El Niño, Climate Change and Its Imperatives for Disaster Risk Reduction Strategy in a Digital Emergency Management Era

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ABSTRACT

A very strong El Niño is developing in the equatorial Pacific. On 8 October 2026 the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center gave an 83% chance that October–December would exceed every El Niño recorded since 1950, and the World Meteorological Organization (WMO) judged the event firmly established (NOAA Climate Prediction Center, 2026b; WMO, 2026a). The event coincides with long-term warming, a rapid expansion of digital tools for hazard monitoring and warning, and persistent exposure and vulnerability in sub-Saharan Africa (SSA). This conceptual paper rests on a structured narrative review of 61 sources, identified through targeted searches in October 2026 and synthesised thematically. It asks what such an event implies for disaster risk reduction (DRR) strategy, with Nigeria as the focal case. It argues that the El Niño–Southern Oscillation (ENSO) is a recurring and increasingly forecastable risk driver whose human consequences are set by exposure, vulnerability and institutional capacity rather than by ocean temperature alone. Three findings follow. First, model evidence points to more intense ENSO extremes, but this projection is not yet detectable in observations. Second, the ENSO signal for Nigeria and West Africa is less clearly established than for eastern and southern Africa, so Nigerian planning should use ENSO to shift readiness, not to predict a single outcome. Third, digital emergency management, from seasonal and artificial-intelligence-assisted forecasting to satellite rainfall monitoring and forecast-based financing, offers real gains in capability, but the sources reviewed document the conditions for effectiveness more than measured reductions in losses, and the gains are limited by connectivity gaps, data scarcity and weak links between warning and action. Six imperatives are derived, ranked and assembled into a framework with lead institutions, decision rules and indicators for Nigeria. The paper concludes that preparing for El Niño in Nigeria is largely a matter of repairing the information-to-action chain that already serves every flood season.

Keywords: El Niño; climate change; disaster risk reduction; digital emergency management; early warning; anticipatory action; sub-Saharan Africa; Nigeria

1. INTRODUCTION

1.1 Background

ENSO is the strongest year-to-year fluctuation of global climate (Timmermann et al., 2018). Its warm phase, El Niño, recurs irregularly (every two to seven years on average) and shifts rainfall, temperature and storm patterns across the tropics and far beyond (McPhaden et al., 2006). The consequences for people are neither uniform nor purely meteorological: floods increase in some river basins while drought takes hold in others (Ward et al., 2014); harvests rise or fall by crop and region (Iizumi et al., 2014); malaria and cholera can follow changes in temperature and rainfall (Kovats et al., 2003); and national economies can pay the cost for years afterwards (Callahan & Mankin, 2023).

In 2026 the topic moved from scientific interest to operational urgency. Early in the year forecasters were describing a weak La Niña fading towards neutral conditions (WMO, 2026b). By 10 September the NOAA Climate Prediction Center had issued an El Niño Advisory and put at 75% the chance that October–December would exceed every previous El Niño back to 1950 (a three-month relative Oceanic Niño Index [RONI] of

+2.5 °C or more) (NOAA Climate Prediction Center, 2026a). In its update of 8 October it raised that figure to 83%, gave 54% and 70% for the overlapping September–November and November–January periods, and judged a strong-to-very strong El Niño likely (greater than 83% chance) through January–March 2027 (NOAA Climate Prediction Center, 2026b). The WMO update for August 2026, published on 3 September, judged El Niño firmly established, gave a probability of nearly 100% that it would continue through both September–November 2026 and December 2026–February 2027, and expected very strong intensity before a peak towards the end of the year. It cautioned, however, that the strength of an event does not translate directly into the magnitude of impacts in any region (WMO, 2026a).

These statements are forecasts, not outcomes. They reflect the most recent bulletins available on 3 November 2026 and will be superseded by later monthly updates. That caution is the starting point here. Hazard strength is only one input to disaster risk: the Intergovernmental Panel on Climate Change (IPCC) has long stressed that impacts depend as much on exposure and vulnerability as on the extreme event itself (IPCC, 2012). Where rain-fed agriculture, informal settlement, fragile infrastructure and limited fiscal space combine, as across much of SSA, the same El Niño can yield very different outcomes depending on what institutions do before it peaks.

