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From Rainfall to Rhythm: Impact Assessment of Indian Monsoon on Climate Patterns, Economic Livelihoods, and Folk Dance

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ABSTRACT

The Indian monsoon is the most dominant component of the South Asian climate system, regulating hydrology, agriculture, and socio-economic stability across the subcontinent. This study outlines the spatio-temporal dynamics of the Indian monsoon, focusing on its two principal phases — the South West monsoon and the North East monsoon — and their driving mechanisms. Key influencing factors include the Indian topography, Himalayan orography, Tropical Easterly Jet, Subtropical Jet Stream, Inter-Tropical Convergence Zone, and pressure cells over Tibet and the Indian Ocean. The South West monsoon, with Arabian Sea and Bay of Bengal branches, typically onsets in Kerala by June 1 and withdraws by early December, exhibiting state-wise variability in arrival and retreat. The India Meteorological Department delineates four seasons: Winter, Pre-monsoon, Monsoon, and Post-monsoon, with the retreating phase marked by clear skies and cyclogenesis in the Bay of Bengal. Additionally, large-scale teleconnections such as El Niño-Southern Oscillation significantly modulate monsoon intensity. El Niño phases correlate with weakened rainfall, drought risk, and adverse impacts on Kharif crops, while La Niña enhances precipitation. Given India's agrarian economy, monsoon variability directly affects agricultural productivity, water reservoirs, rural income, GDP growth, and groundwater recharge. The study underscores the monsoon's role in both sustaining livelihoods and posing hazards through floods and droughts, highlighting the need for improved prediction models and climate-resilient policy frameworks to mitigate economic vulnerability. The Indian monsoon governs the agrarian calendar, hydrological cycles, and cultural rhythms of the subcontinent. While Indian folk dances are widely documented as socio-religious expressions, their dependence on monsoon seasonality, rainfall variability, and ecological context remains understudied. This study examines monsoon as an environmental determinant of folk dance morphology, material culture, and performance ecology.

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KEYWORDS: *Indian Monsoon, South West Monsoon, North East Monsoon, ITCZ, El Niño, ENSO, Agriculture, IMD, Climate Variability, Rainfall.*

1. INTRODUCTION

The Indian monsoon, stands as a paramount feature among the world's monsoon systems, exerting its influence primarily over India and its surrounding aquatic expanses. Its seasonal journey unfolds with a northeast drift during the cooler months, only to pivot and surge southwest during the peak of warmth. This seasonal reversal heralds the arrival of copious rainfall, inundating the region notably in June and July. In proximity to the Equator, the environs adjacent to India exhibit a distinctive meteorological character. Here, prevailing westerly winds maintain a near-constant presence at the surface throughout the year. Surface easterlies, meanwhile, extend merely to latitudes near 20° N by February, bearing a pronounced northerly component. Subsequently, these easterlies recede poleward, ushering in significant transformations in upper-air circulation. This juncture marks the transition between the waning influence of one monsoon and the burgeoning onset of the next. As late March unfolds, the high-sun season engulfs the Equator before migrating northward. Accompanying this migration are atmospheric instability, convective cloud formations, and precipitation. Amidst these shifts, the westerly

subtropical jet stream retains dominion over the aerial currents across northern India, while surface winds veer towards the northeast.

Methodology:

This study synthesizes secondary data from the India Meteorological Department (IMD), peer-reviewed climatologically records, and cartographic sources to examine the spatio-temporal dynamics of the Indian monsoon. Key parameters analyzed include onset and withdrawal dates across states, influencing factors such as the Himalayan orography, Tropical Easterly Jet, Subtropical Jet Stream, ITCZ migration, and pressure cells over Tibet and the Indian Ocean. The study also evaluates large-scale teleconnections, particularly El Niño-Southern Oscillation phases, and their correlation with monsoon rainfall anomalies and agricultural outcomes.

