Earth sciences, watershed management

A watershed is a hydrological unit where all the water from precipitation in the form of rain and snowfall are drained into a common area and from where it is drained off to a common outlet. The mechanism of watershed displays a basin topography which can be as small as a footprint or large enough to encompass all the land that drains water into a river and finally enters sea and ocean. The watershed comprises of one large river or streams that would be connected with several other smaller streams or tributaries. The large stream or river get its source of water from all the smaller streams as all the surrounding water flows to accumulate in the larger stream under the influence of slope and gravity. The picture no.1 shows watershed and the catchment areas.

Figure 01: Watershed basin

Source: terrainworks.com

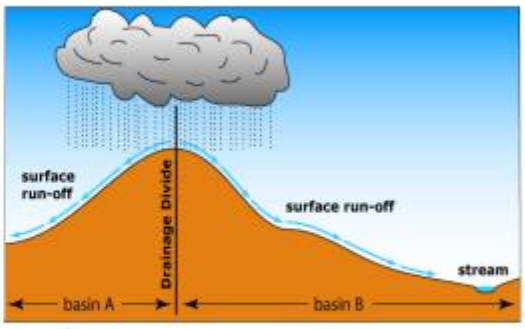
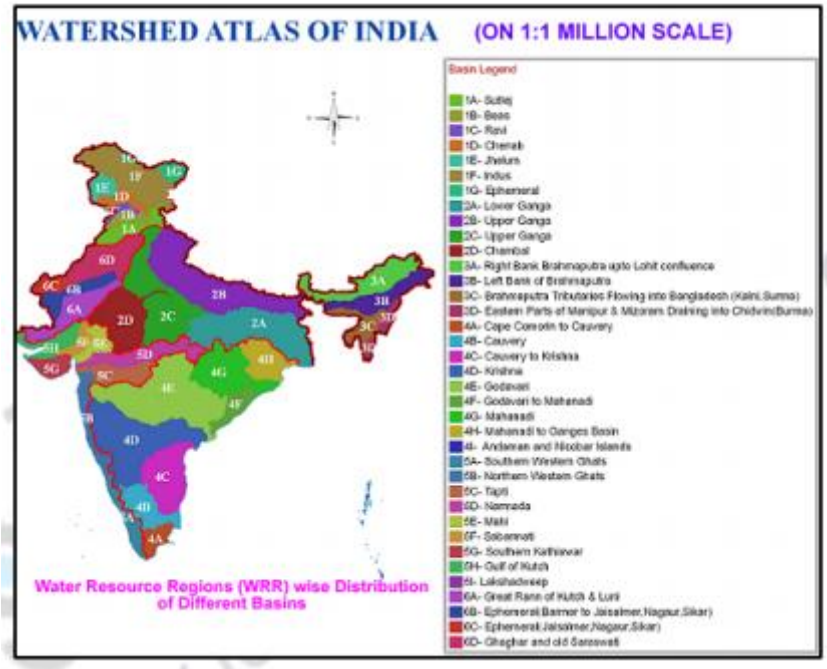


