HR Wallingford
Working with water

Climate change and hydrology

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Climate change effects

> Annual and seasonal precipitation
> Event precipitation – depth duration and frequency
> Rainfall erosivity (soil erosion)
> Potential and actual evapotranspiration
> Soil moisture balance
> Annual and seasonal river flows
> Peak runoff volumes and river flows
> Groundwater levels, base flows, spring flows

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Linking climate effects to impacts

> Rainfall events – increases in depth for different return periods

> Runoff

> Simple rainfall-runoff methods e.g. the Rational method

> Statistical methods

> Conceptual rainfall-runoff models e.g. PDM, HYSIM, Catchmod, US SCS models

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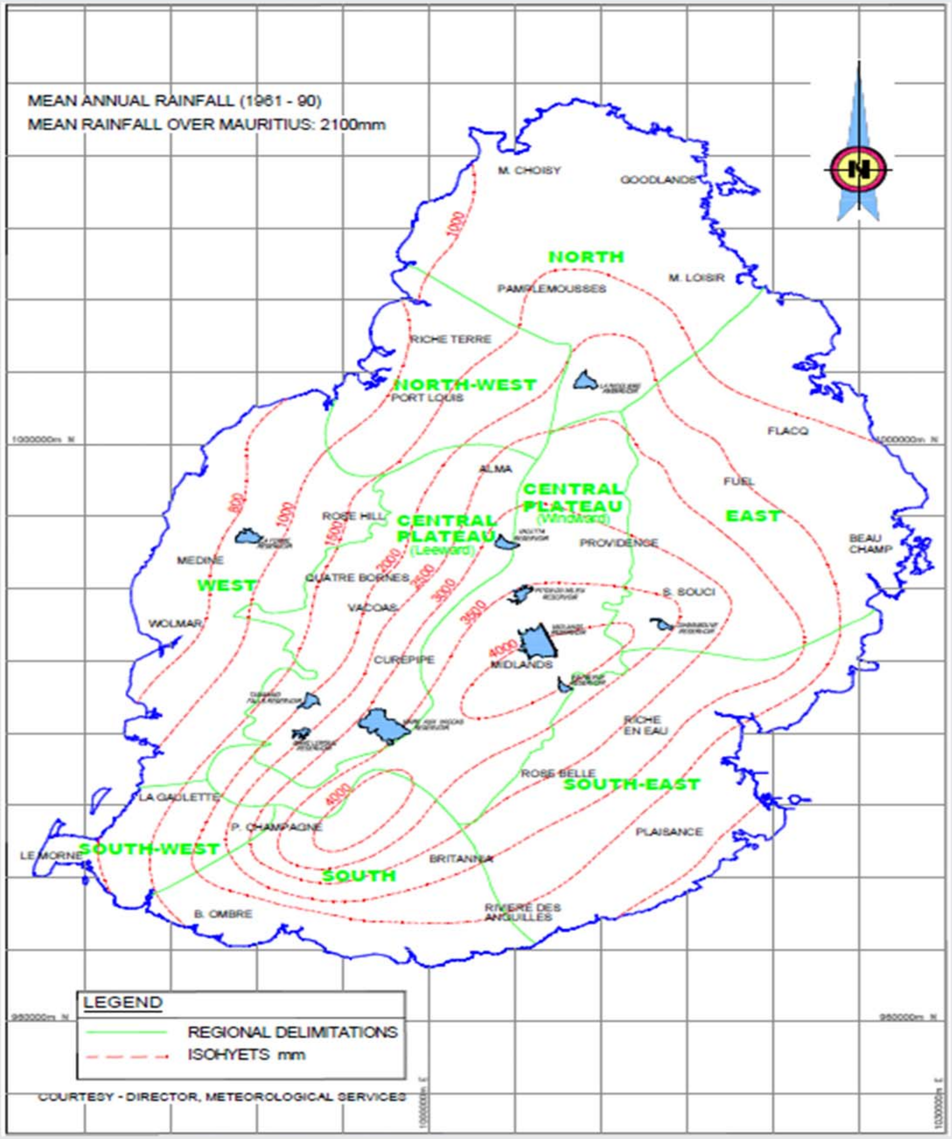
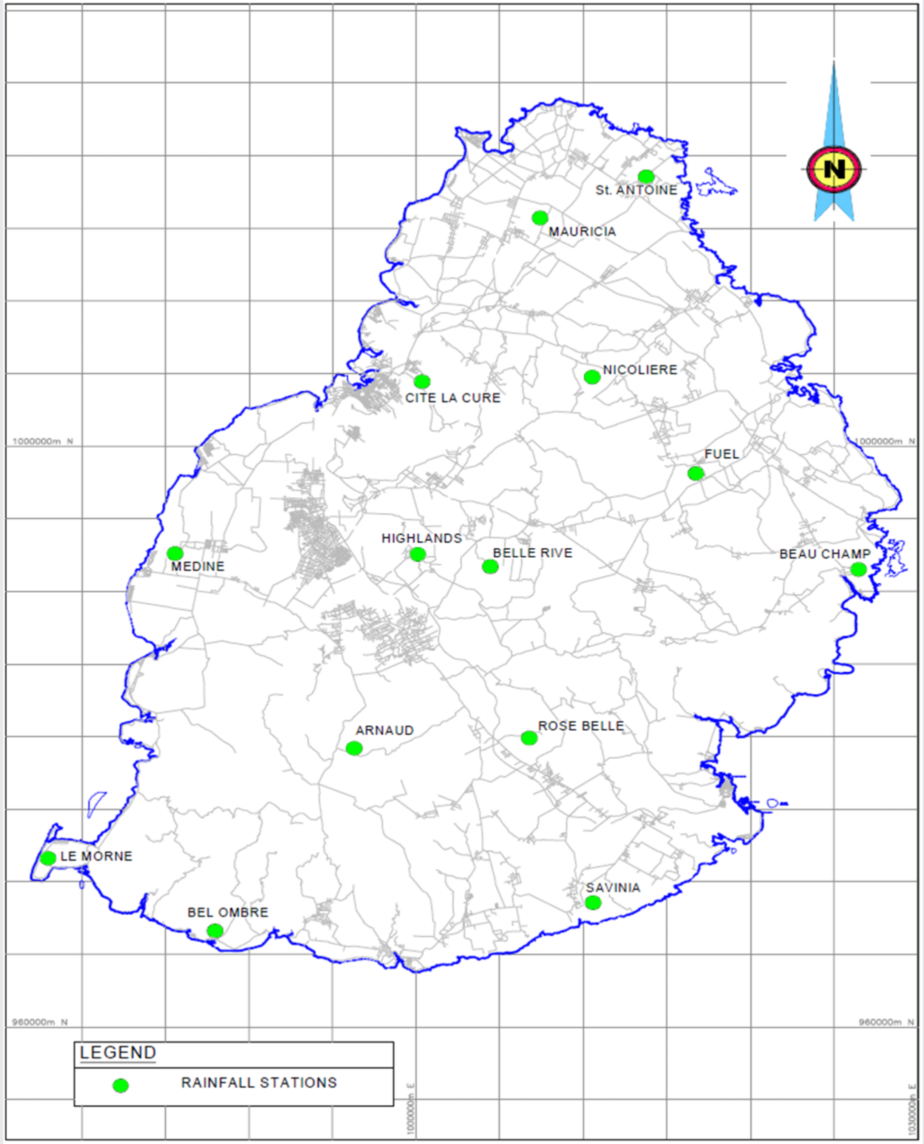
Mauritius – Annual Average Rainfall 1961-1990 (Source: Hydrology Department, Met Service)