Mainly there are two types of Monsoon affecting Indian Climate,

- South West Monsoon
- North Eastern Monsoon

2. Factors effecting South West Monsoon in India:

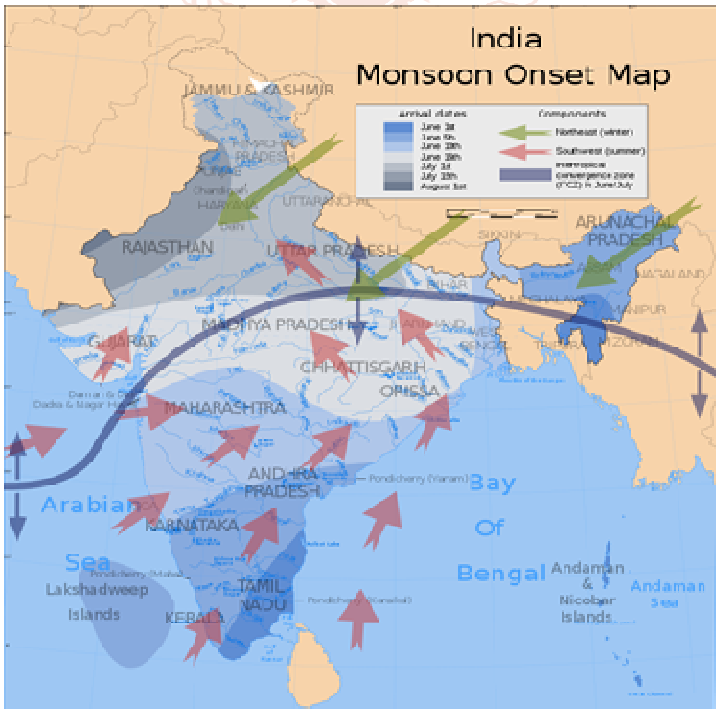
- Indian Topography
- The Eastern Ghats and The Eastern Ghats
- African Easterly Jet or Tropical Easterly Jet.
- Subtropical Jet streams circulation in upper troposphere
- Inter Tropical Convergence Zone(I.T.C.Z)
- The Himalaya.
- High Low pressure zone
- Low pressure formation Over the Plateau of Tibet,
- Permanent High Pressure Cell in the south of the Indian Ocean.

3. Factors effecting North East Monsoon in India:

- Formation of high pressure cells over the Tibetan.
- Shifting of ITCZ to south in India
- Weak high pressure cells in the southern India.
- Collision between retreating south west monsoon and sub tropical jet stream.

The onset of the southwest monsoon typically occurs in the middle of June. This monsoon system manifests through two principal branches known as the Bay of Bengal branch and the Arabian Sea branch. Notably, the Arabian Sea branch exerts a more potent influence compared to its Bay of Bengal counterpart, generating a low-pressure area over the Thar Desert region. Characterized by a robust, predominantly west or southwest airflow, the summer monsoon season heralds significant precipitation across the Asian subcontinent as well as South and East As Source:

ia. The substantial rainfall associated with the southwest monsoon arises from the interaction of air masses traversing expansive warm equatorial oceanic regions, prompting heightened evaporation from the ocean surface. Laden with moisture, the southwest monsoon air undergoes cooling as it progresses northward and ascends over landmasses. Ultimately, a saturation point is reached, leading to the release of abundant precipitation, essential for irrigating rice paddies and saturating rainforests, albeit occasionally resulting in severe flooding events



Source: https://en.m.wikipedia.org/wiki/File:India_southwest_summer_monsoon_onset_map_en.svg

4. Duration of Indian Monsoon works over the states.....

Location	Monsoonal sub System	Average date of arrival	Average date of Withdrawal
Kerala	Indian Monsoon	1st June	1st December
Mumbai	Indian Monsoon	10th June	1st October
Tamil Nadu	Indian Monsoon	12th June	15th October
Odessa	Indian Monsoon	12 th June	Mid of October
West Bengal	Indian Monsoon	15th June	Mid of October