1.2 Problem statement

Three tensions frame the problem. The first is scientific. Models predict more extreme El Niño events under greenhouse warming (Cai et al., 2014), but the most recent synthesis emphasises that internal variability makes detection difficult and that observed Pacific warming has not followed the projected pattern (Cai et al., 2021). Planners must act without waiting for that uncertainty to be resolved.

The second is technological. Seasonal forecasting, remote sensing, machine learning, crowdsourcing and social media have increased the information available to emergency managers (Funk et al., 2015; Ham et al., 2019; Imran et al., 2015; Lam et al., 2023). Yet only 36% of people in Africa used the internet in 2025, with a wide urban–rural gap (International Telecommunication Union [ITU], 2025), so digital tools are thinnest where exposure is greatest. Moreover, much of the evidence for these tools concerns what they can do (forecast skill, speed, coverage) rather than whether, and through which decisions, they reduce deaths, displacement and losses.

The third is institutional. Warnings have repeatedly lagged action. The humanitarian literature shows a long history of failure to translate credible early-warning information into preventive action (Coughlan de Perez et al., 2016), and Nigerian commentary on the 2026 flood season speaks of moving from issuing alerts to building systems around them (Aliyu, 2026).

A fourth, narrower problem is specific to this paper. Most of the evidence on ENSO impacts in Africa comes from the east and south of the continent. Nigeria's ENSO signal is less well documented, so national planning for 2026–27 has to be designed for an uncertain, not a known, pattern of impacts.

1.3 Objectives and research questions

The paper has four objectives: to synthesise current evidence on ENSO and its response to climate change (RQ1); to characterise El Niño-related risk pathways for SSA and Nigeria (RQ2); to establish what digital emergency management does and does not offer DRR, and how it can be tied to institutional decisions and measurable outcomes (RQ3); and to derive strategic imperatives and a framework linking forecasts, digital systems and institutional action (RQ4). The four research questions are:

1. What does the evidence say about El Niño in a changing climate, and how firmly is each part of that evidence established?

2. Through which pathways does El Niño create disaster risk in SSA and Nigeria, and how clear is the signal for Nigeria?

3. Which digital tools and practices improve DRR outcomes, under what conditions, and through which institutional decisions?

4. What should DRR strategy change as a result?

1.4 Contribution and scope

Work on forecast-based action (Coughlan de Perez et al., 2015; Wilkinson et al., 2018) and early warning (WMO, 2022) is general. This paper does three more specific things. It asks how the information-to-action chain should be designed when the climate signal for a country is ambiguous, as it is for Nigeria. It sets out a rule for updating national outlooks when the global driver changes. And it ranks the strategic imperatives by what a country with existing institutions could do first.

The evidence base is a structured narrative review of 61 sources, described in Section 2.3 and Tables 1 and 2. It combines peer-reviewed research, assessment reports, operational bulletins and a small number of dated press reports. Throughout, the paper distinguishes what is established by observation, what is projected by models and what remains uncertain (Section 4.6, Table 4). The paper is conceptual: no primary data are presented, and no forecast is made about the impacts of the 2026–27 event on any country. Section 2 describes the method; Section 3 the conceptual framework; Sections 4 to 6 the evidence; Section 7 the imperatives; Section 8 the Nigerian framework; Section 9 the discussion; and Section 10 the conclusions and recommendations.

2. METHODOLOGY

2.1 Research design

The study is a qualitative conceptual paper based on a structured narrative review and documentary analysis. A narrative design was chosen over a systematic review for three reasons. First, the question cuts across disciplines (climate science, disaster studies, information systems, humanitarian practice) that do not share indexing terms or outcome measures. Second, the 2026 El Niño is unfolding, so some evidence is operational (bulletins, agency statements) rather than peer reviewed. Third, the aim is to derive strategic propositions, not to estimate a pooled effect.

