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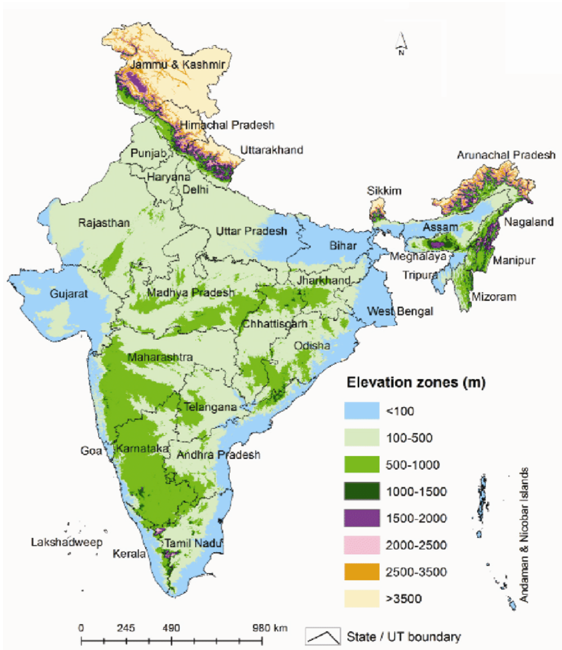
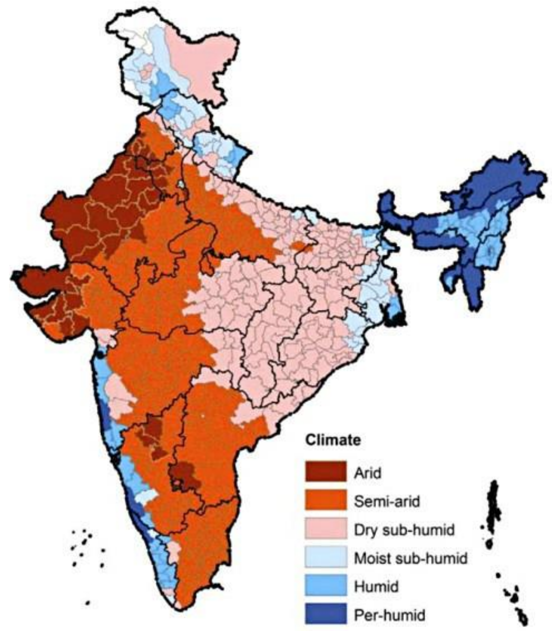
Commentary on the Evapotranspiration Profile of India

The evapotranspiration value of a location depends on several environmental and climatic factors. This commentary will guide us on how and why the evapotranspiration depend on these factors. Note that the maps in the commentary only show ballpark values of the quantities under analysis. All the discussed quantities are dynamic; hence they do not have a fixed value. Furthermore, all the interpretations in the below commentary are my own and might not be accurate to the actual phenomenon occurring in the environment.

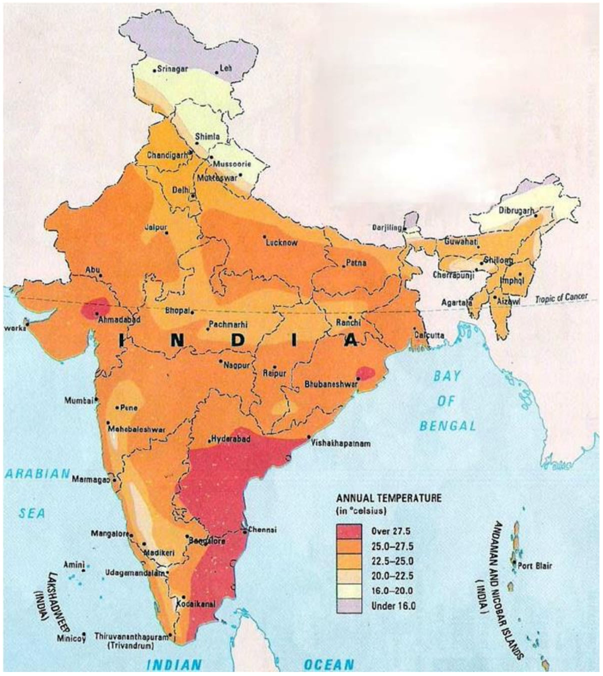
1.) 