5. The India Meteorological Department (IMD) categorizes India's climate into four distinct seasons:

- **Winter (December to February):** This season encompasses the coldest months of the year, namely December and January. In the northwest region, temperatures typically range from 10–15 °C. As one moves towards the equator, temperatures gradually increase, reaching averages of 20–25 °C in the southeast of mainland India.
- **Summer or Pre-monsoon Season (March to May):** Lasting from March to May, this period witnesses rising temperatures across the country. In the western and southern regions, April and the beginning of May are typically the hottest months, while in the northern parts of India, May takes the lead as the hottest month. During May, temperatures soar, averaging around 32–40 °C in most interior regions.
- **Monsoon or Rainy Season (June to September):** The monsoon season spans from June to September and is characterized by the dominant influence of the humid southwest summer monsoon. This monsoon typically initiates its sweep across the country by late May or early June. As October begins, the monsoon rains gradually retreat from North India, while South India continues to receive considerable rainfall.
- **Post-monsoon or Autumn Season (October to November):** This season extends from October to November. In the northwest of India, these months are often marked by clear skies. Conversely, Tamil Nadu experiences a significant portion of its annual precipitation during the northeast monsoon season, particularly in November.

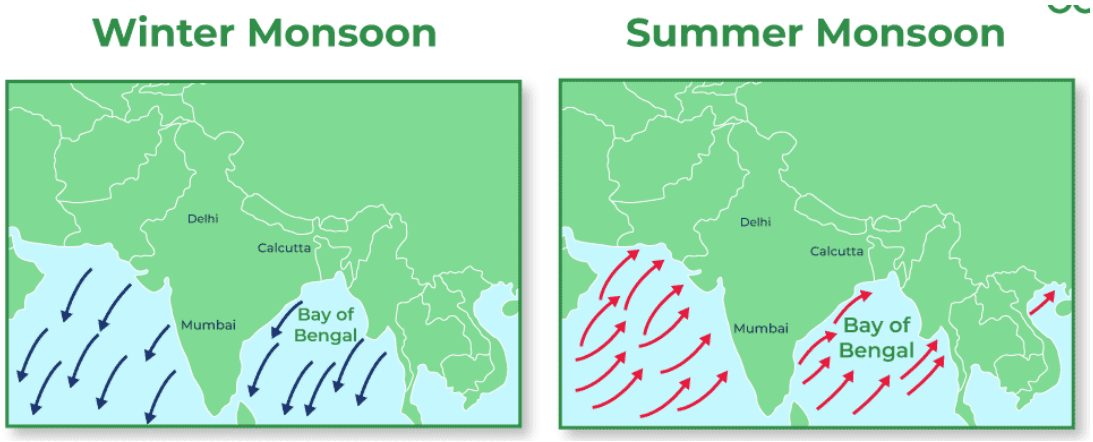
6. Season of Retreating Monsoon

The Season of Retreating Monsoon marks the gradual withdrawal of the southwest monsoon, spanning from mid-September to November, and extending until early January. This period unfolds over a duration of approximately three months, commencing with the retreat from the peninsula in October and progressing to the extreme south-eastern tip by December. Notably, the southwest monsoon retreats from the Coromandel coast around mid-December. In Punjab, this withdrawal occurs during the second week of September.

Unlike the advancing monsoon, the withdrawal of the retreating monsoon is characterized by a gradual process that spans a longer duration.

6.1. The Season of Retreating Monsoon marks the gradual withdrawal of the southwest monsoon, spanning from mid-September to November, and extending until early January. This period unfolds over a duration of approximately three months, commencing with the retreat from the peninsula in October and progressing to the extreme southeastern tip by December. Notably, the southwest monsoon retreats from the Coromandel coast around mid-December. In Punjab, this withdrawal occurs during the second week of September.

During the Retreating Monsoon period, there is a noticeable shift in climate dynamics. As the monsoon begins its withdrawal, skies clear up and clouds dissipate, leading to a gradual increase in temperatures across various regions. However, this transition is also marked by the emergence of severe tropical cyclones originating from the Bay of Bengal. Particularly during the months of October and November, the region is susceptible to the occurrence of these intense cyclonic storms.



