



Winter–spring rainfall at Port Blair as a local El Niño signature and predictor of water scarcity in the Andaman and Nicobar Islands, 1950–2026

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DOI: <https://doi.org/10.66856/ijees.2026.8.2.8075>

Abstract

The January–April rainfall at Port Blair (Sri Vijaya Puram), though only about five per cent of the annual total, is the sole inflow to the Dhanikhari reservoir during its continuous drawdown season and therefore governs summer water security for a population exceeding 1,50,000. We compile a continuous 77-year station series of January–April totals (1950–2026), together with November–December totals and annual totals, and relate them to the state of the tropical Pacific. Four results emerge. (i) There is a graded, continuous relationship between the intensity of the preceding winter's Oceanic Niño Index (ONI) and spring rainfall (Pearson $r = -0.465$, $P < 0.0001$): mean spring rainfall falls from 221 mm after La Niña winters to 164 mm in neutral years to 99 mm after El Niño winters. (ii) The relationship is a suppression, not a forcing: strong El Niño winters (ONI ≥ 1.0) impose a hard ceiling on spring rainfall, none of fifteen exceeded 177 mm, whereas weak warm winters impose none (maximum 280 mm). El Niño removes the possibility of a wet spring without dictating how dry the spring becomes. (iii) The signature is therefore a necessary but not sufficient condition for scarcity: every one of the twenty springs below 60 mm in 77 years was El Niño-associated ($P(\text{El Niño} | \text{collapse}) = 1.0$), yet only about 40 per cent of strong El Niño winters produced such a collapse ($P(\text{collapse} | \text{strong El Niño}) \approx 0.4$). (iv) For water management, the decisive quantity is the cumulative dry-season inflow, the preceding November–December rainfall plus the January–April rainfall, which separates the documented scarcity years from the safe years without overlap (crisis years 207–482 mm; safe years 651–745 mm). The signature is decoupled from the annual total (seven of the collapses fell in above-normal years), is stationary across both halves of the record, and is corroborated at an independent catchment gauge ($r = 0.79$) and by archipelago-wide IMD deficits in 2026. With an El Niño declared in June 2026 and forecast to strengthen through the coming winter, spring 2027 falls in the suppressed regime, and its dry-season inflow is already tracking towards the crisis range. Three zero-cost operational triggers are proposed, and implications for compound groundwater stress and seawater intrusion are discussed.

Keywords: ENSO, El Niño, island hydrology, seasonal rainfall, water scarcity, reservoir management, seawater intrusion

Introduction

The Andaman and Nicobar Islands receive a mean annual rainfall of about 3,079 mm at Port Blair, yet the capital experiences recurrent acute water scarcity ^[1]. Long-term trend analysis has shown annual rainfall to be statistically stationary while temperatures and rainy days rise significantly ^[2]. The coexistence of abundance and scarcity has generally been attributed to steep terrain, limited storage and runoff losses ^[3]. Here we examine a complementary and hitherto unquantified factor: the seasonal timing of rainfall relative to the reservoir drawdown cycle, and its control by the El Niño–Southern Oscillation (ENSO).

The islands receive rainfall from the Southwest monsoon (May–September) and the Northeast monsoon, which locally spans November to January. The January–April interval combines the Northeast monsoon's terminal month, winter showers and the pre-monsoon transition. It contributes only about five per cent of the annual total in a normal year and under one per cent in a poor one, yet it is the only precipitation received while the Dhanikhari reservoir, the principal source for Sri Vijaya Puram, is in continuous net drawdown, and its variability is extreme (seasonal coefficients of variation exceeding 100 per cent ^[2]). We test the hypothesis, first framed from operational observation, that this spring rainfall is strongly ENSO-phased and therefore constitutes both a local El Niño signature and an operational predictor of summer water scarcity.

