2018 SWAT Conference in Chennai, India
Indian Institute of Technology Madras

Assessing Impact of landuse/Land cover Changes on Stream flow in Noyyal River catchment using ArcSWAT model

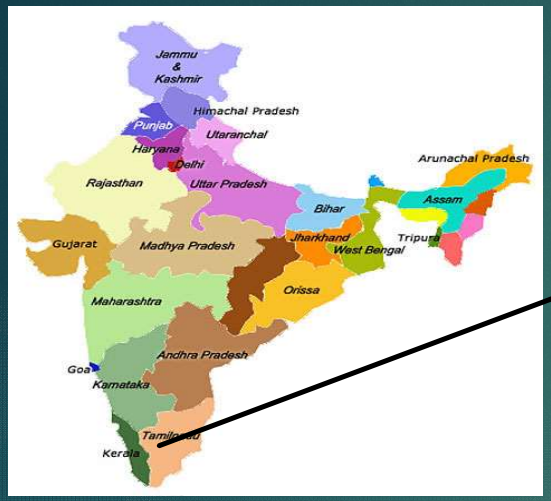
NATIONAL INSTITUTE OF TECHNOLOGY TIRUCHIRAPPALLI,
TAMILNADU, INDIA

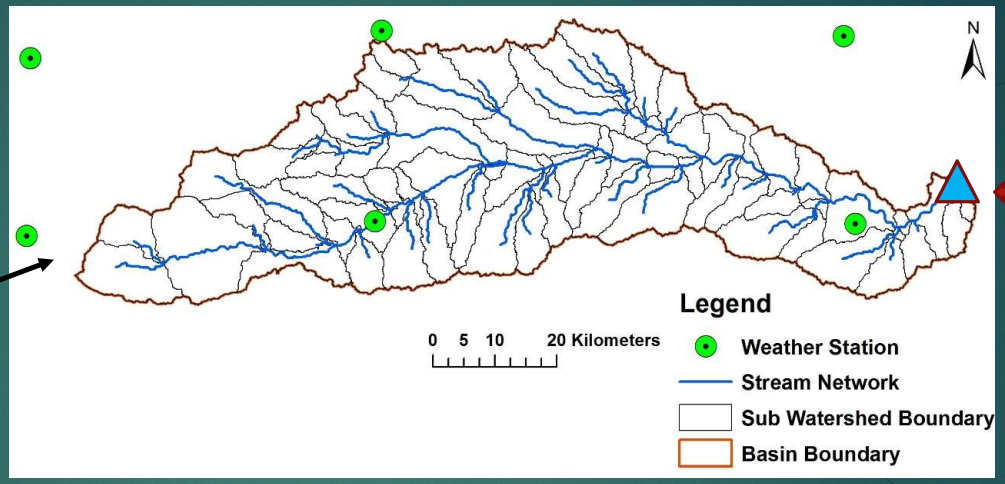
LEELAMBAR SINGH
S. SARAVANAN
J. JACINTH JANNIFER

Background and purpose

- The main objective of this research is to test the performance and feasibility of the SWAT model for predicting stream flow in the river basin
- This investigated the hydrological responses of a watershed to land cover dynamics for the period from 2000 to 2010
- to evaluate the impacts of land use changes on streamflow