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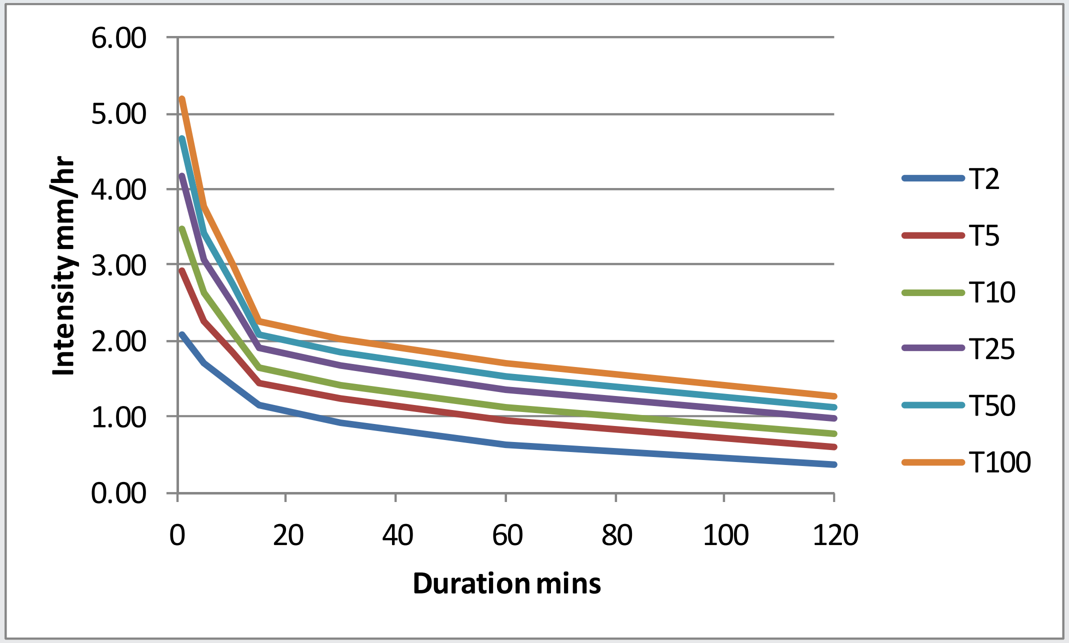
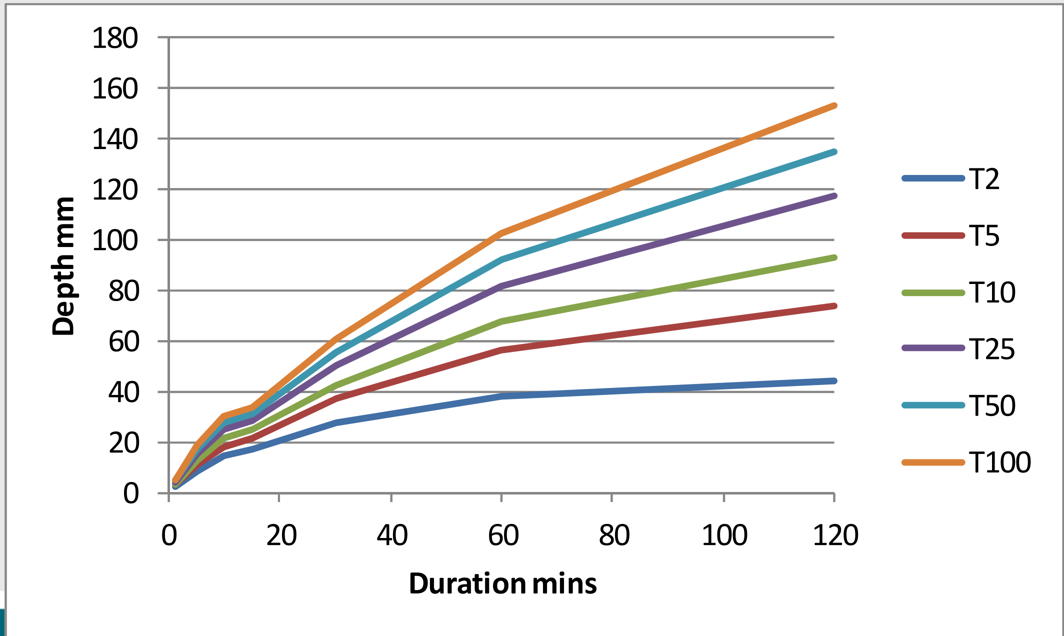
Use of rainfall intensity – duration - frequency (IDF) curves