2.2 Study area

SSA is the study area and Nigeria is the focal country. ENSO-linked rainfall, temperature and food-security anomalies are well known in eastern and southern Africa, where droughts and floods can occur in the same year (Nicholson, 2017). SSA also has heavy dependence on rain-fed agriculture and the lowest internet use of any ITU region (ITU, 2025), so it is a demanding test case for digital emergency management.

Nigeria was chosen for four reasons. It is the most populous country in SSA and has a federal emergency architecture of a national agency (the National Emergency Management Agency [NEMA]), state agencies and local committees (Attah, 2026; Aliyu, 2026). It has a national meteorological service (the Nigerian Meteorological Agency [NiMet]) that issues an annual Seasonal Climate Prediction, and a hydrological agency (the Nigeria Hydrological Services Agency [NIHSA]) that issues an Annual Flood Outlook (Attah, 2026). Its flood hazard is large, uneven and poorly modelled (Nkwunonwo et al., 2020; Umar & Gray, 2023). And its institutions have signalled a move from reactive response to anticipatory preparedness (Attah, 2026; Aliyu, 2026). Nigeria is not presented as representative of SSA. It is used to test how general propositions behave in one institutional setting.

2.3 Search strategy, sources and selection

The review protocol is summarised in Table 2 and described here. Evidence was gathered in October 2026 through targeted searches of four kinds of source: open-web scholarly indexes and publisher platforms (for peer-reviewed literature); institutional repositories and the websites of intergovernmental bodies and

operational agencies, including NOAA, WMO, NiMet and NEMA (for assessments and bulletins); Nigerian press outlets, including the News Agency of Nigeria (only for dated institutional events); and backward citation tracking from key reviews to supplement the keyword searches.

The terms "El Niño" or "ENSO" were combined with each of the following: climate change, extreme events, floods, drought, food security, health, conflict, disaster risk reduction, early warning, forecast-based financing, remote sensing, machine learning, crowdsourcing, social media, Africa, Sahel, West Africa and Nigeria. The publication period covered is 2001 to 2026: the earliest sources retained date from 2001, and the 2026 sources are operational bulletins and dated reports on the unfolding event. Only English-language sources were considered.

Sources were included if they dealt with ENSO science or impacts; DRR theory or policy; digital tools for hazard management; or African and Nigerian flood and climate risk, and if they were published by a peer-reviewed outlet, a recognised academic publisher, an intergovernmental body or an operational agency. Nigerian press reports were used only to document dated events that agencies have not published in citable form (funding approvals, platform directives and similar) and are identified as press sources in Table 1. Sources outside these categories were excluded, and press reports were not used to support scientific claims. The final corpus has 61 sources. Each was checked against its bibliographic record or original web page, and all time-sensitive statements about the 2026–27 El Niño were checked against the original NOAA and WMO bulletins and dated. Two limits apply: the ITU (2025) figures were confirmed from secondary reporting of the primary release, and the 2026 ENSO bulletins describe a developing situation that will be superseded.

Source type	Count	Examples
Peer-reviewed journal articles	31	Cai et al. (2014, 2021); Ward et al. (2014); Coughlan de Perez et al. (2015, 2016); Rodríguez-Fonseca et al. (2015)
Academic books	2	Glantz (2001); Wisner et al. (2004)
Assessment and institutional reports	10	IPCC (2012, 2021); Trisos et al. (2022); UNDRR (2015, 2022); Wilkinson et al. (2018); WMO (2022); ITU (2025); OCHA (2022)
Operational bulletins and agency publications	8	NOAA Climate Prediction Center (2026a, 2026b, n.d.); WMO (2026a, 2026b); NEMA (2025a, 2025b); NiMet (2025)
Press reporting (Nigerian media and News Agency of Nigeria)	10	Attah (2026); Aliyu (2026); Elumoye (2026a, 2026b); Okonji (2026); Usman (2023)

Table 1. Composition of the evidence base (N = 61).