Source: https://www.geeksforgeeks.org/give-differences-between-summer-monsoon-and-retreating-monsoon/

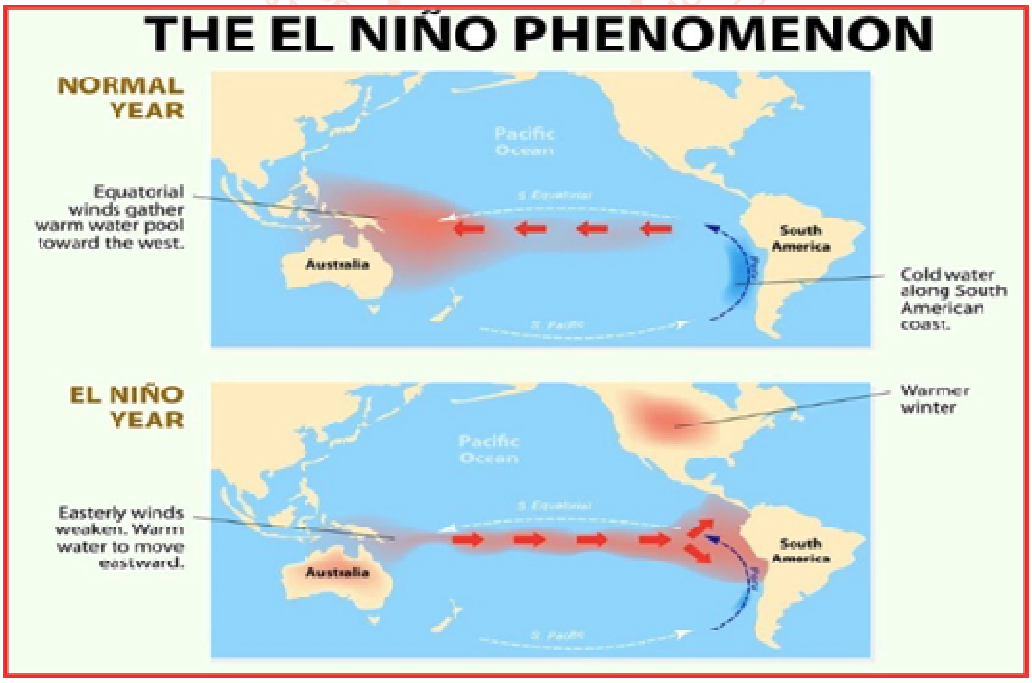
7. Concept about El Nino, La Nino and Neutral Phases:

It's very important to know El Nino, when we study the Indian Monsoon and effects of monsoon in Indian Economy. Southern Oscillation (ENSO) is a very important climate phenomenon which categorised by three phases El Nino, LA Nino, and Neutral.

7.1. El Nino: A warming of the ocean surface, or above-average sea surface temperatures (SST), in the central and eastern tropical Pacific Ocean. Over Indonesia, rainfall tends to become reduced while rainfall increases over the tropical Pacific Ocean. The low-level surface winds, which normally blow from east to west along the equator ("easterly winds"), instead weaken or, in some cases, start blowing the other direction (from west to east or "westerly winds").

7.2. La Nina: A cooling of the ocean surface, or below-average sea surface temperatures (SST), in the central and eastern tropical Pacific Ocean. Over Indonesia, rainfall tends to increase while rainfall decreases over the central tropical Pacific Ocean. The normal easterly winds along the equator become even stronger.

7.3. Neutral: Neither El Niño or La Niña. Often tropical Pacific SSTs are generally close to average. However, there are some instances when the ocean can look like it is in an El Niño or La Niña state, but the atmosphere is not playing along (or vice versa).



Source: https://byjus.com/free-ias-prep/el-nino/

- El Niño significantly impacts both the climate and economy of India, given the country's agricultural dependence. In April, the India Meteorological Department (IMD) issued a forecast predicting a normal monsoon for 2023, anticipating rainfall to reach 96% of the long-term average.

- However, it added a rider, which many observers were quick to notice, and rightly so.
- According to the IMD, both its models and those of others predict that "El Nino conditions are likely to develop during the monsoon season."