IDF curve Mauritius Met Service

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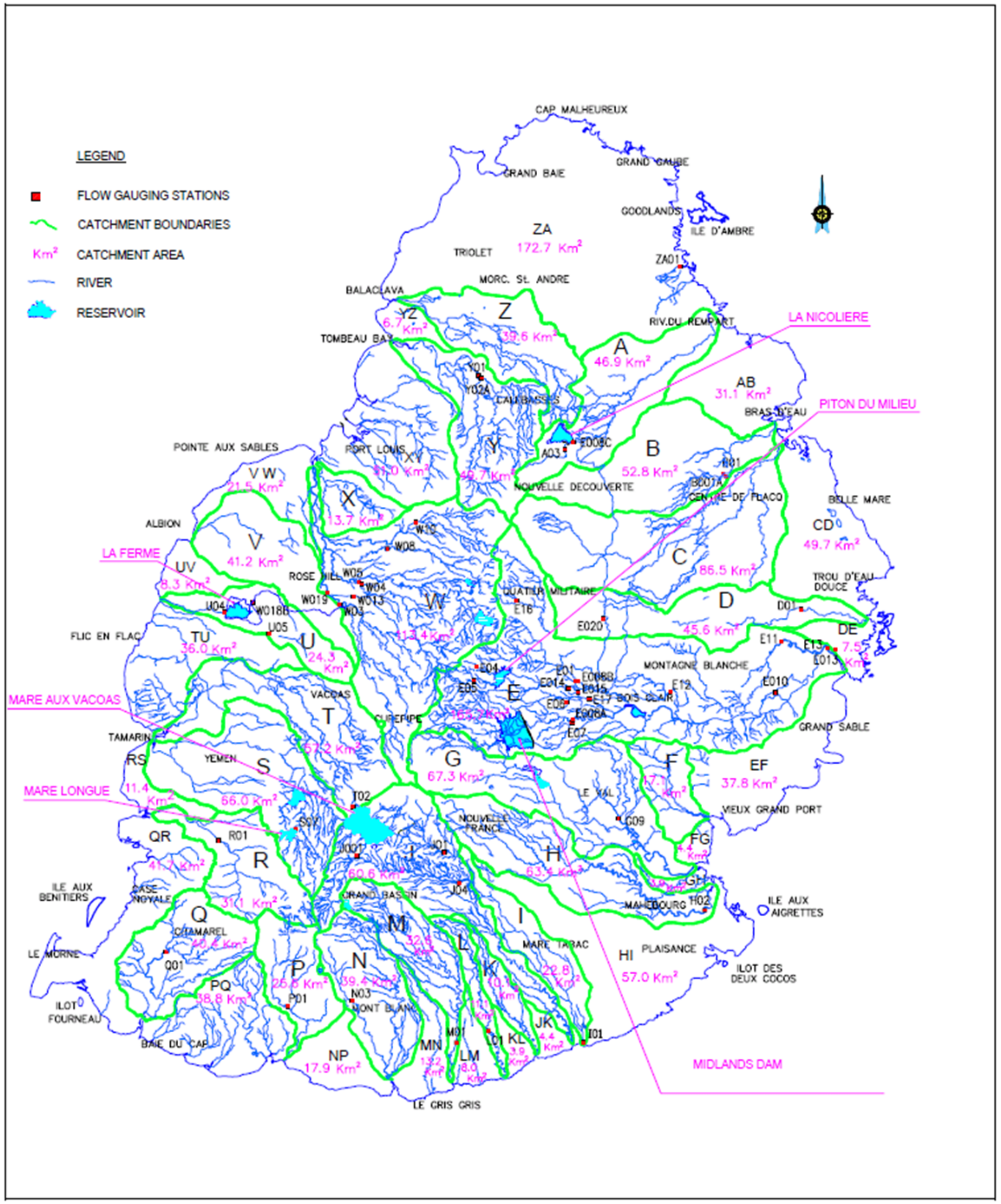
Catchment/site hydrology