Data and Methods

Monthly rainfall for Port Blair, 1949–2009, was obtained from the Directorate of Economics and Statistics (DES), A&N Administration. Station monthly data for 2010–2012 and 2020–2024, and January–April progressive totals for 2025–2026, were obtained from the Meteorological Department, Shadipur, Sri Vijaya Puram. Station monthly data for 2012–2021 were taken from DES tables reproduced in the A&N Forest Statistics publications ^[4]; the 2016 column of the 2017 edition is published as progressive totals and was converted to monthly values by differencing. Overlapping years across sources ^{2012, 2020, 2021} agree exactly, giving a continuous station series from 1949 to 2026. Dhanikhari and Chouldari reservoir levels for 2017–2026 were compiled during a field survey conducted in January–March 2026 ^[5], supplemented by published levels ^[1]. Monthly rainfall at the Dhanikhari catchment gauge (November 2020–March 2026) was taken from the table published by the A&N Administration through the Andaman Public Works Department on 8 April 2026 ^[6]; this gauge, at the reservoir itself and about 15 km from Shadipur, is spatially independent and hydrologically the more relevant instrument for storage prediction.

Each spring (January–April of year Y) was classified by the ENSO state of the immediately preceding December–February (DJF) winter, using the NOAA Oceanic Niño Index ^[7] with standard intensity thresholds ^[8] (weak 0.5–0.9°C, moderate 1.0–1.4°C, strong 1.5–1.9°C, very strong $\geq$

2.0°C; symmetric for La Niña). The preceding-winter scheme assigns each spring to exactly one category and avoids the double-membership of onset/decay schemes in transition years. El Niño onset years (the calendar year in which an event developed) were tabulated separately for the analysis of collapsed springs. Group differences were assessed with the Mann–Whitney *U* test, appropriate for the non-normal, zero-inflated distributions involved. A collapsed spring is defined as a January–April total below 60 mm, which corresponds to the lowest quartile of the 77-year distribution (26th percentile).

Results

The complete record

Table 1 lists all 77 springs with the annual total and the preceding winter state; springs following moderate-or-stronger El Niño winters are shaded and asterisked. The paired columns make the central point of this study visible

at a glance: collapsed springs (▼) are not confined to deficit years, seven of the nineteen completed collapses (†) occurred in years of above-normal annual rainfall, including 2005 (3,774 mm) and 1980 (3,757 mm), among the wettest years of the record. Conversely, the driest year of the entire series, 1979 (1,541 mm), did not produce a collapsed spring (93.6 mm). Annual and spring behaviour are largely independent, and it is the spring, not the year, that tracks the crisis history. The added November–December column shows the Northeast-monsoon core that fills the reservoir before the drawdown; several of the most severe collapses were preceded by a weak Northeast monsoon as well as a failed spring, most starkly 1979 (Nov–Dec 32 mm, the failed top-up behind the record-low annual total), and among recent crises 1993 (220 mm), so an El Niño can suppress both windows of the same water year, compounding the deficit.

Table 1: January–April rainfall, November–December rainfall (same calendar year) and annual total (all mm), with the ENSO state of the immediately preceding December–February winter, for all 77 years at Port Blair / Sri Vijaya Puram, 1950–2026. n.a. = not available (2025) or not yet occurred (2026). W/M/S/VS = weak/moderate/strong/very strong; shaded* = moderate-or-stronger El Niño winter; ▼ = collapsed spring (< 60 mm); † = collapsed spring in a year of above-normal annual rainfall (> 3,079 mm); · EN onset yr = an El Niño event developed later in that same calendar year. Sources: ref. 4 and DES / Meteorological Department, Shadipur.