2.) 

Map 1 shows the altitude distribution of India. We see that the altitude is lower (sea-level) at the coastal regions as well as in parts of North-East, Gujarat and Bihar. On the other hand, the parts consisting the Himalayas (Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh) are at extremely high altitudes.

Map 2 shows the relative humidity across our nation. As can be seen, the Western Ghats, the North-Eastern regions and the northern parts of the Himalayas have high humidity whereas Western India (Rajasthan and Gujarat) and small parts of interior South India are arid in nature.

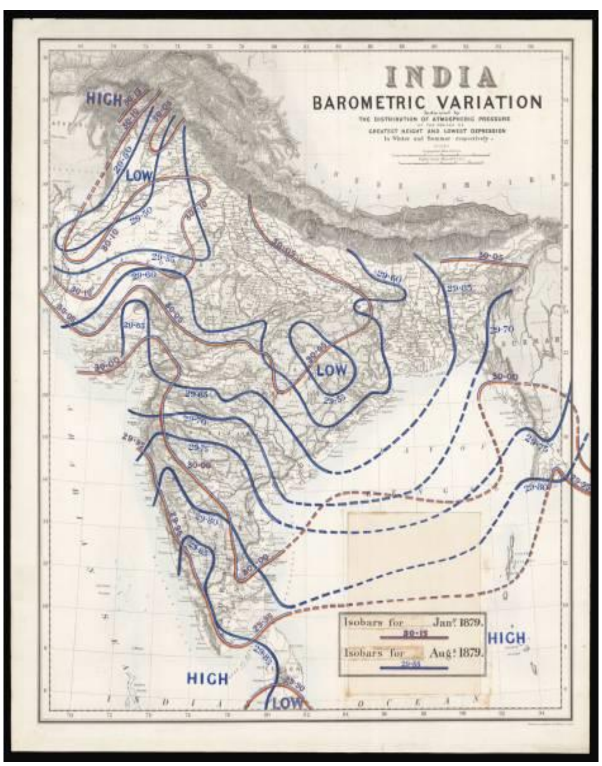
3.)



From **Map 1**, we would know that the higher altitude regions will be colder as compared to the lower altitude regions because of lack of terrestrial heat to warm the air above it. This would also imply that the coastal regions will be warmer than other parts. It is also seen that some of the coastal regions have a lower temperature than their surroundings and vice-versa. This happens because coastal regions have higher humidity (**Map 2**) which means the water molecules are already excited into its steam phase, which causes less fluctuations in temperature due to the change in heat.

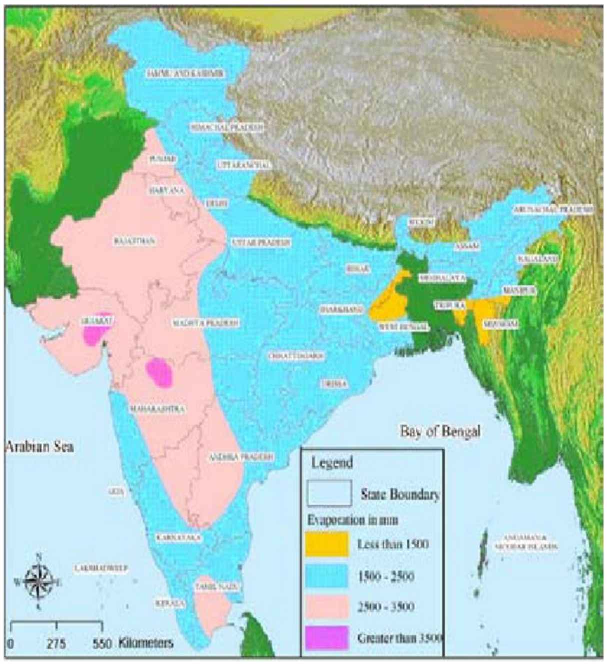
This can be observed in **Map 3,** where the South-East Indian parts (Andhra Pradesh, Telangana, and Tamil Nadu) are the warmest along with some regions in Western India. The Himalayan regions are therefore relatively much cooler than the rest of the country.