Rational method often used for smaller areas

$Q = 0.278\ C.I.A$

Q ~ discharge m^3/s

C ~ Runoff coefficient

I ~ Rainfall intensity mm/hr

A ~ Area km^2

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Estimation of peak flows using the rational method with 5%,20%,40% uplift for climate change

Scenario

Small culvert design

Area = 0.8 km^2

RP = 1 in 10 years

C = 0.192

Climate change impacts

+ 5 % event rainfall (low scenario)

+20% (medium scenario)

+40% (high scenario)

Background information

Table 3.1: Rainfall Intensity (mm/min) - for Different Return Period (Duration in minutes)

Return Period (Years) \ Duration (minutes)	1	5	10	15	30	60	120
T2	2.0868	1.7155	1.4153	1.1550	0.9354	0.6354	0.3699
T5	2.9185	2.2616	1.8416	1.4519	1.2297	0.9388	0.6126
T10	3.4693	2.6232	2.1239	1.6483	1.4246	1.1236	0.7733
T25	4.1650	3.0800	2.4805	1.8967	1.6709	1.3577	0.9763
T50	4.6812	3.4190	2.7450	2.0809	1.8536	1.5305	1.1269
T100	5.1936	3.7554	3.0076	2.2637	2.0349	1.7025	1.2764

(Source: Mauritius Meteorological Service)

Q = 0.278 C.I.A

Q ~ discharge m^3/s

C ~ Runoff coefficient

I ~ Rainfall intensity mm/hr

A ~ Area km^2

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Discussion

Using simple models to estimate peak flows

1. What other parameters are affected by climate change? How can these be included in the rational method?
2. Climate impacts assessment give a range of results. How can these uncertainties be included in design?
3. For larger schemes what other hydrological information and methods can be used?

Information and research needs

1. What data and information are available and what else is needed to understand current risks to Mauritius' roads?
2. What research is needed to develop simple guidelines for including climate change in road design for Mauritius

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Approach in the UK

Based on research and guidance in

1. Flood risk management approaches
   - Detailed catchment modelling (daily, sub-daily with climate change projections)
   - Precautionary allowances
   - Scenario planning using a range of climate scenarios
   - Cost-benefit analysis
2. Urban drainage design manuals
   - Detailed modelling (historical climate, standard uplifts for climate change)
   - Use of weather generators to extend historical record and to downscale climate projections

