual average sediment. It is followed by EENE 2016/17 with a magnitude 7 times higher and EENE 1982/83 with a magnitude 5 times higher.

Thanks

PUCP
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Texas A&M AgriLife Research
USDA ARS Agricultural Research Service

Ask not what your country
can do for you, but what you
can do for your country.

JOHN F. KENNEDY