4.)

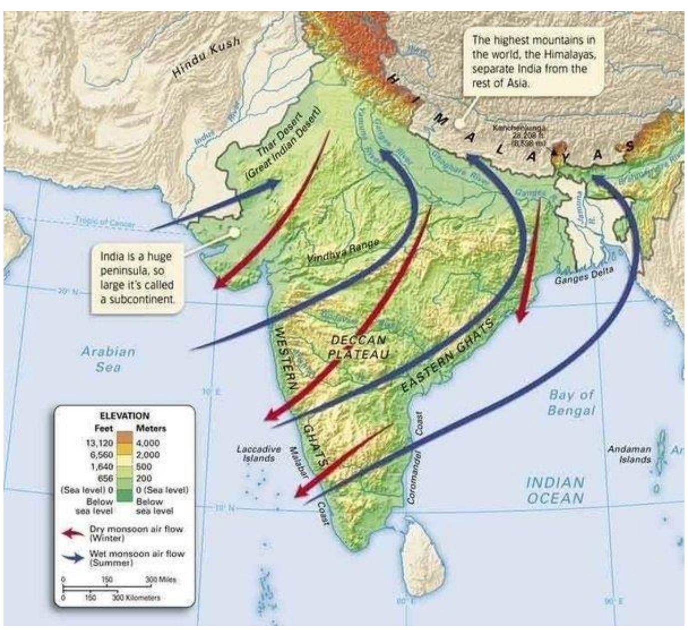


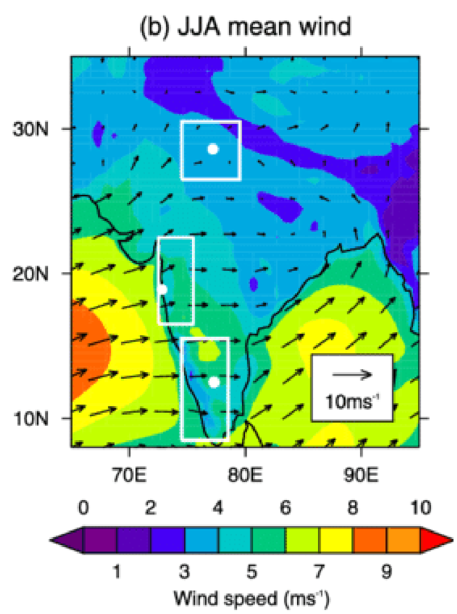
Altitudes and temperatures have a direct correlation with pressure changes. With an increase in temperature (or decrease in elevation), the air molecules gain energy and vibrate more. As a result, there is an increase in atmospheric pressure. Hence, higher altitudes (and low temperature) regions have lower pressures as well. This argument is best seen in **Map 4** which describes the barometric variation contours of India. The Himalayas are rightly portrayed as low-pressure regions. However, the Indo-Gangetic Plains are also depicted as low-pressure regions, despite the elevated temperature and low altitude conditions. This is attributed to wind movements in the troposphere, the causes of which are not fully understood by me. The rest of the country shows increasing barometric rates owing to the hot temperature - low altitude conditions.

5.)