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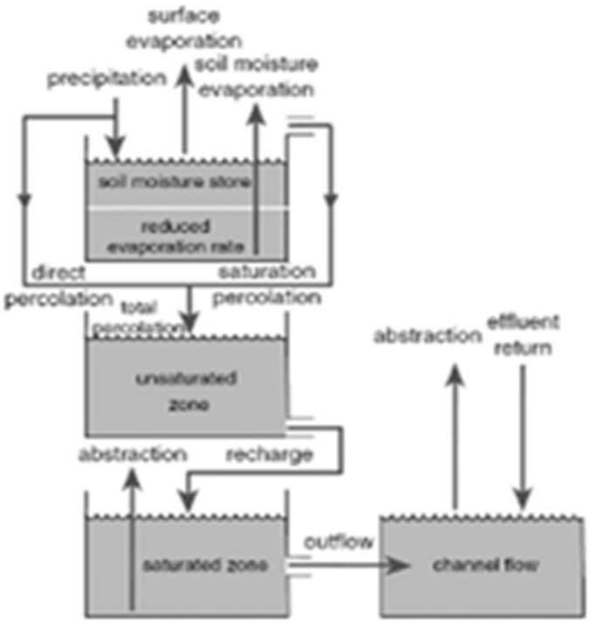
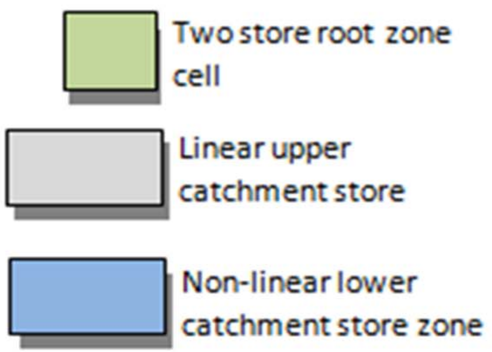