Year	Jan–Apr rain (mm)	Nov–Dec rain (mm)	Annual total (mm)	Preceding DJF winter (ONI class)
1950	96.3	258.5	2422	La Niña M
1951	135.3	644.4	3275	La Niña W
1952	110.4	316.4	3019	El Niño M*
1953	239.2	327.4	2877	El Niño W
1954	129.5	119.2	4027	El Niño W
1955	165.7	335.8	3339	La Niña W
1956	297.4	240.1	3031	La Niña M
▼ 1957	29.4	103.6	2898	La Niña W · EN onset yr
▼ † 1958	33.2	548.4	3151	El Niño S*
1959	129.6	316.1	3586	El Niño W
1960	156.4	225.7	3080	Neutral
1961	391.1	394.2	4362	Neutral
1962	227.9	638.2	3260	Neutral
1963	214.2	364.8	3229	Neutral
▼ † 1964	22	418.2	3324	El Niño M*
1965	111.6	629.3	3216	La Niña W
1966	113.6	657.8	2928	El Niño S*
1967	196.1	198.5	3605	Neutral
1968	79.3	292.2	2620	La Niña W
1969	175.2	260.5	2691	El Niño M*
1970	71.7	611.9	3663	El Niño W
▼ 1971	37.1	154.7	2895	La Niña M
1972	141.4	702.8	3748	La Niña W
▼ 1973	50.5	475.9	2912	El Niño S*
1974	483.9	326.9	3089	La Niña S
1975	267.5	396.2	2765	La Niña W
1976	159.6	774.7	3496	La Niña S
1977	96.5	92.9	2332	El Niño W
1978	198.4	105.7	2663	El Niño W
1979	93.6	32	1541	Neutral
▼ † 1980	8.2	808.8	3757	El Niño W
1981	68.3	575.4	3204	Neutral
1982	67.9	300.6	2446	Neutral
▼ 1983	8.4	328.7	2975	El Niño VS*
1984	420.9	701.2	3421	La Niña W
▼ 1985	54	327.4	2828	La Niña W
▼ 1986	0.7	169.4	2198	Neutral · EN onset yr
1987	102.8	561.1	2635	El Niño M*
1988	143.3	604.7	3365	El Niño S*
1989	117.7	272.8	2542	La Niña S
1990	122.2	402.8	2594	Neutral
1991	180.5	214.2	3097	Neutral

1992	144.2	183.2	2794	El Niño S*
▼ 1993	30.8	219.7	2543	El Niño W
1994	253.8	190.9	3512	Neutral
▼ † 1995	23.3	501.2	3358	El Niño M*
1996	213.1	493.4	3473	La Niña M
▼ 1997	24.2	331.2	2796	Neutral · EN onset yr
▼ 1998	0.9	265.6	2812	El Niño VS*
1999	477.2	311.1	2975	La Niña S
2000	528.4	220.7	2943	La Niña S
2001	265.4	196.9	3113	La Niña W
2002	100.7	465.4	2617	Neutral
2003	177.2	126.7	2443	El Niño M*
2004	164.8	294.6	3189	Neutral
▼ † 2005	55.3	652.7	3774	El Niño W
2006	156.3	113.4	3004	La Niña W
▼ 2007	40.7	273.4	2556	El Niño W
2008	444.2	443.7	4153	La Niña S
2009	185.3	150.5	2497	La Niña W
2010	96.2	388.3	3117	El Niño M*
2011	719.9	326.7	3889	La Niña S
2012	216.9	388.3	3465	La Niña M
▼ † 2013	56	482.1	3406	Neutral
▼ 2014	0.4	190.6	2877	Neutral · EN onset yr
2015	280.3	395.7	2888	El Niño W
2016	107.4	703.6	3650	El Niño VS*
2017	246.2	493.7	3292	La Niña W
2018	238.2	547.5	3436	La Niña W
2019	193.1	195.8	3221	El Niño W
▼ 2020	11.1	386.6	2882	El Niño W
2021	358.2	347.8	3461	La Niña M
2022	332.1	368.8	2587	La Niña M
▼ 2023	29.9	503.7	3351	La Niña W · EN onset yr
2024	147	504	3453	El Niño S*
2025	262	n.a.	3494	La Niña W
▼ 2026	50.7	n.a.	n.a.	Neutral · EN onset yr

A graded relationship: the dose–response

Classifying springs by a simple El Niño / La Niña / neutral label understates the relationship, which is in fact continuous. The intensity of the preceding winter, measured by the Oceanic Niño Index (ONI), correlates negatively with spring rainfall across the full record (Pearson $r = -0.465$, $P < 0.0001$; Spearman $\rho = -0.41$). Mean January–April rainfall declines monotonically with Pacific warmth: 221 mm after La Niña winters ($\text{ONI} \leq -0.5$, $n = 30$), 164 mm in neutral years ($n = 20$), and 99 mm after El Niño winters ($\text{ONI} \geq +0.5$, $n = 27$). This is a dose–response, not a threshold effect, and it is robust to the exact ONI cut-offs used.

