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# An Overview of Application of Remote Sensing to Assess the Impact of Land Cover Change on Flood Peak by Distributed TOPMODEL

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Starting from the first Industrial Revolution lasted in the mid-18th century to approx. 1830 and the mostly in Britain. The second Industrial Revolution lasted from the mid-19th century to until the early 20th century and took place in Britain, continental Europe, North America, and Japan. In this industrial revolution major deforestation was accrues. In last decade, land use and land cover changing very rapidly which create the disturbance in different natural process. A proper assessment of change land use and land cover should be done to estimate its impact on various hydrological processes. There are many methods for detecting different hydrological components using empirical relations, statistical methods or various hydrological and hydrodynamic models. Remote sensing and hydrological models have emerged as a robust technique to understand these processes. This study provides a brief review on the use of remote sensing and modelling to assess land use land cover effects on flood peak. It was found that distributed TOPMODEL and various satellite imagery such as Digital Elevation Model (DEM), with an overland flow velocity module was used to simulate flood peak. These concisely summarized studies will help the reader to understand the modelling of TOPMODEL and use of remote sensing, particularly in the context of land use and land cover change effects at flood peaks.

## Introduction

Runoff is part of the rainfall, snow melts and irrigation water that flows across the earth's surface and in other words it is that part of the water which does not infiltrate in the surface of the land and flows on the surface of the earth according to the law of gravity. The runoff water finally meets the waterbody. The runoff rate depends on meteorological factors and the physical characteristics of the watershed. Physical characteristics such as land use, vegetation, soil properties, catchment size, drainage network, slope percentage of the basin and topography of the basin. Land use land cover (LULC) in many environments has been heavily modified by human beings. The resulting effects on flood hydrographs are important to land managers and flood management. In many catchments, runoff flow is a common pathway for water in river. Therefore, changes in surface roughness can be very important in driving the response of river flow to precipitation. Land management practices may alter vegetation distribution in the catchment area and this affects flood peak. At low vegetation cover there were higher peaks and narrower hydrograph sizes per unit of rainfall compared to when vegetation cover was more extensive. Recent modelling studies have also hinted at the idea that surface vegetation cover is likely to be of great importance at the time of flood peaks from the catchment. Riparian buffer zones have been implemented, usually in agricultural areas, to trap sediment and nutrients before entering the reservoir in many countries. For watersheds in which saturation-excess land flow dominates storm runoff. Hilly areas and near-stream areas can be a significant contributory area of land runoff in a storm event, with flow from upslope concentrated in this area and the erosion of this area by loss of vegetation may therefore have a greater impact on flood peaks than similar modifications in other parts of the basin. The spatial sensitivity of flood peaks is a suggestion that hilltop or drainage divide roughness may have a greater effect on flood peaks than near stream or hillside roughness. A scenario with a decreasing surface roughness in the downstream direction resulted in a slightly earlier, but much lower, flow peak than a scenario with a downstream-increasing surface roughness. Higher surface roughness may have a greater effect than mountainous and adjacent areas in terms of reduction in flow peak. Such differences in connectivity in terms of overland flow velocity and volume and the resulting flood peak can be very significant. However, as the slope increases, the land flow will move at a faster rate. At the catchment scale, different spatial patterns of topography and land cover can affect the synchrony of overland flow concentration on hillsides. Spatial distributed modelling tools are needed to test how different configurations of land cover (eg, position in the basin, size of land cover patch changes, gradient) affect the peak and timing of floods in natural river basins.

## Methodology

Gao *et al.* (2015) Developed a spatially distributed version of TOPMODEL, with an empirically based overland flow velocity module, that was well suited for blanket peat catchments. The model was specifically designed to test spatial alternatives to land-cover change in systems that dominate overland flows during storm events.