Figure 02: Drainage divides

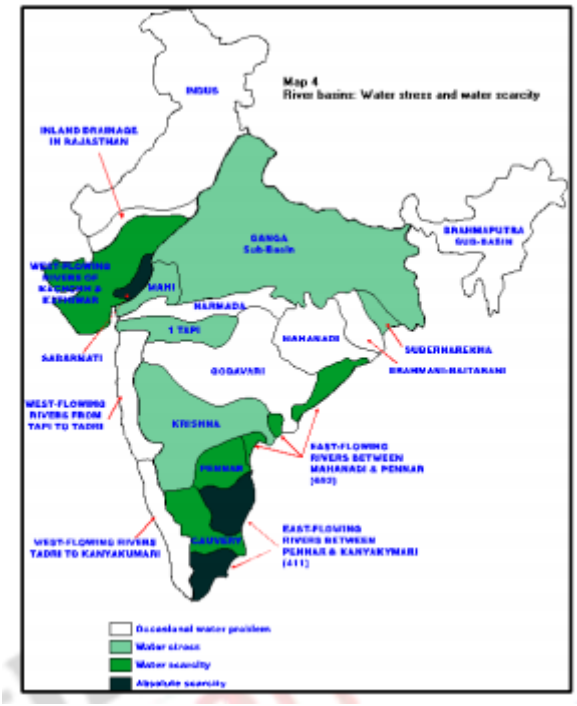
Source: studyblue.com

There are several watershed represented by their location and the topographic feature in a particular region. Two watershed basins (Fig 02) are separated by ridges and hills that are called as the drainage divide. It depends on the slope of basin that from different watershed in a particular area. The drainage divide is responsible for draining surface run-off water under the influence of slope thereby creating basin topography. The surface water flows to meet another stream and tributaries and finally making a watershed of the particular place. The watershed consists of surface water

like, lakes, streams, reservoirs, and wetlands as well as all the underlying ground water.



A watershed is a precipitation collector and feeds the river life. It is not simply the hydrological unit but also socio-political-ecological entity which plays crucial role in determining food, social, and economical security and provides life support services to rural people. The watershed in India (Fig 03) shows the area demarcation of watershed and in relation the river basin of India (Fig 04) that displays the river and stream where the particular watershed is the source for the water. So the relationship between watershed and drainage basin is inter-related and the study of watershed is integral in drainage pattern and its basin.



4. Factors that determine the geomorphologic characteristics of a watershed:

4.1 Precipitation: The greatest factor controlling stream flow is the amount of precipitation that is in the form of rain or snow. This fed the river and the streams down flow along the path, serving as the main source. Thus the change in the amount of precipitation will affect the characteristics of watershed.

4.2 Infiltration: The amount of water that soaks or seeps inside the soil also determines the watershed. When rain water soaks in (other than surface run off) and infiltrates the soil it remain in the shallow soil layer, where it will gradually move downhill, through the soil, and eventually enters the stream by seepage into the stream bank. Water that infiltrate enters much deeper, recharging groundwater aquifers. Water may travel long distances or remain in storage for long periods before returning to the surface.

4.3 Soil characteristics: The type of soil characteristics also determines the watershed as clayey and rocky soils absorb less water at a slower rate than sandy soils. Soil saturation happens where like wet sponge, soil already saturated from previous rainfall cannot absorb water and result in surface runoff.

4.4 Land cover: Land covers have a great impact on infiltration and rainfall runoff affecting the watershed where impervious surfaces leads to flooding of areas.

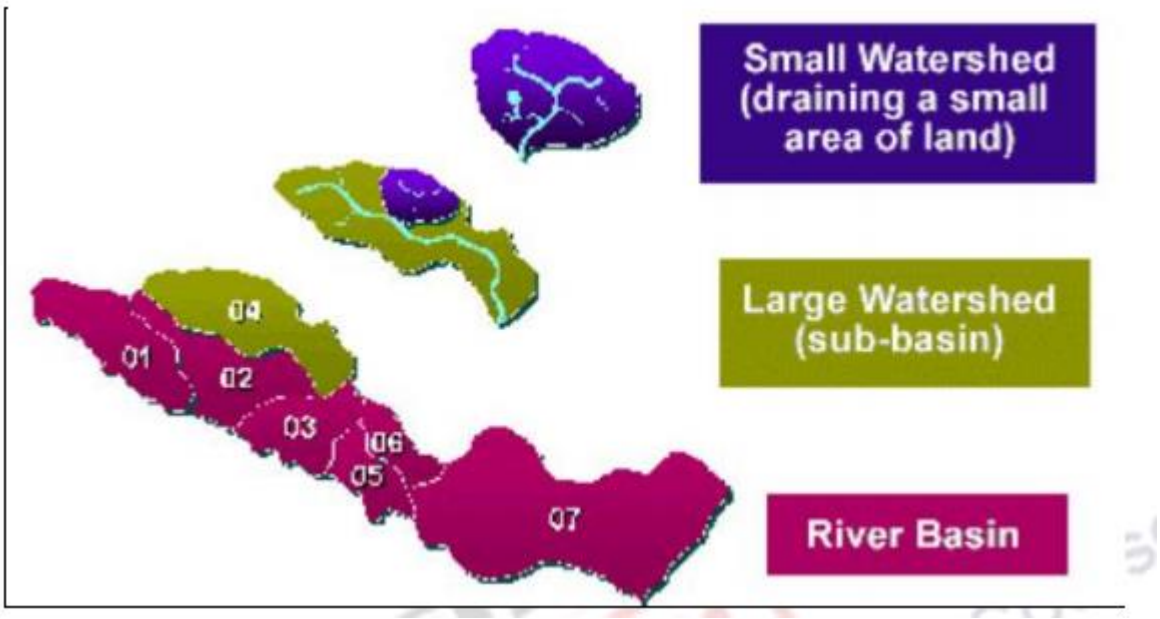
4.5 Slope of the land: The angle of the surface determines the amount of run off where water falling on steeply-sloped land runs off more quickly than water falling on flat land.