Study Area

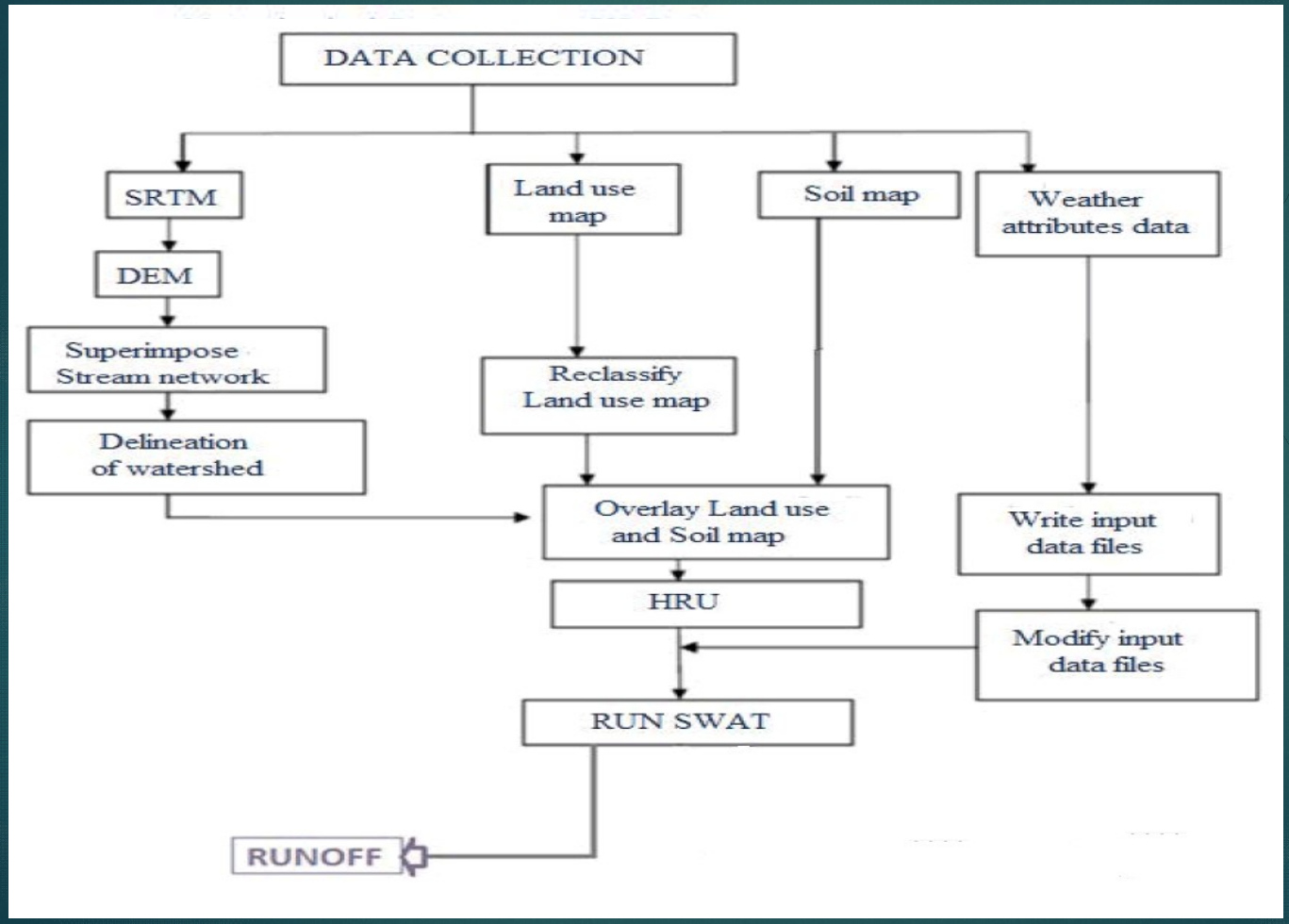




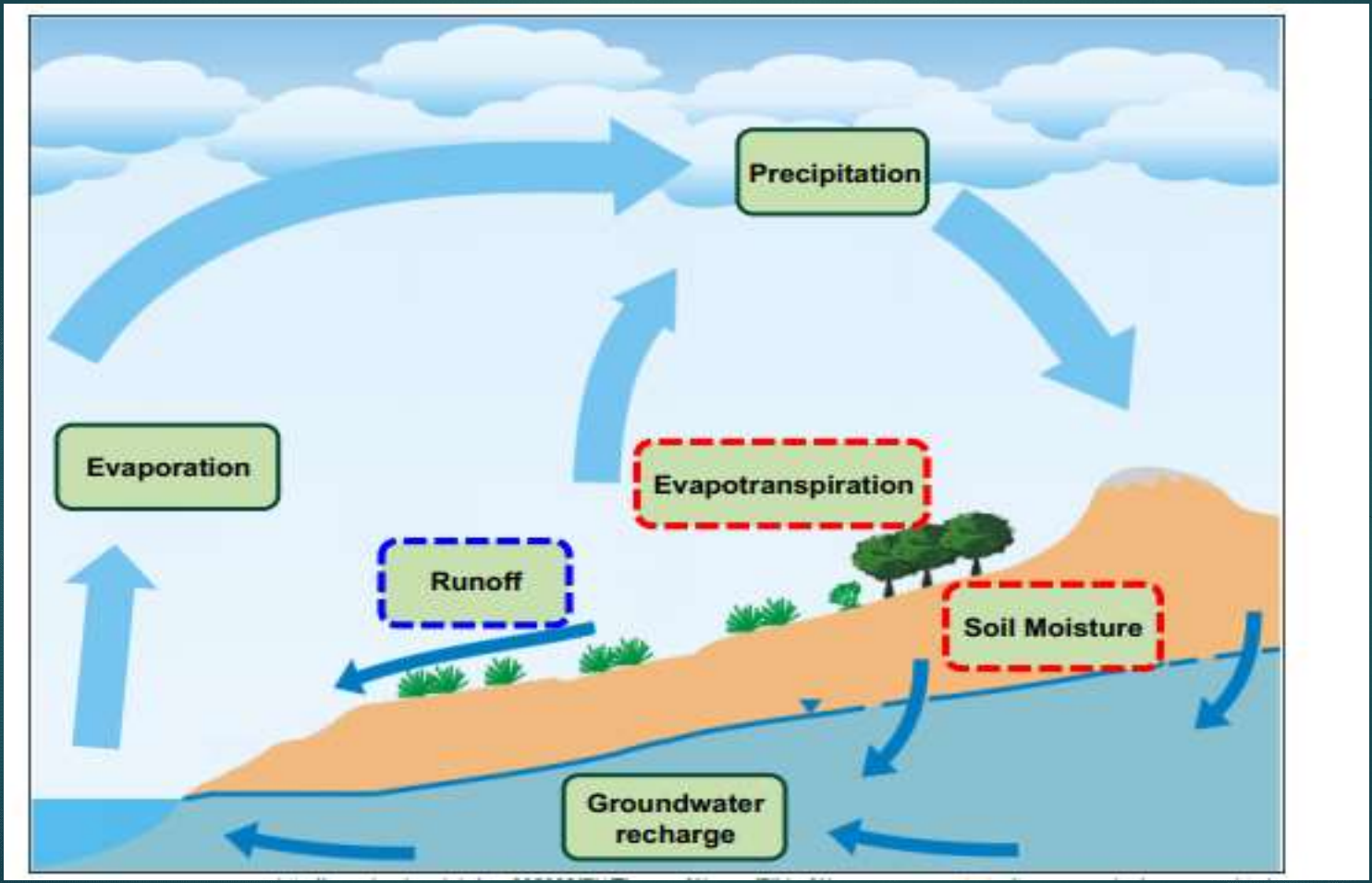
- The **Noyyal River** is a small river in Western Tamil Nadu, and a tributary of Kaveri River.
- 70% cover agricultural land

Watershed Area : 3600 km2
Annual average precipitation : 700-800 mm

Study Procedure



Hydrological Cycle



SWAT Hydrological model

- Soil and Water Assessment Tools (Arnold et al. 1998)

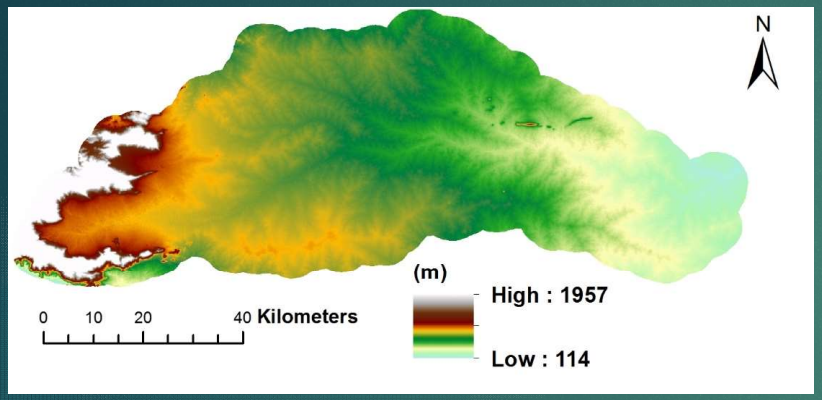
- ✓ SWAT is continuous, long-term, and distributed-parameter model designed to predict the impact of land management practices on the hydrology and sediment and contaminate transport in agriculture watersheds.
- ✓ SWAT subdivide a watershed into sub-basin connected by a stream network, and further delineates HRUs(Hydrologic Response Unit) consisting of unique combination of land cover and soils within each sub-basin.
- ✓ The hydrological cycle as simulated by SWAT is based on the water balance equation:

$$SW_t = SW_0 + \sum_{i=1}^{t} (R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw})$$