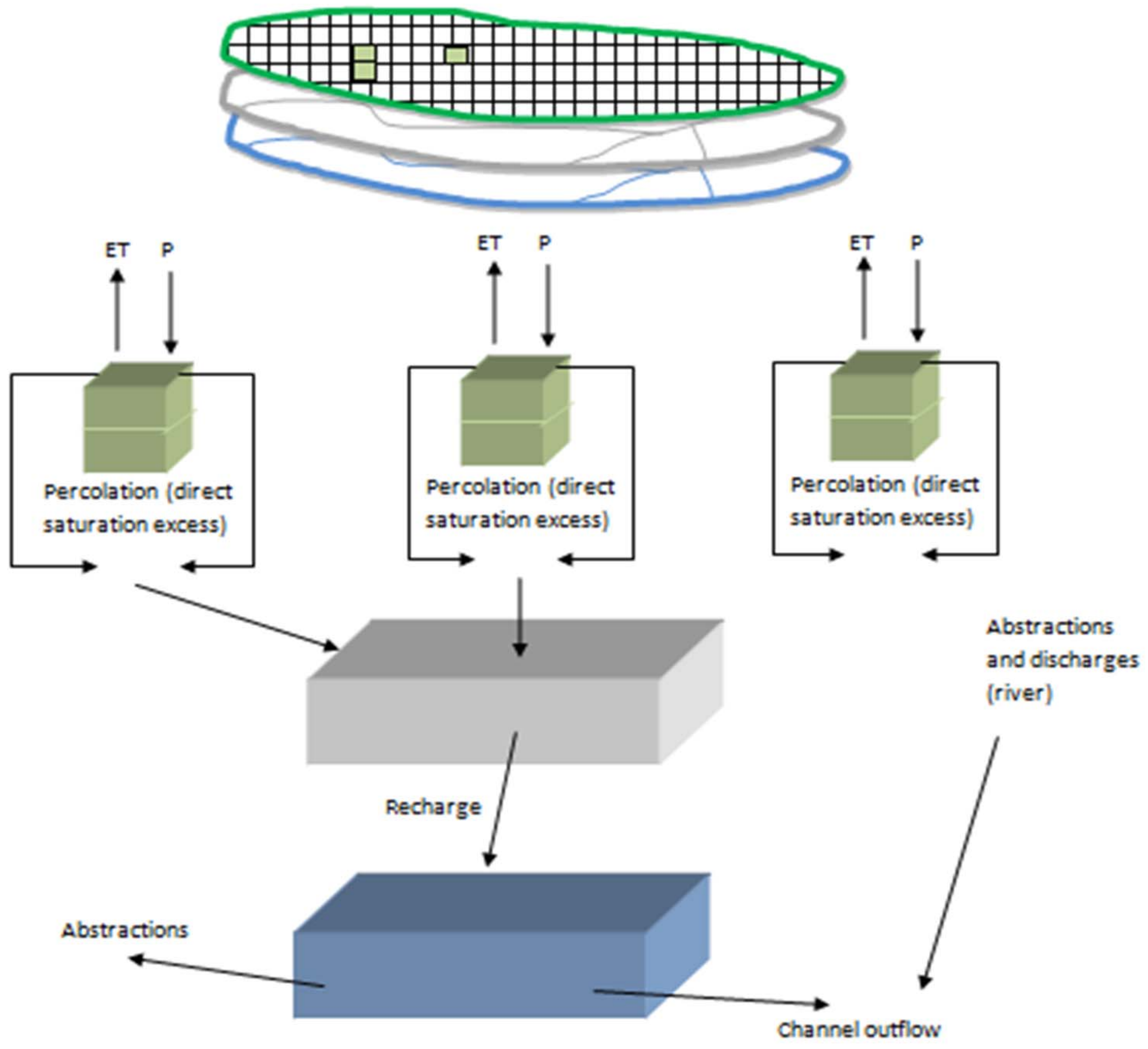
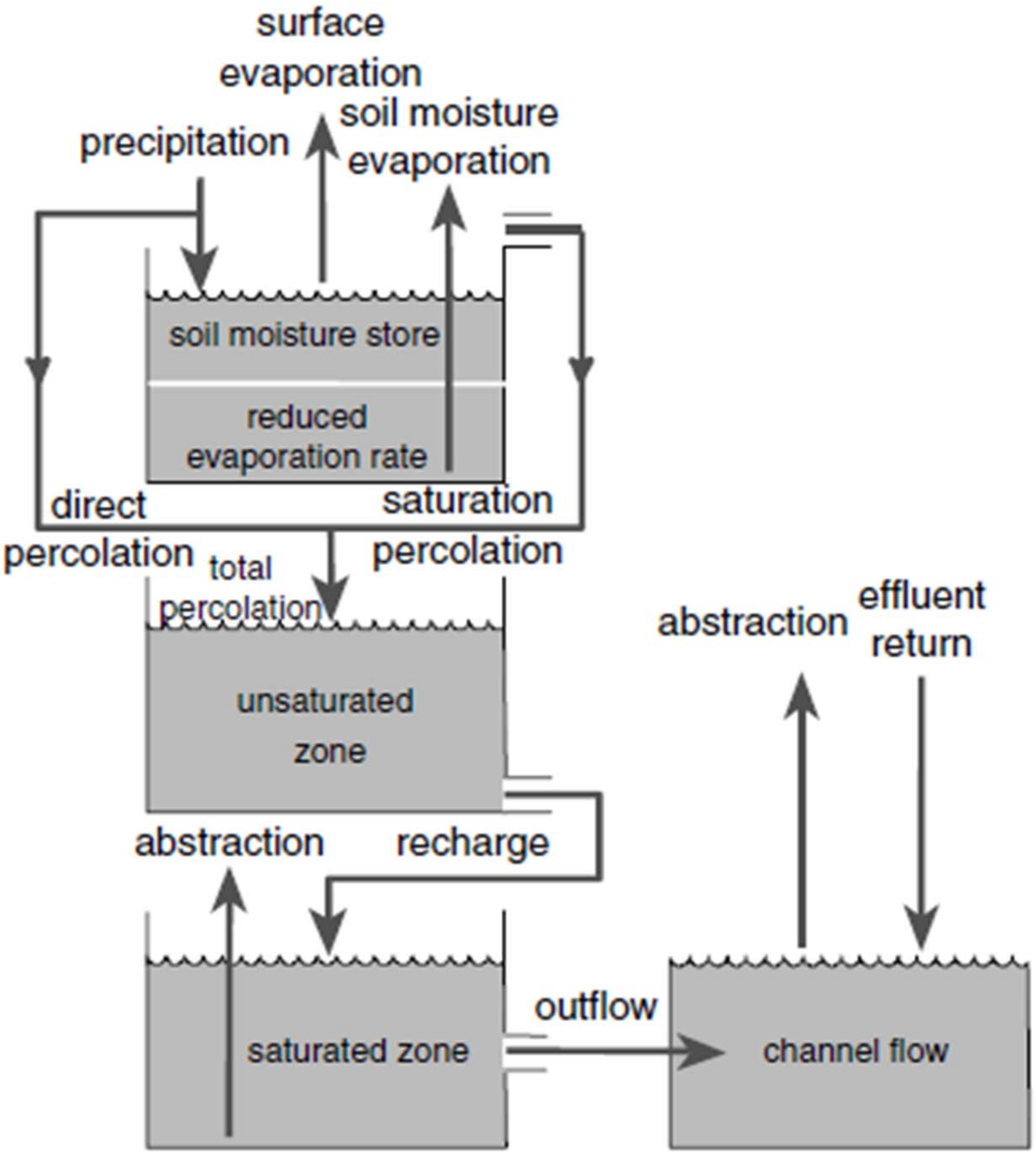
TCM (semi – distributed)