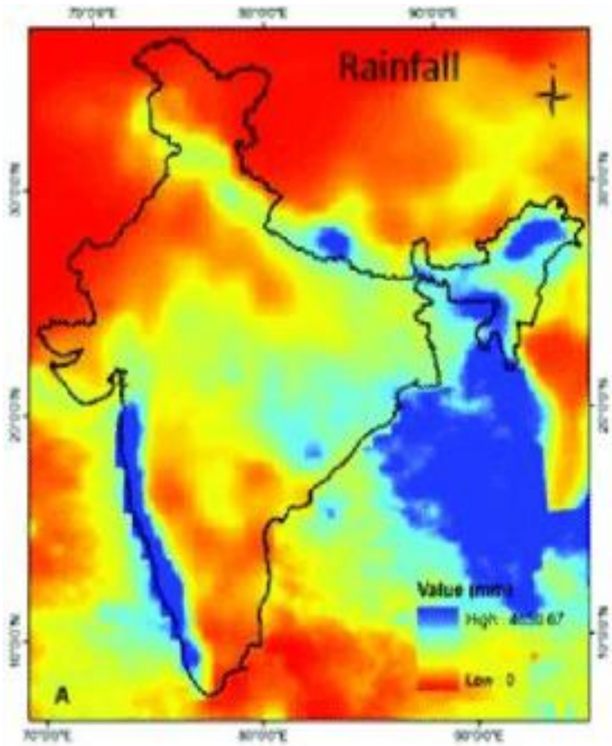
Using **Maps 2, 3 and 4,** we can deduce the evaporational trends in India. Naturally, in the hotter regions, the rate of evaporation will be higher due to the higher energy of air molecules. However, the humidity levels also play a key role. A higher humidity would correspond to the air being already saturated with water vapour. Hence, the potential of air to accommodate more water vapour decreases; the pressure equilibrium shifts to the left thereby causing a lesser rate of evaporation. Thus, the rate of evaporation is inversely proportional to temperature, humidity as well as the atmospheric pressure in the region.
This somewhat matches with the trends shown in **Map 5**. Since there are minimal parts in India with both high temperature AND humidity (since it is a water-rich country), there are minimal regions with incredibly low evaporation rates (only parts of West Bengal, Mizoram, and Tripura). Intermediate to low evaporation rates are seen where there is an influence of either hot temperatures OR high humidity conditions (Western and Eastern Ghats, North-East, Himalayas and parts of Central India). Regions of low humidity and temperatures are found in Western and parts of South and Central India which also correspond to regions of high rates of evaporation.

6.) 

7.) 

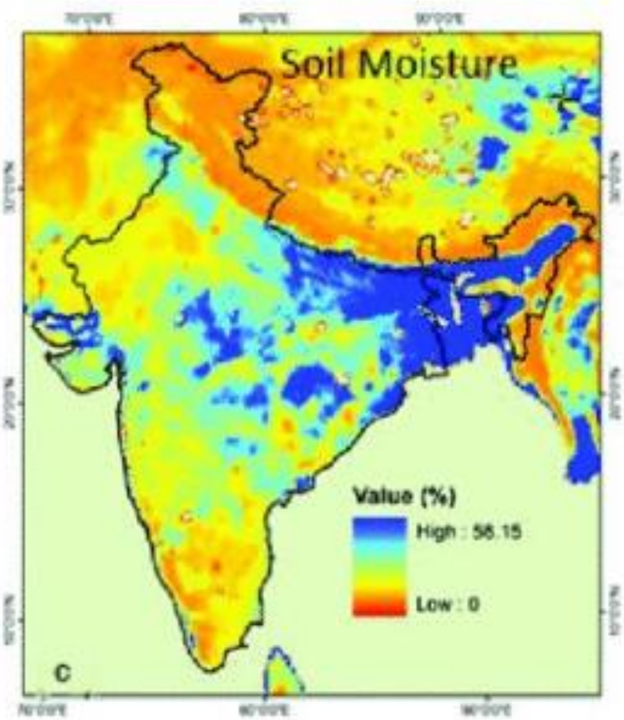
Maps 6 & 7 show the wind speeds and directions in the pre-monsoon to post-monsoon period. These majorly rely on the pressure gradients shown in **Map 4**. The wind flows from locations of high pressure to low pressure and its speed depends on the steepness of the gradient. India faces the Westerly Winds during the Monsoons which enter through the Western Ghats and spread across the country. A modified version of these winds also enter through the Bay of Bengal into North-Eastern India.