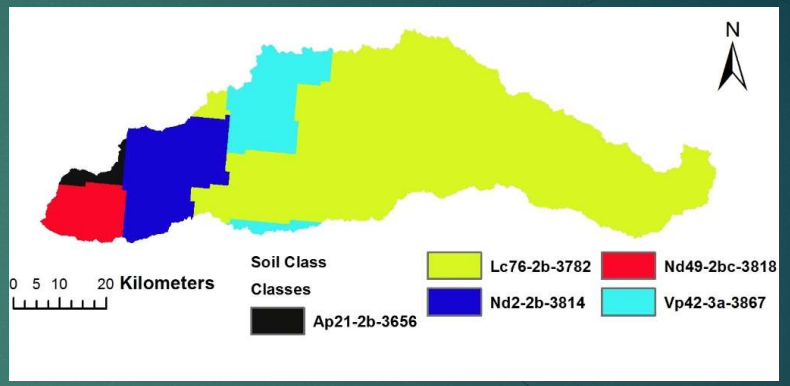
SW_t = *Final soil water content (mm)*
SW_0 = *Initial soil water content on day i (mm)*
R_{day} = *Amount of precipitation on day i (mm)*
Q_{surf} = *Amount of surface runoff on day i (mm)*
E_a = *Amount of evapotranspiration on day i (mm)*
W_{seep} = *Amount of water entering the vadose zone from the soil profile on day i (mm)*
Q_{gw} = *Amount of return flow on day i (mm)*