El Niño as a ceiling, not a cause

The mechanism is better described as suppression than as forcing, and the distinction is visible in the spread of warm-winter springs. Springs following a strong El Niño winter ($\text{ONI} \geq 1.0$, $n = 15$) range from 0.4 to 177 mm, a hard upper ceiling of about 180 mm that not one strong event has breached in 77 years. Springs following a weak warm winter ($\text{ONI} 0.5\text{--}0.9$, $n = 12$) range from 8 to 280 mm, with no such ceiling. A strong El Niño therefore does not determine how dry the spring will be; it removes the possibility of a wet one. Where the spring lands beneath that ceiling is set by other factors: the Indian Ocean Dipole, the phasing of the Madden–Julian Oscillation, and local Bay of Bengal sea-surface temperatures. This ceiling behaviour explains why the two most suppressed springs of the record, 0.9 mm (1998) and 8.4 mm (1983), followed the two

strongest twentieth-century events, and why weak events scatter unpredictably.

A necessary but not sufficient condition

The signature is one-directional, and stating it precisely is essential. Every one of the twenty springs below 60 mm in 77 years was associated with El Niño, eleven followed an El Niño winter (including 1993, whose 1992–93 winter registered weakly warm within the extended early-1990s warm period), six coincided with an El Niño onset in the same calendar year (1957, 1986, 1997, 2014, 2023, 2026; marked in Table 1), and three preceded an onset by one year [1971, 1985, 2013], with 1958 qualifying under two categories and counted once. Thus $P(\text{El Niño present} \mid \text{spring collapsed}) = 1.0$. The converse is far weaker: only six of fifteen strong El Niño winters produced a collapsed spring, so $P(\text{collapse} \mid \text{strong El Niño}) \approx 0.4$. El Niño is therefore a necessary condition for a collapsed spring but not a sufficient one, the logical structure of a ceiling. This asymmetry is the correct and defensible form of the finding: a collapsed spring reliably indicates El Niño, but an El Niño does not reliably collapse the spring (the wet spring of 2015, an El Niño onset year, is the standing counter-example).

A caution on base rates is warranted. Because El Niño events are frequent and their onset and decay shoulders are broad, 84 per cent of all years in the record fall within one year of an event by the adjacency criterion above. Against so high a background rate, the perfect 20-of-20 association, while exact, is only modestly significant on a binomial test ($P = 0.034$), and should not be over-interpreted in isolation.

It is the graded dose–response and the hard ceiling, neither of which a base-rate artefact is, that carry the physical weight of the result; the 20-of-20 count is best read as their operational corollary at the scarcity-relevant tail. The record minimum, 0.4 mm (2014), is independently corroborated by the zero February–April seasonal minimum reported for 2014 by Adamala and Velmurugan ^[2].

Hydrological consequence: the scarcity threshold

For the period with documented municipal supply records, station January–April totals and scarcity status align without exception (Table 2): the four crisis summers ^{[2014, 2020, 2023,}

^{2026]} follow springs of 0.4, 11.1, 29.9 and 50.7 mm, while all non-crisis years since 2020 exceed 140 mm, with no observations between 60 and 140 mm. The 2014 episode predates the reservoir-level series but is documented as a scarcity year ^[1]. Reservoir behaviour is consistent: March levels at Dhanikhari for 2017–2025 (55.49–62.01 m) track the preceding October–January rainfall, with the record minimum (55.49 m, March 2020) following the failed 2019–20 top-up and the maximum (62.01 m, March 2021) following the strong La Niña winter of 2020–21 ^[5]. During the 2026 episode the level fell from 56.49 m (13 March) to about 52.8 m, with supply restricted to once in three days ^[5].

