

Monsoons

“The Asian monsoon cycle is a lifeline to over 60 percent of the world’s population” (NASA). Who would have thought that monsoons affect such an enormous population? Coming from the North East, a place where the local hazards are hurricanes, rains that are expected, but by no means depended on for sustaining life, I had no idea. The very basic definition of a monsoon is seasonal rains, but what actually drives the monsoon is a pressure differential between land and sea. During the hot months moisture coming from the sea quickly condenses due to the intense heat of the land. This condensation leads to cloud formation and the ensuing and unrelenting rains.

It is well known that most of India’s rainfall comes during monsoon, but what this statistic refers to is mainly the summer monsoon. 80% of India’s rainfall occurs during the summer monsoon, or between the months of June through September. The rest of the rainfall occurs during winter monsoon; a phenomenon I didn’t know existed before this trip. Different crops are grown during each monsoon, kharif crops during summer monsoon and rabi crops during winter monsoon. Kharif means autumn in Arabic and is reasonably coined due to the autumn harvest of the summer crop. Kharif crops vary, but some examples of them are paddy, maize and tea. Likewise, rabi means spring and is given its name because of the spring harvest of the winter crop. Major rabi crops are wheat, barley and mustard.

Since India has so much rainfall every year, I was interested to find out how it compares to the rest of the world. Apparently, India is the state with the highest rainfall¹. Additionally, there are two cities in northeast India that have jockeyed for

¹ <http://www.mapsofindia.com/top-ten/geography/india-rain.html>

the title of wettest place on Earth: Cherrapunji and Mawsynram. Cherrapunji still holds the world record for most rainfall in a calendar month and in a year; 9,300 mm in July 1861 and 26,461 mm between August 1st 1860 and July 31st 1861². To put those numbers into an American perspective 9,300 mm is around 30 feet and 26,461 mm is around 80 feet! That is an unfathomable amount of rainfall and without hearing many of the PhD talks I wouldn't be able to comprehend how that is even possible. Luckily, I now know some of the contributing hydrologic and geographic factors.

To begin, the Indian subcontinent is divided up into different regions that, because of their relative location and geography, add momentum to the cyclical monsoon. The subcontinent is surrounded by three major bodies of water, Arabian Sea on the west, Bay of Bengal on the east and Indian Ocean directly south. Moreover, the geography of the subcontinent is that of Kerala being a couple of degrees north of the equator which plays an integral role in driving the monsoon. These characteristics set up many phenomena that appear to drive the monsoon, two of which are representative enough to understand the main idea. First, is the Hadley Circulation, which divides India into a northern box and a southern box and plays off of relative distances from the equator. The southern box heats up because of its proximity to the equator and provides the driving force of convection as it circulates to the upper box. This basic temporal differential gives a nice visual for why the summer monsoon comes from the south and hits Kerala first as it moves north up India's western coast.

The second phenomenon has to do with horizontal movements created by the bodies of water surrounding the subcontinent. It is observed that when the Arabian

² <http://en.wikipedia.org/wiki/Cherrapunji>

Sea and the west Indian Ocean are dry, the Bay of Bengal and the east Indian Ocean are wet and vice versa. This can be explained by describing the Indian Ocean as a dipole moment contributing to the horizontal oscillation of the monsoon. These two phenomena can be combined to complete the circular pattern that the monsoon follows.

To jump back to why the northeast of India receives the most rainfall in the world, it can be explained by looking at the summer monsoon, the winter monsoon and the hydrologic principles influenced by the Himalayas. The northeast of India, instead of getting two separate monsoons, gets a combination of the two creating one stronger monsoon season. In addition, as the summer monsoon passes the region heading north, it hits the Himalayas, effectively reversing the direction and hitting the region again as recycled rain. This same hydrologic feedback happens on the west coast of the country, just at a much smaller scale. Because the monsoon is affected by so many factors, it becomes increasingly more difficult to model and project. That is why climate science has such a necessary degree of uncertainty.

All things aside, the monsoon is a mesmerizing phenomenon that affects a vast amount of people worldwide. It is a key area of climate science and must continue to be given attention to further understand its future implications.