GIS input data

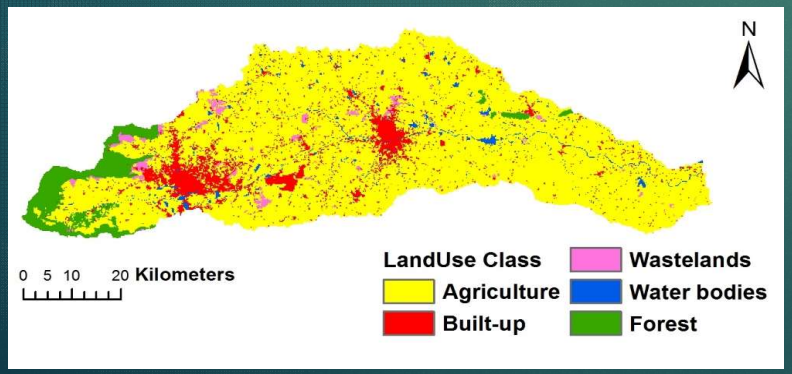
DEM



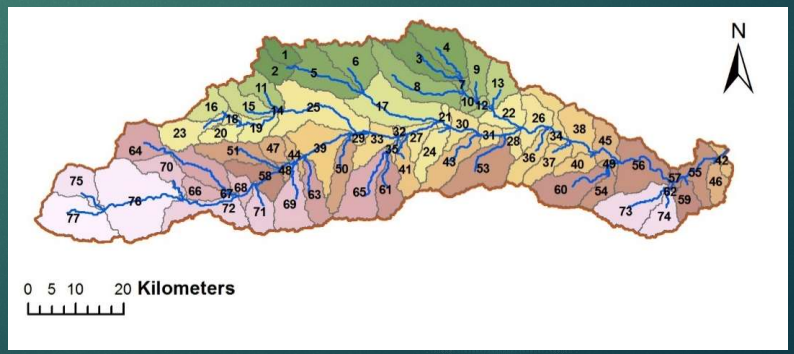
Soil Map



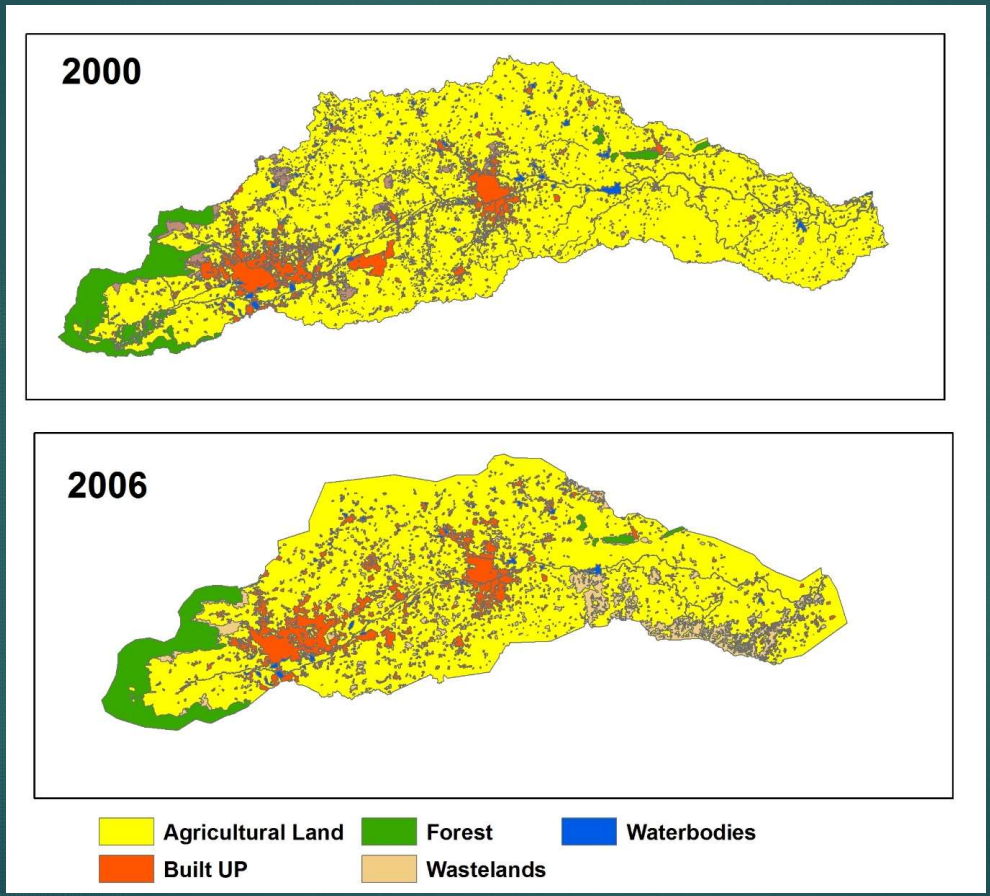
LandUse Map

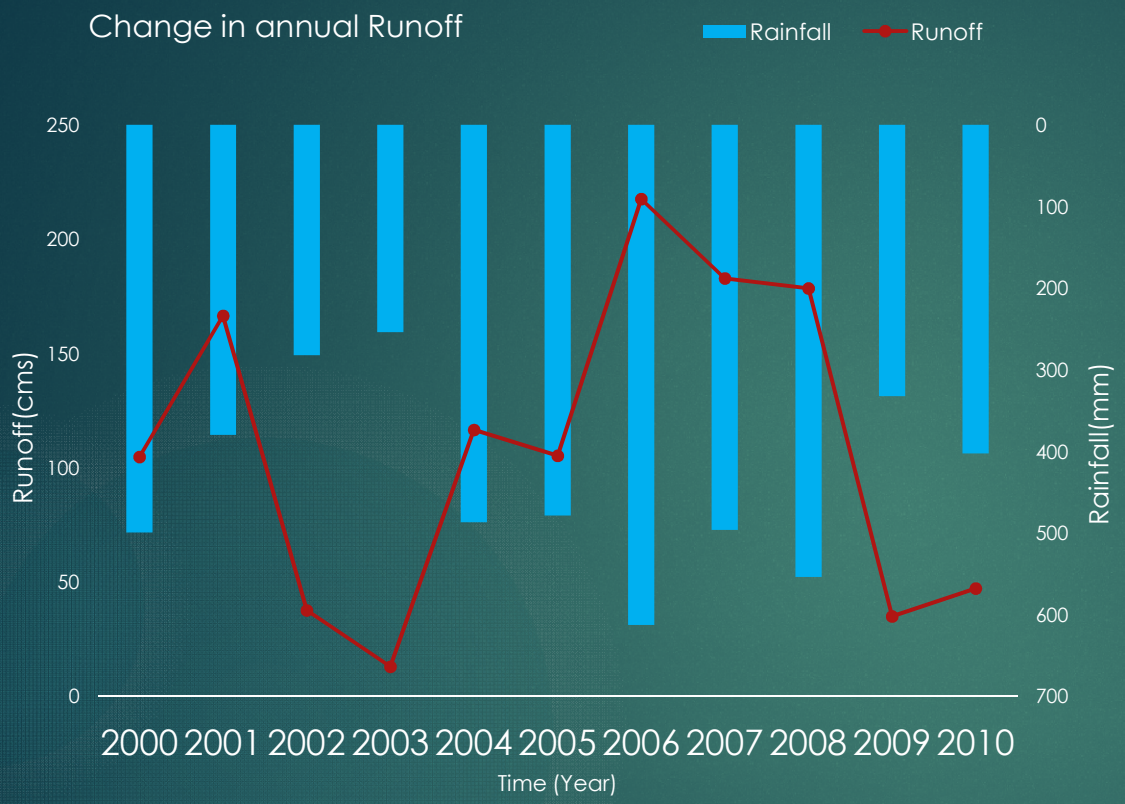


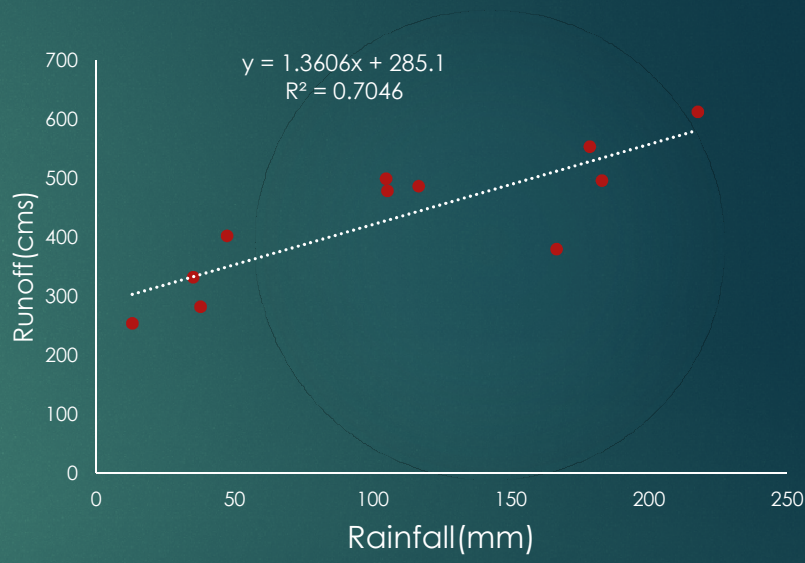
Watershed



Landuse comparison for 2000 and 2006