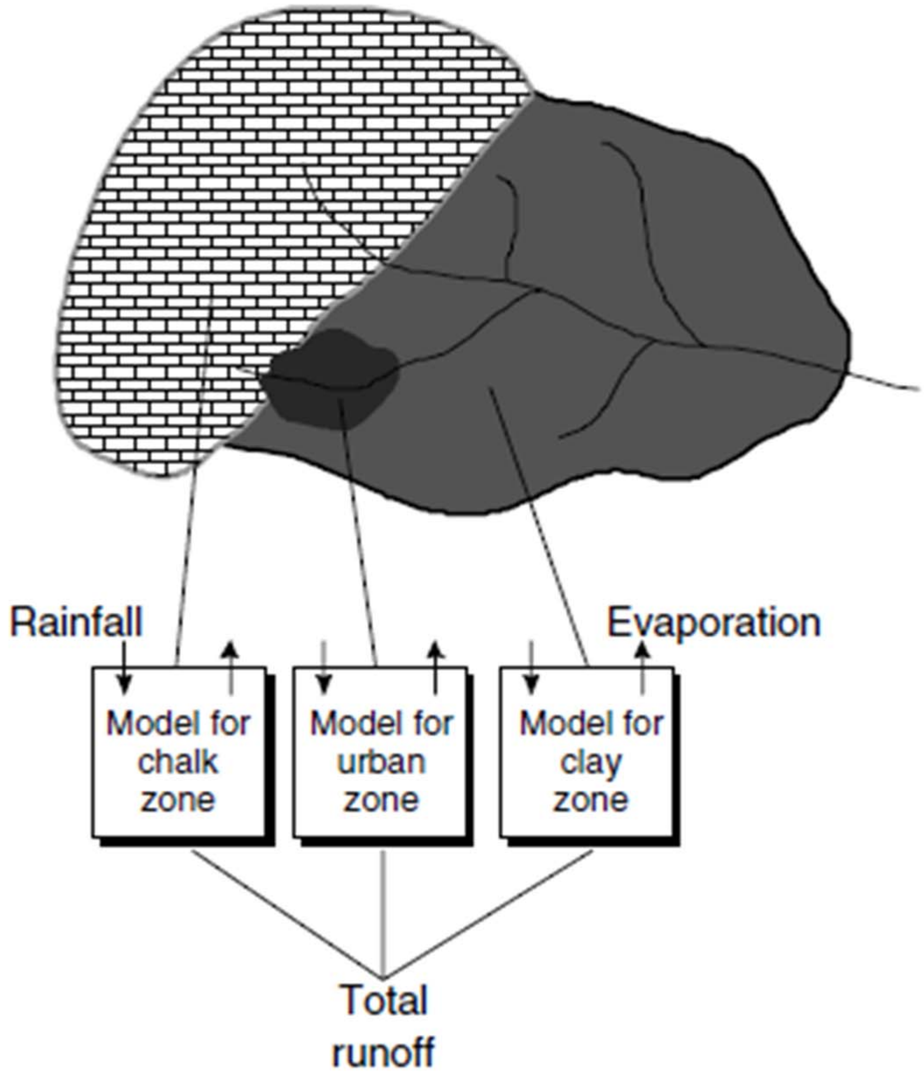


Original CATCHMOD structure reproduced from Cloke et al 2010









Catchmod, model, used for climate change and water resources studies Wilby (2005)

PDM model (used often for flood studies)