4.6 Evaporation: The watershed also depends on the amount of evaporation determined by temperature, solar radiation, wind, atmospheric pressure, and other factors.

4.7 Water use by people: Anthropogenic factor plays an important role as water resource is usage varies from one place to the other. This greatly have an impact on the characteristic of watershed that varies accordingly from upper stream and lower stream river flow.

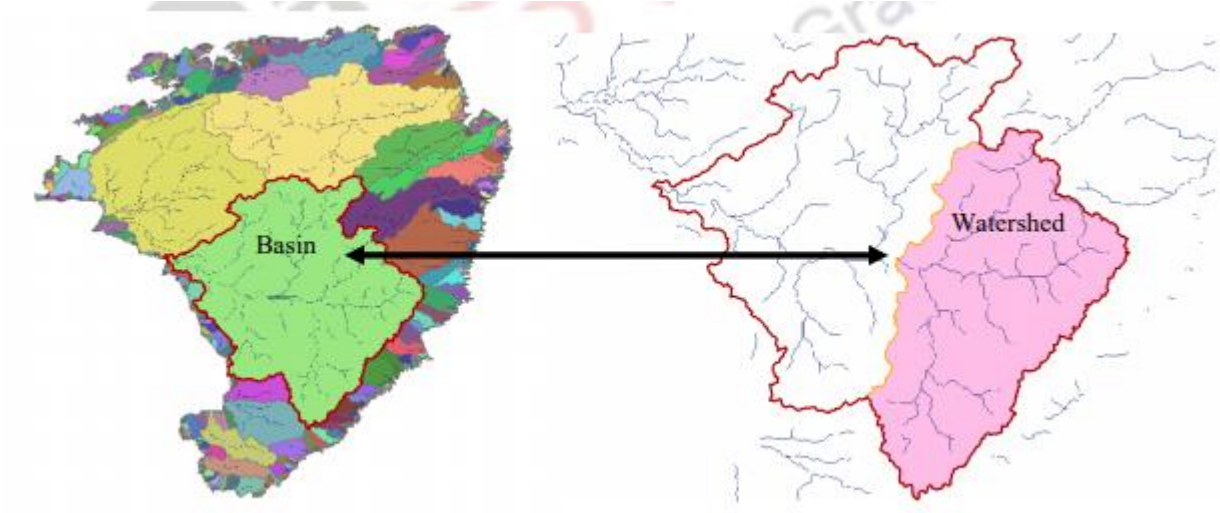
5. Scale delineating the watershed:

A watershed is a basin where water flows across or through on its way to a common stream, river, or lake. A watershed can be very large (e.g. draining thousands of square miles to a major river or lake or the ocean), or very small, such as a 20-acre watershed that drains to a pond and sometimes a small watershed nests inside of a larger watershed which is sometimes referred to as a sub watershed. Thus identification of watershed largely depends on the area it covers depending on the numbers of channels. A larger stream would create a larger basin in corresponding to the smaller stream with a smaller basin. Fig. 5 & 6 shows the demarcation of larger watershed and smaller or sub watershed looking at the numbers of streams flowing in an area. The topography is greatly influenced by the river flowing on the particular area. Thus maintaining a healthy watershed requires a systematic approach for sustainable development. Application of Remote Sensing and GIS (Geographic Information System) becomes a very important tool in delineating stream flow and demarcation of watershed and sub watershed. It helps in analyzing the various techniques that could be implemented in carrying research for maintaining watershed management.