Element	Approach
Purpose	To derive strategic propositions for DRR from evidence on ENSO, climate change and digital emergency management, with Nigeria as focal case.
Information sources	Open-web scholarly indexes and publisher platforms; institutional repositories; websites of intergovernmental bodies and operational agencies (NOAA, WMO, NiMet, NEMA); Nigerian press for dated events; backward citation tracking from key reviews.
Search terms	"El Niño" or "ENSO" combined with each of 18 terms covering climate change, hazards and impacts, DRR and early warning, digital tools, and geography (listed in the text).
Period and language	Sources from 2001 to 2026; English only. Evidence gathered October 2026; 2026–27 El Niño statements verified against NOAA and WMO bulletins available on 3 November 2026.
Inclusion	ENSO science or impacts; DRR theory or policy; digital tools for hazard management; African and Nigerian flood and climate risk; from a peer-reviewed outlet, academic publisher, intergovernmental body or operational agency.

Exclusion	Sources outside these categories; non-English sources; press reports as evidence for scientific claims.
Quality control	Each source checked against its bibliographic record or original web page. Peer-reviewed work and assessment reports support scientific claims; operational bulletins support statements on the current ENSO state; press reports document dated institutional events only.
Synthesis	Hand coding against five themes; comparison across sources for agreement, disagreement and gaps; each key claim classified as established, projected or uncertain (Table 4).

Table 2. Summary of the narrative review protocol.

2.4 Appraisal and synthesis

Sources were read and coded by hand against five themes from the framework in Section 3: ENSO behaviour and change; hazard and risk pathways; digital tools and their conditions of effectiveness; institutional and governance requirements; and the SSA and Nigerian context. Within each theme, findings were compared across sources to locate agreement, disagreement and gaps. Evidence was appraised by type and purpose rather than scored: the study design and source category determined what each source was allowed to support (Table 2).

Each key claim was then assigned an evidence status. A claim is *established* when it rests on observation or repeated empirical findings; *projected* when it rests on model simulations or scenario analysis; and *uncertain* when sources disagree, the signal is not stationary, or no evidence was found. Table 4 applies this classification. An imperative in Section 7 is a proposition that rests on more than one line of evidence (not necessarily independent research groups) and implies a change in practice. The framework in Section 8 assembles these propositions into pillars with lead institutions and indicators.

2.5 Limitations and ethics

The study is not a systematic review and will have missed some relevant work. It is limited to English-language sources, and its searches used open-web indexes rather than a fixed set of subscription databases. The impact evidence is concentrated on eastern and southern Africa, so attribution to Nigeria is treated as an open question. The 2026 operational evidence is time limited, and the framework is conceptual and untested. No human participants were involved and no personal data were collected, so ethical review was not required.

3. CONCEPTUAL FRAMEWORK

The paper brings four bodies of theory together under one lens: disaster risk as hazard, exposure and vulnerability; resilience and adaptive capacity; the convergence between climate adaptation and DRR; and socio-technical thinking on information systems and anticipatory action.

3.1 Risk and vulnerability

The IPCC (2012) views disaster risk as the product of hazard, exposure and vulnerability, each shaped by climatic and non-climatic factors. Wisner et al. (2004) give the social explanation in their pressure-and-release model, in which hazard meets vulnerability built up over time through root causes, dynamic pressures and unsafe conditions. Adger (2006) sees vulnerability as susceptibility to harm plus lack of capacity to adapt, a property not of individuals alone but of social and ecological systems. For this paper the point is simple: El Niño is a hazard driver, and outcomes in Nigeria depend on who is exposed, how vulnerable they are and what capacity exists to anticipate and absorb the shock.

3.2 Resilience and adaptive capacity

Folke (2006) carries resilience thinking from ecology into social–ecological analysis (thresholds, uncertainty,

adaptive capacity and adaptive governance). Cutter et al. (2008) operationalise community resilience through the disaster resilience of place (DROP) model, which allows comparison at local scale. Resilience matters here for two reasons. ENSO is a recurrent shock from which systems can learn, and learning to reorganise and act early is an institutional property that can be designed.