8.)



Clouds travel along with the wind; with the same speed and in the same direction. Thus, the monsoon clouds propagate similar to the monsoon air flow patterns. This leads to a similarity between the wind and precipitation distributions.
Map 8 shows this precipitation profile of India. As seen in **Maps 6 & 7**, the positions where the Westerlies enter the sub-continent are precisely the locations of the highest rainfall (Western Ghats and the North-Eastern states). As the winds travel further interior into the sub-continent, their intensity reduces. An analogous situation arises with the water content in the clouds. As a result, the latter ends of the wind trajectories receive the least rainfall (most of Western India). The Himalayas (**Map 1**) produce a conducive environment for intense orographic precipitation which results in good irrigation in the northern Gangetic Plains. However, this also leads to a rain shadow in Jammu & Kashmir as well as Tibet. Map 8 also supplies a cause for an increase in humidity as seen in **Map 2**. The orographic precipitation results can be evidently seen in Map 2 with a sporadic increase in humidity in Himachal Pradesh, Uttarakhand, and parts of Kashmir.

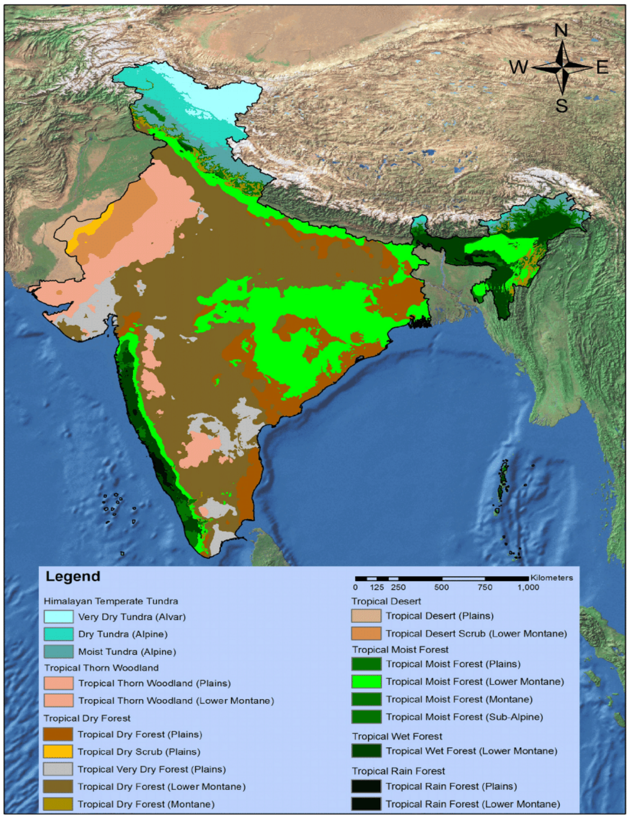
9.)



Not all the precipitation (in **Map 8**) is available as soil moisture in the earth. Several factors such as infiltration into the groundwater, surface runoff, evaporation, ingestion by biotic factors, soil composition, etc. influence the retention of soil moisture.