Applications of Remote sensing and GIS in Watershed Management

Remote Sensing (RS) and Geographic Information Systems (GIS) technology plays very important role in watershed management in assessing watershed conditions through various modeling. Through the use of computer aided software and availability of huge resources of digital data, mapping of watershed have proven tremendously much easier for a researcher in the field of GIS technology. Due to this fact, the use of RS and GIS in the application of watershed management has changed from operational support (e.g., inventory management and descriptive mapping) to prescriptive modeling and tactical or strategic decision support system. The application has enabled mapping giving accurate information through many multi resolution data that has helped in delineation of ridge line, stream flow, erosion prone areas, etc.



Some of the features of remote sensing and GIS in the study of watershed are as follows;

6.1 Watershed Characterization and Assessment: The available Digital Elevation Model (DEM) and USGS's National Hydrography Dataset (NHD) and EPA (environment protection agency) BASIN database provides enormous water quality data relating to watershed that helps in demarcation of watershed boundary, drainage network system, flow accumulation, and drainage density.

6.2 Management Planning: The analysis of characterization and assessment studies could generate understanding of the complex relationships between natural and human systems by looking at water quality. Many factors like drought, flood and water degradation could be studied through proper planning and utilization of resource. Thus GIS provide a common framework for watershed management by providing a platform for assessment of data for analyzing spatial dimensions that are important for understanding impacts of human activities.

6.3 Watershed Restoration (Analysis of Alternative Management Strategies): GIS helps in water assessment programs that include total maximum daily load (TMDL). The watershed ranging from small rural watersheds to heavily urbanized landscapes GIS provide framework for restoration the watershed is studied by creating digital maps showing the existing conditions of drainage pattern and thereby comparing to maps that could possibly represent alternative scenarios. It acts as a platform by integrating the complexities of a real world system within the confine of a digital world accurately and efficiently, thus providing a platform for collaborative functions among researchers, watershed stakeholders, and policy makers.

7. Application of Watershed modeling:

Watershed modeling is considered as an important objective to study in hydrology. Modeling of a particular watershed assesses the health of a particular watershed for further implementation of different management plans. In watershed modeling one needs to consider every possible aspect that can directly or indirectly influenced the particular watershed. Some of the important considerations are;

7.1 Soil: The soil survey geographic data base provides analysis while studying factors of erodibility, agricultural capacity, development suitability, dwellings, small commercial buildings, local roads and tress.

7.2 Geology: The geology of the surface plays an important role in hydrology. Especially geology is a determining factor in shifting of bank lines or we can say watershed boundary. This data is taken from geological survey, and by creating a separate vector file it use to compile in GIS.

7.3 Impervious surface: The NEMO (Nonpoint Education for Municipal Officials) project developed an analytical methodology to correlates the amount of impervious surface in the watershed and study the impact on stream quality.

7.4 Land use/land cover: Shows the change over a period of time relating to urban land, agricultural land, forest, water, wetland, barren land. Land use and land cover analysis is very much important as it shows the present and past conditions of a particular surface.

7.5 Ground water: The ground water data use to take from the secondary sources like district ground water board and potential areas of ground water used to assess with the help multi criteria analysis by giving weight to every factors that is taken in to consideration.

7.6 Rainfall: rainfall is most important in watershed modeling. The amount of rain fall in a watershed determines its future applicability in management. The rainfall data can be taken from meteorological departments as well as from TRMM (Tropical rainfall measuring mission).

7.7 Sediment yield: it is estimation of sediment transported by water in a particular cross section. It is a manual process. It also includes bed and bank samples of sediment. It compile with other layers by joining the data.

7.8 Chemical prosperity: Analysis of chemical prosperities of water also collected and tested by manually at number of cross-sections and added by creating separate vector layer

7.9 Social data: the present status of the utilization of the particular watershed, local dependency on it and associated problems are collected by manual data collection. By creating different vector layer is use to relate with other layers.