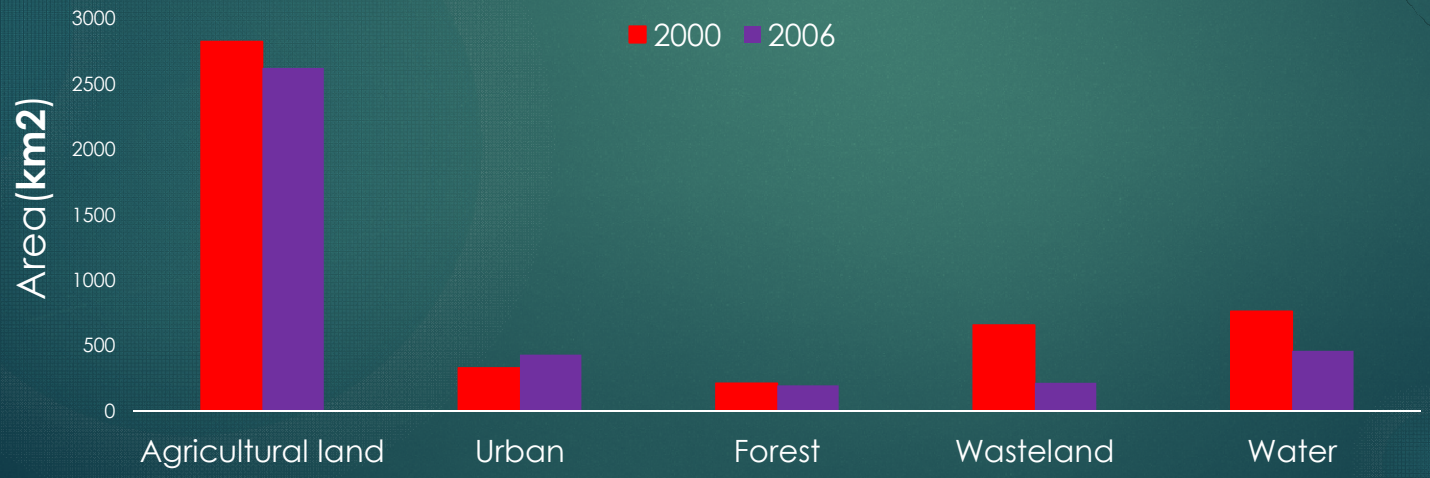



Change in annual Runoff
Rainfall
Runoff
250
200
150
100
50
0
Runoff(cms)
0
100
200
300
400
500
600
700
Rainfall(mm)
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Time (Year)


y = 1.3606x + 285.1
R² = 0.7046
700
600
500
400
300
200
100
0
Runoff(cms)
0
50
100
150
200
250
Rainfall(mm)

Characteristics of landuse changes in catchments from 2000 to 2006

	2000 (km2)	2006 (km2)	2000-2006(%) Changes
Agricultural land	2821.5	2620.3	-7.2
Urban	328.9	428.9	+1.3
Forest	210.8	193.8	-8.1
Wasteland	654.9	213.95	-67.4
Water	760.8	458.3	-39.8