3.3 Convergence of adaptation and DRR

DRR and climate adaptation grew up as separate communities with their own institutions, funding and vocabularies. Thomalla et al. (2006) argued that this isolation limited success in reducing vulnerability, and the IPCC (2012) reached a parallel conclusion. Kelman (2015) adds a caution: policy debate can overstate climate change as a single driver and neglect the vulnerability processes that turn hazards into disasters. The Sendai Framework (United Nations Office for Disaster Risk Reduction [UNDRR], 2015) provides the operating architecture, with four priorities (understanding risk; strengthening governance; investing in resilience; and enhancing preparedness and building back better) and seven global targets. The 2022 global assessment adds that risk creation is ahead of risk reduction (UNDRR, 2022).

3.4 Information, anticipatory action and the information-to-action chain

Sakurai and Murayama (2019) find the literature on information technology in disaster management scattered and lacking a holistic perspective, and call for a comprehensive strategy and shared data standards. Forecast-based financing links forecast thresholds to pre-agreed actions and funds so that action starts before the disaster (Coughlan de Perez et al., 2015). Wilkinson et al. (2018) review more than 25 forecast-based early-action instruments and conclude that data, triggers, action protocols and financing must work together.

3.5 Integrated lens

The four strands form a chain: a climate driver produces hazards; hazards meet exposure and vulnerability; digital and institutional systems detect, forecast and communicate; and decision rules convert information into action (Table 3). A weak link anywhere can produce a disaster even if the forecast was right. This is the analytical claim of the paper, and Sections 5 and 8 test it against the Nigerian case.

Link in the chain	Core question	Anchoring literature
Driver and hazard	How strong and frequent are El Niño events, and how do they change under warming?	Cai et al. (2014, 2021); Timmermann et al. (2018)
Exposure and vulnerability	Who and what is exposed, and why are they vulnerable?	IPCC (2012); Wisner et al. (2004); Adger (2006)
Detection, forecast and communication	Can risk be sensed, predicted and communicated in time and to everyone?	Sakurai & Murayama (2019); WMO (2022)
Decision and action	Are there pre-agreed triggers, funds and responsibilities?	Coughlan de Perez et al. (2015, 2016); Wilkinson et al. (2018)
Learning and governance	Do institutions integrate adaptation and DRR and learn from each event?	Thomalla et al. (2006); Folke (2006); UNDRR (2022)

Table 3. Information-to-action chain used to analyse El Niño risk.

4. EL NIÑO UNDER A CHANGING CLIMATE

4.1 The phenomenon

ENSO is a coupled ocean–atmosphere process of the tropical Pacific in which sea surface temperature, trade winds and atmospheric pressure interact; El Niño is the warm phase and La Niña the cool phase (McPhaden et

al., 2006). Glantz (2001) argued early that its importance lies in its human dimensions: how societies experience events, anticipate them and respond to them. Events also differ from one another. Timmermann et al. (2018) show how events differ in where warming peaks, how they evolve and how they connect with climate elsewhere. For practitioners the consequence is that no two events are alike and the next one cannot be read off the last.

4.2 Extreme events

The most disruptive events are extreme El Niños, in which warming extends eastwards and convection reorganises (Cai et al., 2014). The 1982/83 and 1997/98 events are the classic cases. Santoso et al. (2017) set out the defining characteristics of these extremes and reviewed the strong 2015/16 event, which they judged the first extreme El Niño of the twenty-first century but different from the two earlier ones. The NOAA Climate Prediction Center (2026b) now gives an 83% chance that October–December 2026 will exceed any previous event in its record. If that happens, the 2026–27 event would be a major test of the preparedness of tropical countries, at a time when digital warning tools are more widespread than during the earlier extremes. The figure is a probability from a dated bulletin, not a certainty.

