

THESIS

IMPACT OF RAINFALL AND LANDUSE PATTERN ON
WATER AND SEDIMENT YIELD OF SOAN BASIN



7350

FIAZ HUSSAIN
(2012-MS-WRE-03)

For the Degree of

MASTER OF SCIENCES

IN

WATER RESOURCES ENGINEERING

CENTRE OF EXCELLENCE IN WATER RESOURCES ENGINEERING
UNIVERSITY OF ENGINEERING & TECHNOLOGY, LAHORE, PAKISTAN

2015

ABSTARCT

This study was undertaken for spatial and temporal rainfall pattern along with landuse landcover classification and change detection of Soan basin Pothwar region, further the assessment of water and sediment yield and modelling the impact of landuse changes on sediment yield of Soan basin was done using semi-distributed basin scale SWAT model

The temporal rainfall trend using Mann-Kendall and Sen's Slope estimates test revealed the decreasing trend of average annual rainfall due to negative values of Q and Z – statistics. The average annual rainfall ranges 400mm – 1710 mm in Soan basin and temporal and spatial rainfall analysis 1991 to 2012 depicted that there is substantial year to year and season to season variability in rainfall pattern and rainfall pattern is generally erratic in nature. The seasonal patterns showed that 60 % to 70 % rainfall occurred in monsoon months (Jun-Sep). The mean monthly analysis indicated that intensity of rainfall gradually goes on increasing from May to August and decreases sharply by the month of October. August is the highest rainfall recording month in all the stations

The landuse classification patterns indicated that most of the area of Soan basin is covered by mountainous area with shrubs and fallow land. This fallow land becomes the agricultural land with the availability of water and with the time of cropping season. The landuse changes detection were performed for four sub- periods i.e. 1991 - 1993, 1998 - 2000, 2009 - 2011 and 2012 – 2014 by selecting 2014 base year. Major landuse changes were observed in the forest and agriculture. The forest area decreased due to deforestation and there was reduction of about 242 km² (2.42 %) during 1991 to 2014 while during 2000 to 2014 and 2011 to 2014 its reduced about 32 km² (0.32 %) and 7 km² (0.07%) respectively. The agricultural area increased regularly during the period

1991-2014. The percentage increase was about 4.89 % (489 km²) during 1991 to 2014 while this increasing rate become dominant during 2011 to 2014 period where about 10.65 % increase in agricultural area i.e. 1064 km². Similarly the fallow land and mountainous land has also decreased i.e. 1390 km² (13.91 %) and 1671 km² (16.72 %) respectively. The water bodies of Soan basin increased at the rate of 8 km² (0.08 %) during 1991 to 2014 respectively.

Soan basin is ungauged so for the assessment of water and sediment yield first SWAT model was calibrated (1991 to 1993) and validated (1998 to 2000) separately using SUFI-2 algorithm of SWAT CUP for water and sediment yield at Dhoke Pathan upstream gauging station using thirteen water yield and eight sediment yield parameters. The model performance for calibration and validation was evaluated using coefficient of determination (R^2) and Nash-Sutcliffe (NSE). The results were efficient and satisfactory for the gauging station during calibration and validation ($R^2= 0.85 - 0.88$ and $NSE = 0.78 - 0.83$ for water yield and $R^2= 0.80 - 0.82$ and $NSE = 0.77 - 0.80$ for sediment yield). The correlation equation $Q_{stim} = 1.06Q_{obs}$ with $R^2= 0.94$ indicated that model performance is good and there was a strong correlation between observed and predicted flow at gauging site.

After calibration and validation, the SWAT model simulation was done for Soan basin duration (1991 – 1993, 1998 – 2000 and 2009 – 2011). The estimated average annual water and sediment yield were 325 mm and 33.77 t/ha respectively for whole study duration. Two correlation equations were developed for Soan basin $W.Y_{mm} = 0.3575 (PREC_{mm}) - 0.1224$, with $R^2 = 0.73$ and $S.Y_{t/ha} = 0.146 (W.Y_{mm}) - 0.55$, with $R^2 = 0.83$

The impact of rainfall change was assessed on landuse, water and sediment yield and it was clearly identified that the forest, agricultural, and mountains area with

shrubs and bushes decreased with decrease in rainfall. It was estimated that about 70 mm decrease in rainfall amount produced 103 mm and 4.31 t/ha decrease in water and sediment yield of Soan basin.

Six landuse change scenarios were developed to analyzed impact on sediment yield **S1 Scenario:** 50 % fallow land converted into agricultural land produced 6.25 % increase in S.Y. **S2 Scenario:** 50% forests converted into mountainous land with shrubs and bushes indicated 22 % increase in S.Y, **S3 Scenario:** 100% mountainous land converted into forest showed 20.43% decrease in S.Y, **S4 Scenario:** 100% agricultural land converted into fallow land indicated 24.23 % decrease in S.Y, **S5 Scenario:** 100% fallow and mountainous area converted into agricultural land produced 18.94 % increase in S.Y, **S6 Scenario:** 100% forest and mountainous land converted into agricultural land indicated 45.88 % increase in S.Y

In conclusion decreasing trend of rainfall and landuse changes are the most important agro-climatic variables that could be used for better planning of water resources development and management schemes as well as conservation of soil moisture also SWAT model give reasonably good results of water and sediment yield of Soan basin Pothwar region Pakistan which could be used to effectively design agricultural related practices, soil and water management and conservation techniques designs etc. in absence of gauged information's.