TOPMODEL has been used worldwide as a standard model. It is use for hydrological analysis. It was a continuous lumped or semi distributed deterministic hydrological model when it is firstly developed by Beven and Kirkby. Recently, fully distributed topmodel has developed, tested and evaluated by Gao *et al.* (2016) The distributed model uses for grid (20m*20m) cell. Distributed topmodel represents the movement of runoff water across and between cells. In distributed topmodel module for runoff calculation uses the multiple-direction flow theory. In this model runoff calculated by the darcy weisbach equation.

$$V^2=8gds/f$$

Overland flow velocities depending on slope, water depth and surface roughness. According to Darcy-Weisbach equation velocity depends on the surface roughness. When distributed topmodel run for the different spatial configurations of land cover in a basin, the velocity parameter for the cells in the model are varied depending on the land cover land use type in the grid cell.

## TOPMODEL Concept (Schematic Diagram)

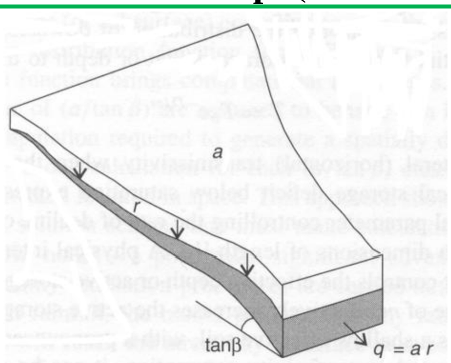


**Figure 1: Sectional view of catchment**

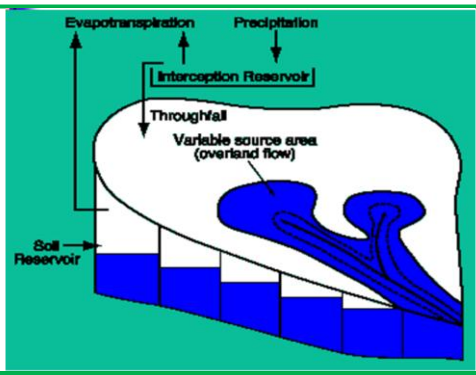


**Figure 2: Water flow in watershed**

## Model Components

1) Vegetation Interception Capacity, ($SR_{MAX}$)
   - A storage from which water is extracted by evapotranspiration at the potential rate.
   - Available precipitation is intercepted.
   - The net precipitation in excess of it reaches the soil.
2) Overland Flow
   - Infiltration Excess (Hortonian).
     - Green-Ampt Model.
   - Saturation Excess (Dunne).
3) Subsurface Flow
   - Darcy's Law

Saturated hydraulic conductivity of soil follows a negative exponential law Vs depth

$K_S(z)=K_0EXP(-mz)$

Where, z = depth, $K_0$ = $K_s$ at ground surface and, m = decay function of $K_s$ with z

4) Flow Routing
   - Kinematic Wave Routing
     - CHV (main channel velocity)
5) Topographic Index (TI)
   - Measure of the extent of flow accumulation at the given point of the topographic surface
     - Derived from Digital Terrain Model/ DEM

$TI = \ln( a / \tan \beta )$

Where, a = upslope area drained by a grid square

Tan β = local slope

r= recharge rate

## Data Required

a) Land use land cover
b) Runoff
c) DTM
d) Meteorological Data

Max. and Min. Temperature, Rainfall, Wind Velocity, Relative Humidity & Solar Radiation

## Model Parameters

a) m - decay function of $K_s$ with z
b) $L_n$ ($T_0$) – mean Topographic Index, λ
c) $SR_{max}$ - vegetation interception capacity, max
d) $SR_{init}$ - vegetation interception capacity, initial
e) $Ch_{Vel}$ - main channel velocity

## Conclusions

In the present time land use land cover is heavily changing by anthropogenic activities. According to the previous study land cover land use change affects the ecosystem and climate change is very fast accelerated. Water is the involve in the all activities of nature. The change of water balance at any were like basin, sun basin, and small grid cell this all affected by the water unbalancing.

The use of remote sensing-based GIS analyses in mountain areas has still many challenges to overcome. The accuracy of image classification methods could be tested more rigorously using ancillary and ground data. We are all use for research purpose many types of the data this data availability with excellent accuracy is major problem and for future research present data with highly accurately storing and finding is the major challenge.

In this article we discuss about modelling study of LULC change impacts on flood peaks. The spatial changes in land-cover affect flood peaks of downstream. These principles and use of the distributed TOPMODEL should both be useful in the future for decision making among practitioners and flood policy groups.

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