8. Impact of El Nino on Indian Agriculture:

- **Weak Monsoon for India:** The emergence of El Niño in May or June 2023 could lead to a weakening of the southwest monsoon season. This season typically accounts for approximately 70% of total rainfall in India, upon which the majority of farmers still heavily rely.
- **Sporadic increase in rainfall:** Despite overall weakened monsoon conditions, sub-seasonal influences such as the Madden-Julian Oscillation (MJO) and monsoon low-pressure systems may temporarily enhance rainfall in certain regions. This phenomenon was observed during the El Niño event of 2015.
- **Drought:** El Niño events often trigger drought conditions. Past occurrences of El Niño have resulted in drought or a diminished southwest monsoon across India.

Impact on Kharif Crops: A poor monsoon, influenced by El Niño, can significantly affect the growth of Kharif crops. Particularly vulnerable are water-intensive crops such as paddy (rice), groundnuts, and pulses. Additionally, cotton and sugarcane crops may also suffer adverse effects from a severe El Niño event

Agriculture: Indian economy totally depends on Agriculture and every agricultural process depends on Monsoon. Insufficient Rainfall affect on agricultural productivity. So, monsoonal rainfall very important to grow agricultural production**.**

A. **Water Reservoirs and Irrigation**: Monsoon replenishes water reservoirs and it helps to maintain Irrigation system.

B. Rural Economy: In India agriculture production belongs to rural area. Every crop production related to farming comes from rural farm. Soit's very common that if agricultural income goes high automatically, source of income of every farmer as well as main economy of rural area goes high.

C. GDP Growth: Agricultural sector contributes to higher GDP; on the other hand poor monsoons can lead to agricultural distress and have a negative impact on economic growth.

D. Pressure on Government Finances: The government may face increased financial pressure due to the need for relief measures to support affected farmers. It means government finance depends on farmer's income. Subsidies, loan waivers, and other financialassistance programs may be helps to the farmers for mitigate the economic impact on the agricultural sector.

E. Groundwater Conservation: Monsoonal rainfall also helps to Groundwater Conservation.

F. Tackling Floods and Droughts: Climate change is increasing unpredictability in weather patterns. Now a day's Floods and Droughts very common climatic hazard in India, and its affects Indian agriculture as well as Indian Economy.

G. Research and Development: The data of rainfall, humidity, agricultural productivity, Crop intensity, crop combination, flood and drought deserter etc helps to research Institute, which is very important data for weather prediction, growth, and developmentin India.

9. Spatial Variation of Indian Monsoon Phenomena and Indian Folk Dance:

The spatial variation of the Indian Monsoon—characterized by a sharp gradient between the heavy orographic rainfall of the coasts and mountains versus the rain-shadow and arid interiors—creates a diverse "rhythmic map" of India.

The relationship between the Monsoon's spatial distribution and folk dance can be analyzed through three primary geographical lenses:

9.1. High Rainfall Zones: The Rhythms of Vitality

In regions like the Western Ghats, Northeast India, and the Himalayan foothills, the monsoon is intense and reliable.

- Kinesics Fluidity: The abundance of water is reflected in fluid, high-energy movements. In Kerala, the monsoon is the backdrop for Kalaripayattu-inspired folk forms and boat-race dances. The movements are expansive, mirroring the overflowing water bodies.

- Verticality: In the Assam Valley, the Bihu dance involves rapid hip and hand movements. The high humidity and lush growth are translated into a "celebration of fertility" that is physically demanding and fast-paced.

9.2. Semi-Arid and Rain-Shadow Zones: The Rhythms of Invocation

In the Deccan Plateau and the Rarh region of West Bengal, the monsoon is often unpredictable. Here, the spatial variation leads to a "culture of anxiety" and prayer.

- Ritualistic Earthiness: In the plateau regions, dances like the Karma dance (practiced by the Gond and Oraon tribes) are deeply rooted in the earth. The footwork is heavy and rhythmic, designed to "wake the soil" and invite the rain.
- The Chhau Transition: In the Purulia district, the Chhau dance's vigorous leaps and earth-bound landings reflect the rugged, sun-baked terrain of the plateau, where the arrival of the monsoon represents a dramatic victory over the harsh, dry environment.