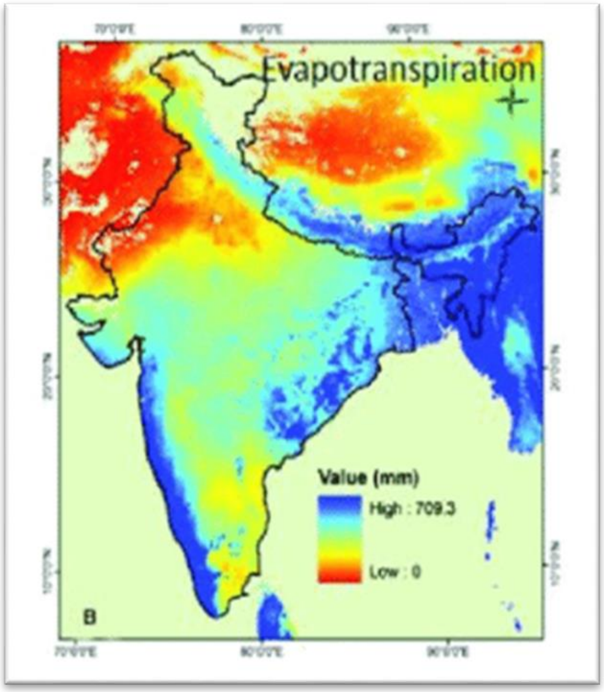
The humidity trends in **Map 2** and evaporation trends in **Map 5** are seen in alignment with the soil moisture profile in **Map 9** because humid environments lead to a lesser amount of evaporation and therefore a higher retention of soil moisture. The profiles of other factors are not discussed in this commentary, but their relationships with soil moisture can be analysed. Infiltration of water into the ground and seepage into the groundwater is mainly dependent on the Geology of India with respect to its porosity and permeability. Both these factors have optimal medial values in the Vadose Zone to facilitate storage (restricts surface runoff) but not excessive drainage into the groundwater. As can be seen in the map, highest soil moisture content is visible in the North-East and sporadic regions of Central and Western India.

10.)



Map 10 illustrates the vegetation distribution of India. The tropical moist forests and rainforests have the highest amounts of vegetation per unit area while the tundra, deserts and scrubs have the lowest vegetation values per unit area. This vegetational spectrum is caused by the soil moisture as the moisture releases nutrients to the plants and also facilitates water. Hence a likeness is seen between Map 10 and **Map 9**. This segregation of biomes is also a cumulative effect of the temperature, altitude, and rainfall trends. Thus, hints of resemblance can also be noticed between Map 10 and **Maps 1, 3 and 8.**
The density of vegetation supplies a direct proportionality to the amount of transpirational loss of water to the atmosphere. Thus, the densely vegetated regions such as the western Ghats, the North-Eastern hotspots, and parts of Eastern and North-Central India will contribute to the highest transpirational losses in the country. On the contrary, the whole of Western India (deserts), Kashmir (alpine) and pockets of South India (scrubs) have negligible effects on the aggregate transpiration of the country.

Hence, the combined Evapo-transpirational profile of India (Map 11) can be closest produced as an amalgamation of **Maps 5 and 10**. However, all the other maps were partial contributors to the formation of these two.

11.) 

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Map 1: https://www.researchgate.net/figure/Map-showing-states-and-elevation-zones-of-India_fig1_315835800

Map 2: https://sites.google.com/a/miamioh.edu/geo122w2016/home/hemis-np-03

Map 3: https://www.researchgate.net/figure/Average-annual-temperature-of-India_fig1_226241280

Map 4: https://www.crouchrarebooks.com/maps/view/atmospheric-pressure-map-of-india

Map 5: https://www.researchgate.net/figure/Average-annual-evaporation-prepared-on-GIS-platform-based-on-data-from-Pisharoty-1990_fig2_46534226

Map 6: https://www.quora.com/What-is-a-retreating-monsoon

Map 7: https://www.researchgate.net/figure/50-m-wind-speed-and-direction-during-the-monsoon-season-a-and-c-show-the-anomaly_fig2_277622863

Map 8: https://www.researchgate.net/figure/A-Rainfall-B-Evapotranspiration-and-C-Soil-Moisture-variability-over-India-during_fig4_305712724

Map 9: https://www.researchgate.net/figure/A-Rainfall-B-Evapotranspiration-and-C-Soil-Moisture-variability-over-India-during_fig4_305712724

Map 10: https://www.researchgate.net/figure/The-biome-and-sub-biome-life-zone-distribution-in-India_fig3_255179344

Map 11: http://ambhas.com/satellite/generation-of-evapotranspiration-et-product-for-india/