Table 2: Recent station January–April totals, ENSO context and documented scarcity episodes.

Year	Jan–Apr (mm)	ENSO context	Documented scarcity episode
2014	0.4	El Niño onset (2014–16 event)	Yes (ref. 1)
2020	11.1	After 2019 warm event / record +IOD	Yes
2021	358.2	La Niña	No
2022	332.1	La Niña	No
2023	29.9	La Niña–El Niño transition	Yes
2024	147.0	El Niño decay	No
2025	262.0	Weak La Niña	No
2026	50.7	El Niño onset	Yes

The decisive quantity: cumulative dry-season inflow

The reservoir does not respond to the spring rainfall in isolation; it integrates all inflow from the end of the filling monsoon through the drawdown. Combining the two dry-season windows, the preceding November–December top-up and the January–April spring, into a single cumulative dry-season inflow separates the documented scarcity years from the safe years completely and with a wide margin (Table 3). The three crisis water-years for which both windows are available received 207, 399 and 482 mm; the

three safe years received 651, 680 and 745 mm. There is no overlap, and the gap between the highest crisis value (482 mm) and the lowest safe value (651 mm) is larger than in either window taken alone. This cumulative figure is the single most useful operational quantity identified in this study: it captures both blows of an El Niño water-year, a suppressed Northeast-monsoon top-up followed by a suppressed spring, in one number that maps directly onto what the reservoir physically stores.

Table 3: Cumulative dry-season inflow (preceding November–December rainfall plus January–April rainfall) for years with documented municipal supply records, showing complete separation of crisis and safe years.

Water-year (to spring)	Prev Nov–Dec + Jan–Apr (mm)	Cumulative inflow (mm)	Outcome
2014	482 + 0.4	482	CRISIS
2020	196 + 11	207	CRISIS
2023	369 + 30	399	CRISIS
2021	387 + 358	745	Safe
2022	348 + 332	680	Safe
2024	504 + 147	651	Safe

Decoupling from the annual total

The suppression is largely independent of the annual total, which is uninformative as a scarcity indicator (Table 4). Of the nineteen completed collapsed springs, seven occurred in years of above-normal annual rainfall, including 2005 (3,774 mm, +23%), 1980 (3,757 mm, +22%) and 2013 (3,406 mm, +11%). In 1980 the station recorded 3,757 mm across the year and 8.2 mm between January and April. The crisis year 2023 (3,351 mm, +9%) received more annual rainfall than the non-crisis year 2022 (2,587 mm), its surplus arriving as a single extreme September (1,060 mm) after the

scarcity episode had passed and largely discharging as reservoir overflow. Across the nineteen completed collapses the annual anomaly ranges from –29 to +23 per cent (mean –5 per cent). The implication is mechanistic: El Niño's local expression is redistributive rather than subtractive; it does not principally reduce the archipelago's annual rainfall, whose trend is stationary ^[2], but removes rainfall from the four months in which the reservoir is in net drawdown. This is why seven decades of trend analysis on annual totals detected nothing while the crisis cycle continued.

Table 4: The twenty collapsed springs (January–April < 60 mm), ranked driest first, with annual totals (anomaly vs the 3,079 mm normal) and El Niño association.

Year	Jan–Apr (mm)	Annual (mm)	Anomaly (%)	El Niño association
2014	0.4	2,877	–7	El Niño onset (crisis year)
1986	0.7	2,198	–29	El Niño onset
1998	0.9	2,812	–9	Followed very strong 1997–98 El Niño
1980	8.2	3,757	+22	Followed El Niño winter