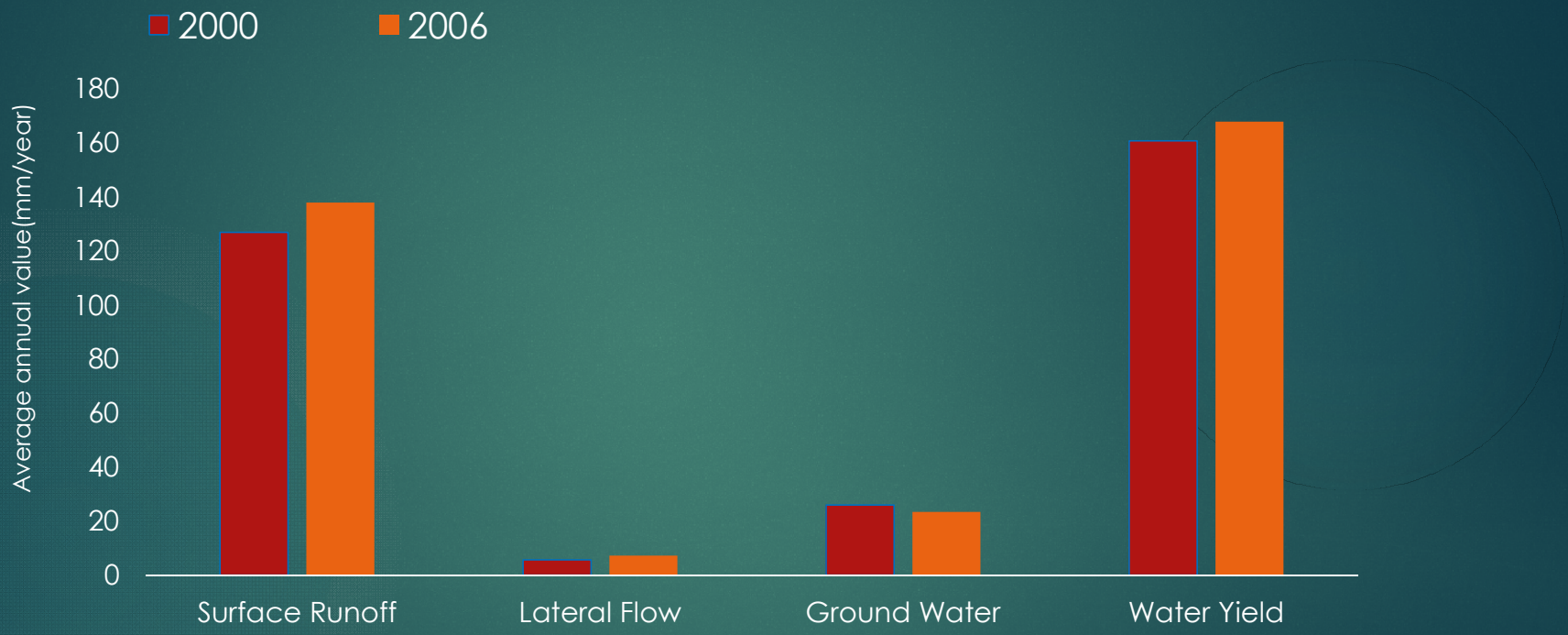


Annual water budgets of Noyal catchment under two landuse conditions of 2000 and 2006

	Year	PRECIP(mm)	SUR_Q(mm)	LAT_Q(mm)	GW_Q(mm)	PERC(mm)	ET(mm)	WYLD(mm)
2000	2000	504.17	100.67	4.68	16.28	23.22	416.39	123.43
	2001	680.75	167.38	5.17	8.01	25.50	507.67	181.56
	2002	416.83	42.35	3.66	7.77	15.69	416.19	54.91
	2003	356.12	19.14	2.64	3.41	3.24	398.95	25.82
	2004	744.87	154.06	6.38	18.83	71.61	487.21	180.58
	2005	737.58	160.60	5.99	21.12	51.60	534.46	190.63
	2006	791.52	187.79	8.65	57.64	127.47	501.38	257.64
	2007	867.64	206.66	6.78	63.03	63.49	608.54	282.31
	2008	841.38	244.91	7.88	50.11	70.29	566.23	307.53
	2009	553.84	57.67	5.14	13.68	33.48	495.01	77.94
	2010	505.14	53.33	4.43	24.74	49.33	451.17	84.39
2006	2000	504.17	122.21	6.14	14.76	28.65	365.46	141.11
	2001	680.75	177.02	6.68	9.15	35.14	446.84	189.85
	2002	416.83	47.56	5.07	6.06	19.63	368.05	57.69
	2003	356.12	22.95	3.95	2.10	8.05	348.80	27.00
	2004	744.87	163.11	8.08	14.63	79.69	395.84	183.82
	2005	737.58	169.18	8.06	18.35	60.58	453.20	193.59
	2006	791.52	189.84	10.71	51.37	149.25	409.41	250.92
	2007	867.64	232.51	8.79	59.60	78.69	502.40	289.90
	2008	841.38	259.61	9.49	47.68	76.96	481.69	315.78
	2009	553.84	70.77	6.42	12.31	46.12	422.96	88.50
	2010	505.14	60.67	5.56	20.87	54.86	379.00	88.10

Note: PRECIP is annual precipitation, SURQ is the surface runoff contribution to streamflow, LATQ is the lateral flow contribution to streamflow, GW Q is the groundwater flow contribution to streamflow, PERC is the percolation from the root zone to the aquifer zone, TLOSS is the water loss from reach by transmission through the streambed, ET is the actual evapotranspiration, and WYLD is the annual water yield in streamflow (WYLD = SURQ + LATQ + GWQ - TLOSS). The precipitation PRECIP is basically

balance with the sum of SURQ + LATQ + PERC + ET over a year or longer period of time, without including the minor changes in catchment water storage


2000
2006
Average annual value(mm/year)
180
160
140
120
100
80
60
40
20
0
Surface Runoff
Lateral Flow
Ground Water
Water Yield

Conclusion and discussion

- Analysis indicate urbanization as the strongest contributor to increases in surface runoff generation, water yield and evapotranspiration (ET). Runoff increasing as urbanization increasing in that area(increased from 2000 to 2010).
- Agricultural Land approx. 7.2% reduced during 2000-2006
- Future approaches-Calibration and validation
- The model can be used for further analysis of the effects of the climate and, water quality analysis and sediment yield analysis; furthermore, the modelling can be applied for planning dam construction in the future and thereby is useful for the sustainable development of the country.

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Thank you..