4.3 Projected change

Cai et al. (2014) analysed models from the Coupled Model Intercomparison Project and showed a doubling in the frequency of extreme El Niño under greenhouse warming, because the eastern equatorial Pacific warmed faster than its surroundings. In their broader review, Cai et al. (2021) report that most models project faster warming in the eastern than in the western equatorial Pacific, that ENSO rainfall responses intensify and shift eastward, and that ENSO variability and extremes increase, with stronger intermodel agreement in the latest generation of models. These are projections: they describe what models simulate under future warming, not what has been observed.

4.4 Uncertainty and planning

The same review is explicit about limits. Equatorial Pacific warming since 1980 has run in the opposite direction to the projected pattern, although within the model range, and because the difference reflects internal variability it is hard to quantify and detect (Cai et al., 2021). The IPCC (2012, 2021) makes the general point that changes in extremes reflect both human influence and natural variability. Two practical conclusions follow. Planners should not treat ENSO trends as a certainty for which the science does not yet provide support. Nor should they treat uncertainty as a reason to wait: one extreme event is costly, events are forecastable months ahead, and preparedness that works for El Niño usually reduces exposure to other hazards too. This is no-regret investment logic (IPCC, 2012), and it recurs in Section 7.

4.5 Forecasting ENSO

Predictability allows anticipatory action. Dynamical forecasts made several months ahead underlie the NOAA and WMO outlooks cited above. Ham et al. (2019) trained a convolutional neural network on model simulations and then reanalysis data, and obtained skilful ENSO forecasts up to about one and a half years ahead that beat the dynamical systems they compared in a 1984–2017 validation. Lam et al. (2023) describe GraphCast, a machine-learning model that produces a ten-day global forecast in under a minute on a single accelerator and beats the leading operational deterministic system on 90% of 1,380 verification targets. Once trained, such models are cheap to run, so access to good guidance for national meteorological services may widen over time. Reichstein et al. (2019) give the necessary caveat: purely data-driven models do not guarantee physical consistency and may extrapolate poorly, so physics-aware hybrids are a sensible direction. These points matter most for the 2026–27 event, which lies at the edge of the historical record on which such models learn.

4.6 Evidence status: what is established, projected and uncertain

Because the literature mixes observation, model projection and operational forecasting, Table 4 separates the-

m. It shows that the global evidence for ENSO's influence is firm, that the climate-change response of ENSO is projected but not yet detected, and that the Nigerian and West African signal is uncertain. The distinction governs how each claim is used in the rest of the paper: established findings justify standing preparedness, projections justify no-regret measures, and uncertain signals justify using ENSO to shift readiness rather than to trigger costly action (Section 9.2).

Claim	Status	Basis	Use in this paper
ENSO shifts rainfall, temperature and storm patterns across the tropics and recurs every two to seven years	Established (observed)	McPhaden et al. (2006); Timmermann et al. (2018)	Treat ENSO as a standing planning variable (Imperative 1)
ENSO influences flood risk in basins covering 44% of land; crop-yield effects vary in sign and size by crop and region	Established (observed); regionally variable	Ward et al. (2014); Iizumi et al. (2014)	Global findings are not transferred to Nigeria without local testing
ENSO rainfall anomalies in eastern and southern Africa	Established, but heterogeneous across seasons and sub-regions	Nicholson (2017); Iizumi et al. (2014)	Not a template for West Africa
Extreme El Niño events become more frequent or intense under greenhouse warming	Projected (models); not yet detected in observations	Cai et al. (2014, 2021)	Supports no-regret measures; no trend is asserted
Observed equatorial Pacific warming since 1980 compared with the projected pattern	Observed; opposite to projected pattern but within model range, attributed to internal variability	Cai et al. (2021)	Observation and projection are kept distinct
ENSO influence on Sahel and West African rainfall	Uncertain: partial, non-stationary, shared with Atlantic and Indian Ocean influences	Giannini et al. (2003); Janicot et al. (2001); Rowell (2001); Rodríguez-Fonseca et al. (2015)	ENSO as a prior, not a trigger (Section 9.2)
West African climate-change projections (heat days, delayed rainfall onset, malaria changes)	Projected (climate change, not ENSO-specific)	Trisos et al. (2022)	Slow-onset changes that interact with ENSO seasons; not forecasts for 2026–27
Nigerian outcomes in the 1997/98 and 2015/16 El Niños	Not established in the sources reviewed	Table 6	Research gap (Section 9.4)
State and outlook of the 2026–27 El Niño	Observed and forecast; probabilistic and time-sensitive	NOAA Climate Prediction Center (2026b); WMO (2026a)	Dated; to be updated monthly
Digital tools reduce disaster losses	Capability documented; outcome evidence limited in the sources reviewed	Ham et al. (2019); Lam et al. (2023); Coughlan de Perez et al. (2016); Wilkinson et al. (2018)	Treated as a hypothesis to be tested (Section 6.6)