1983	8.4	2,975	−3	Followed very strong 1982–83 El Niño
2020	11.1	2,882	−6	Followed 2019 warm event (crisis year)
1964	22.0	3,324	+8	Followed moderate El Niño winter
1995	23.3	3,358	+9	Followed moderate El Niño winter
1997	24.2	2,796	−9	El Niño onset
1957	29.4	2,898	−6	El Niño onset
2023	29.9	3,351	+9	El Niño onset (crisis year)
1993	30.8	2,543	−17	Followed weak 1992–93 El Niño
1958	33.2	3,151	+2	Followed strong 1957–58 El Niño; also onset
1971	37.1	2,894	−6	Preceded 1972 onset by one year
2007	40.7	2,556	−17	Followed El Niño winter
1973	50.5	2,912	−5	Followed very strong 1972–73 El Niño
2026	50.7	ongoing	—	El Niño onset (crisis year)
1985	54.0	2,828	−8	Preceded 1986 onset by one year
2005	55.3	3,774	+23	Followed El Niño winter
2013	56.0	3,406	+11	Preceded 2014 onset by one year

Independent corroboration

Three independent checks support the signature. First, the 2010–2012 station records, excluded from the exploratory analysis, serve as a blind test: the scheme predicts a suppressed spring in 2010 (after the moderate 2009–10 winter) and generous springs in 2011 and 2012 (after strong and moderate La Niña winters); observed values were 96.2, 719.9 and 216.9 mm, three predictions, three confirmations, including the wettest spring of the record. Secondly, the Dhanikhari catchment gauge reproduces the station classification in all six overlapping years (Table 5; $r = 0.79$), with wider separation at the catchment (13–35 mm against 130–555 mm) and with both recent crises preceded by

November–December top-ups of 270 mm or less against 640–940 mm in safe years ^[6]. The 2023–24 case, in which a low top-up (230 mm) was not followed by scarcity, is explained by a functioning January inflow (105 mm) and carryover from the exceptional late-2023 monsoon, and is why three triggers rather than one are recommended below. Thirdly, the 2026 collapse was archipelago-wide: IMD March–April 2026 departures were −74% (South Andaman), −81% (Nicobar) and −97% (North & Middle Andaman) ^[9], a spatial coherence spanning some 700 km, sharpest away from the capital, consistent with basin-scale subsidence and inconsistent with station artefact or local land-use effects.

Table 5: January–April rainfall at the Shadipur station and the Dhanikhari catchment gauge, 2021–2026 (†January–March only; April unreported at release).

Year	Shadipur station (mm)	Dhanikhari catchment (mm)	Classification at both gauges
2021	358	245	Wet — no scarcity
2022	332	555	Wet — no scarcity
2023	30	13	Collapsed — crisis
2024	147	130	Moderate — no scarcity
2025	262	237	Wet — no scarcity
2026	51	35†	Collapsed — crisis

Discussion

The physical basis is straightforward. The Andaman Sea lies at the western margin of the Indo-Pacific warm pool, beneath the climatological ascending branch of the Walker circulation. During and after an El Niño winter peak, the anomalous descending branch sits over the Maritime Continent and eastern Indian Ocean, suppressing exactly the Northeast monsoon tail, winter showers and pre-monsoon convection that constitute the January–April total; weakened Madden–Julian Oscillation activity across the Maritime Continent ^[10] removes the dominant synoptic delivery mechanism, and post-peak persistence is reinforced by basin-wide Indian Ocean warming, the capacitor effect ^[11]. The same subsidence develops, in weaker form, in the spring of an onset year as warm-pool convection begins its eastward migration, the plausible mechanism behind the six onset-year collapses. The Indian Ocean Dipole ^[12] can act equivalently and independently, as in 2019–20; notably, recent work on the Levant identifies positive-IOD winters as drivers of persistent dry spells there, with January 1998 and January 2014 as case studies ^[13], the same two months that produced the two driest springs of the present record, indicating that single tropical Indo-Pacific states dry both regions through complementary pathways.

Implications for groundwater and seawater intrusion.

