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India is experiencing a colder than normal winter thanks to the north-south winter flow set up by the weather phenomenon known as La Niña (pronounced “la ninya”). The La Niña itself is going on for a record-breaking third consecutive year. Now, forecasts for the 2023 fall and winter are predicting that its companion phenomenon – the El Niño (“el ninyo”) – will occur with more than a 50% probability.

At this juncture, what outlook can we develop on the cyclone season and the Indian monsoon? As the saying goes, predicting is very difficult, especially the future. But we can use scientific knowledge to give it a shot.

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A La Niña event is visible in this image as a streak of cooler water along the equatorial Pacific, November 2007, captured by NASA Earth Observatory. | Photo Credit: NASA

El Niño refers to a band of warmer water spreading from west to east in the equatorial Pacific Ocean. Years in which an El Niño occurs are simply called ‘El Niño years’, and global weather patterns in that year tend to be anomalous in certain ways. Similarly, a La Niña occurs when the band of water spreads east-west and is cooler.

Both phenomena affect the weather worldwide and can have drastic effects on economies that depend on rainfall. Together, El Niño and La Niña make up a cyclical process called the El Niño Southern Oscillation (or ENSO).

The first thing to note is that El Niño forecasts before spring tend to be notoriously unreliable due to a so-called ‘spring predictability barrier’. The climate system is quite noisy in spring as the Sun transitions across the equator, from one hemisphere to the other. This complicates El Niño predictions before the spring.

Second, and perhaps more importantly, in a La Niña year, the tropical Pacific Ocean soaks up heat like a sponge and builds up its volume of warm water. During the El Niño, this warm water spills from the western part of the Pacific Ocean to the eastern part. But the earth has had three

straight La Niña years, which means the Pacific's warm-water volume is fully loaded and is likely to birth an El Niño soon. The question is: Will this be a strong El Niño, like the one in 2015-2016?

An El Niño year creates a global-warming crisis in miniature, since the warm water spreading across the tropical Pacific releases a large amount of heat into the atmosphere. Some headlines have already blared that an El Niño this year could increase the planet's average surface temperature by more than 1.5° C from pre-industrial levels (a.k.a. the threshold of the Paris Agreement). Then again, it isn't clear if this transient spike will produce anything more dramatic beyond the extremes we're already experiencing.

An El Niño will of course bring its usual global perturbations, including to the cyclones and the monsoon.

Storm like weather conditions loom over the Howrah Bridge thanks to Cyclone Yaas, May 24, 2021. | Photo Credit: PTI

A transition from a La Niña winter – which we are in currently – to an El Niño summer has historically tended to produce a largest deficit in the monsoon, on the order of 15%. This means that pre-monsoon and monsoon circulations tend to be weaker in an El Niño year. The vertical shear (change in the intensity of winds from the surface to the upper atmosphere) tends to be weaker as well. This in turn can favour enhanced cyclogenesis, i.e. cyclone formation.

Of course, the global climate system is not so simple. Intraseasonal or subseasonal timescale variability in sea-surface temperature and winds is also very important for cyclogenesis over the northern Indian Ocean. These timescales denote the durations for which certain temperature and wind characteristics persist in the pre- and post-monsoon periods.

This said, the net effect is for cyclogenesis to be subdued in an El Niño year.

Again, we will have to wait until spring to get a sense of how the cyclone season will play out this year.

As for the monsoon itself: if an El Niño state does emerge by summer, we will likelier than not have a deficit monsoon in 2023. Some research has indicated that the Indian Ocean dipole – a seesawing of sea-surface temperature over the western Indian Ocean – could compensate for the negative effects of an El Niño. But it is not yet clear whether there is a robust relation between the dipole, the El Niño, and the summer monsoon. We also don't know if the dipole will evolve the 'right' way this year.

As has been the case in recent decades, a monsoon deficit itself will be accompanied by a smorgasbord of both wet and dry extreme events. A weaker monsoon circulation will produce a severe deficit over much of India. And while the overall seasonal total could be deficient, there are likely to be isolated pockets of heavy or very heavy rainfall.

A view of the Western Ghats in July 2022 from Bisle viewpoint, Hassan, Karnataka. | Photo Credit: K. Murali Kumar

Then there are the monsoon's vagaries themselves. For example, pre-monsoon cyclones are susceptible to warming in the Arctic region, and could in turn affect the onset of the summer monsoon.

Indeed, the summer monsoon system is quite complicated: its various components are affected

by a plethora of meteorological events both local and global. Even details at the intraseasonal scale can have an effect.

For example, the Bay of Bengal has of late been receiving freshwater from heavy rains as well as anomalously high river-runoffs. These waters tend to sneak into the Arabian Sea and produce surface warming and the build-up of subsurface heat. These changes together may create favourable conditions for the formation of bigger and badder cyclones, especially if the circulation and the vertical shear are weaker as well.

In all, India will have to wait for the El Niño forecast to be updated in the coming weeks. It will also have to hope for the best and, unavoidably, prepare for the worst. Apart from preparedness, an unfavourable prediction will also test the India Meteorological Department's suite of forecast products, and efforts to translate its forecasts to usable advisories for fishing, farming, flood alerts, etc.

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