9.3. Alluvial Plains and Deltaic Regions: The Rhythms of Sowing

The Indo-Gangetic plains and the Bengal Delta see a seasonal transformation where the land becomes a vast sheet of water and mud.

- Low Center of Gravity: Folk dances in these muddy terrains often feature a semi-squatted posture (the Chauk position in some forms). This provides stability on slippery alluvial soil.
- Occupational Kinesics: The spatial variation in crop types (e.g., rice in the East vs. wheat in the North) changes the dance. The Tusu and Bhadu dances of West Bengal are performed during the transition of the monsoon and harvest cycles, with movements that mimic the manual labor of transplanting paddy in flooded fields.

9.4. Spatial Variation Table of Indian Monsoon Phase and Indian Folk Dance Morphology:

Physiographic Region	Monsoon Phase	Rainfall Intensity	Agriculture Stage	Folk Dance Example	Kinesic/Morphological Feature
Western Ghats & Konkan Coast Onset	Onset (Early June)	Extreme (Orographic)	Field Preparation	Tarpa Dance	Spiraling, communal circles mimicking the vigorous growth and wind of the early monsoon.
Brahmaputra Alluvial Valley	Peak (June–July)	Very High	Sowing & Transplanting	Bihu	Rapid hand vibrations and hip swaying; mirrors the "quickening" of life and fertility in high-humidity zones.
Chota Nagpur Plateau (Rarh Region)	Mid-Monsoon	(July–Aug)	Moderate (Variable) Weeding & Crop Growth	Karam / Chhau	Grounded, rhythmic stomping. High-energy leaps in Chhau reflect the "victory" over the hard, sun-baked plateau soil.
Indo-Gangetic Plains	Mid-Monsoon	(July)	High Paddy Transplanting	Kajari / Jhoola	Rhythmic, repetitive swaying. Movements often mirror the physical act of planting in mud or the motion of swings.
Thar Desert / Rain Shadow	Late/Weak Onset	Very Low (Arid)	(Arid) Water Conservation	Kalbelia / Ghoomar	Sinuous, swirling motions like desert winds. Focus is on "invocation" rather than agricultural labor.
Deccan Plateau (Interior)	Withdrawal	(Sept–Oct) Low to Moderate	Pre-Harvest	Dhangari Gaja	Heavy footwork and drum-centric rhythms, celebrating the strength required to sustain life in semi-arid conditions.

10. Conclusion:

The Indian monsoon is not a static meteorological event but a dynamic seasonal reversal of winds driven by differential heating, pressure gradients, and upper-air circulation. Its onset, progression, and withdrawal show distinct regional patterns, with the Arabian Sea branch being more vigorous than the Bay of Bengal branch. Indian Monsoon controls Topographic and Atmospheric aspects, Topography including the Himalayas, Western and Eastern Ghats, along with large-scale features like the Tropical Easterly Jet, Subtropical Jet Stream, and ITCZ migration, fundamentally control monsoon intensity, timing, and spatial distribution. The Tibetan Plateau's low-pressure formation is critical for South West monsoon onset. The Indian monsoon functions as both a lifeline and a climatic hazard. Its behavior is modulated by physiographic controls and global teleconnections like ENSO, directly impacting water resources, rural livelihoods, and economic growth. Improved predictive models integrating monsoon-ENSO interactions and localized patterns are essential for climate-resilient agriculture, disaster management, and sustainable development policy in a warming climate. Also, Folk dance systems encode monsoon knowledge through seasonality, morphology, and material culture. Pre-monsoon rituals invoke rain, peak monsoon confines performances indoors, and retreating monsoon triggers post-harvest celebrations like Bihu, Bhangra, and Onam. Movement amplitude, tempo, and prop ecology reflect rainfall zones and topography — vertical forms in high-rainfall hills, expansive forms in arid plains, bamboo in monsoon forests, minimal props in drought zones. Lastly, The Indian monsoon is thus not only a meteorological phenomenon but a biocultural force shaping climate, economy, and the very rhythms of folk dance; its variability demands integrated approaches to climate adaptation and cultural heritage conservation.

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