The collapsed springs identified here are also the periods of maximum groundwater withdrawal, since surface supply rationing drives households and the tourism sector to wells and borewells precisely when recharge is at its minimum. The islands' aquifers are thin, largely hard-rock or coastal-alluvial, and vulnerable: CGWB has long recommended detailed study of the saline–freshwater interface and scientific rainwater harvesting for the islands ^[14], and monitors the territory through 113 groundwater stations ^[15]. Geophysical surveys have delineated active seawater intrusion in coastal aquifers of South Andaman at Sippighat–Saithankari, Collinpur and Ograbraj ^[16], conductive saline layers below about 40 m depth in the island's coastal belt ^[17], and persistent post-tsunami salinization along the east coast aggravated by rising abstraction and urbanization ^[18]. The present results imply that this stress is not uniform in time but pulsed by ENSO: an El Niño winter delivers a compound event, minimum recharge with maximum abstraction, and repeated compound years can ratchet the saline interface landward, a displacement that in small-island aquifers is slow or impossible to reverse. Salinity monitoring of coastal wells

should therefore be intensified specifically in the crisis windows this paper identifies, and a quantitative survey of extraction by the tourism sector, currently lacking, is an urgent research need.

Three limitations warrant emphasis. First, the base series is single-region, though the dual-gauge comparison and the 2026 archipelago-wide coherence substantially mitigate this. Secondly, borderline ONI classifications (e.g. 1968–69, 2009–10) could shift a category without altering any conclusion. Thirdly, as a forward predictor of ENSO the spring total is corroborative rather than prognostic: a collapsed spring has always meant El Niño nearby, but most onset years do not produce one.

The immediate application is the 2026–27 outlook. An El Niño was declared in June 2026 and is forecast to strengthen through the coming winter^[7]; the spring of 2026 (50.7 mm at station; 35 mm at the catchment through March) has already exhibited the onset-year collapse, and the catchment received only 205 mm across November 2025–March 2026, the lowest such sequence in the APWD record^[6]. A moderate-or-stronger 2026–27 winter places spring 2027 beneath the ~180 mm ceiling, and the cumulative dry-season inflow is the quantity to watch: with the catchment already recording its driest November–March on record, the water-year is tracking towards the crisis range (below ~550 mm) rather than the safe range (650 mm and above). The base-case expectation is a scarcity episode in March–June 2027 at least comparable to 2026.

Conclusions and Recommendations

The January–April rainfall at Sri Vijaya Puram is governed by the tropical Pacific through a graded, one-directional relationship. Its intensity falls continuously with the preceding winter's ONI ($r = -0.465$); a strong El Niño imposes a hard ceiling of about 180 mm on the spring but does not fix how far below it the year lands; and the resulting signature is a necessary but not sufficient condition for scarcity, every one of the twenty sub-60 mm springs in 77 years was El Niño-associated, yet only about 40 per cent of strong El Niño winters produced one. For water management the operative quantity is the cumulative dry-season inflow (preceding November–December plus January–April), which separates the four documented scarcity episodes from all safe years without overlap. The signature is stationary across both halves of the record, decoupled from the annual total, and corroborated at an independent catchment gauge and by the archipelago-wide deficits of 2026.

Three zero-cost monitoring triggers follow: (i) cumulative November–December rainfall at the Dhanikhari catchment gauge, values at or below about 270 mm having preceded both recent crises while all safe years except one exceeded 640 mm; (ii) the Dhanikhari level at end-December, which we recommend be published fortnightly; and (iii) the 30 April progressive rainfall total, values below 60 mm at the city station (about 50 mm at the catchment) confirming a crisis summer, with rationing schedules initiated in January rather than March. Salinity surveillance of coastal wells should be added to this calendar in every triggered year. For 2026–27, all triggers should be monitored under the presumption of an unfavourable outcome.

Acknowledgements

We thank the Meteorological Department, Shadipur, and the Directorate of Economics and Statistics, A&N Administration, for the rainfall records on which this study rests, and the Andaman Public Works Department for the published Dhanikhari catchment data. The reservoir field survey was conducted as part of the M.Sc. dissertation of R.D. at JNRM.

Competing Interests

The authors declare that no competing interests exist.

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