Table 4. Evidence status of the main claims used in this paper.

5. RISK PATHWAYS AND THE EVIDENCE FOR SSA AND NIGERIA

5.1 Global pathways

El Niño produces risk through five connected pathways (Table 5). On floods and drought, Ward et al. (2014) found reliable anomalies in flood risk in El Niño or La Niña years (or both) in basins covering 44% of Earth's land surface, and argued that ENSO should enter disaster-risk analysis and policy. On agriculture, Iizumi et al. (2014) found that El Niño raises global mean soybean yield by about 2.1–5.4% and changes maize, rice and wheat yields by between −4.3% and +0.8% (negative in Zimbabwe), with the sign and size depending on crop, region and phase, so that generalisation is hazardous. On health, Kovats et al. (2003) conclude that the human toll of natural disasters rises in El Niño years; links to cholera and malaria are well established in some regions but weaker for other diseases, and planners have little experience of temporal risk management, which seasonal forecasts could improve. On the economy, Callahan and Mankin (2023) show persistent losses of national growth, and global income losses of US$4.1 trillion and US$5.7 trillion following the 1982–83 and 1997–98 events respectively. On conflict, Hsiang et al. (2011) find that the probability of new civil conflict in the tropics doubles in El Niño years relative to La Niña years, an association that should prompt conflict-sensitive programming, not violence prediction.

Pathway	Mechanism	Evidence	Relevance to SSA and Nigeria
Flood and drought	Shifts in rainfall and river flow	Ward et al. (2014); Nicholson (2017)	Region-specific; northern floods a priority in Nigeria (Umar & Gray, 2023)
Food and agriculture	Yield anomalies by crop and region	Iizumi et al. (2014)	Mixed signs; Zimbabwe maize negative under El Niño
Health	Vector- and water-borne disease; disaster burden	Kovats et al. (2003)	Seasonal forecasts can target surveillance and stocks
Economy	Persistent growth losses	Callahan & Mankin (2023)	Tropical economies bear heavy costs
Conflict and fragility	Association with new conflict onset	Hsiang et al. (2011)	Calls for conflict-sensitive anticipatory programming

Table 5. El Niño risk pathways and their relevance to the study area.

5.2 Sub-Saharan Africa

The evidence is patchy regionally. In eastern Africa, drought severe enough to incapacitate populations is common, and floods occur too, sometimes in the same year; ENSO is one of several drivers that differ between rainy seasons and sub-regions (Nicholson, 2017). A single regional message (El Niño means drought, or El Niño means floods) is therefore unreliable, which is the same point the WMO (2026a) makes globally.

Vulnerability then magnifies hazard. Rain-fed smallholder farming, low incomes, weak infrastructure and little credit and insurance can turn an adverse season into a food-security and health emergency. Callahan and Mankin (2023) show that the growth penalty falls heaviest on tropical economies, and the 2022 global assessment adds that hazards now interact with food and fuel price shocks and conflict, so that local shocks cascade across sectors and borders (UNDRR, 2022).

The African chapter of the IPCC Sixth Assessment Report (Trisos et al., 2022) is the right starting point for risk regionalisation. For West Africa it projects a steep rise in potentially lethal heat days, from 50–150 per year at 1.6 °C of warming to 100–250 per year at 2.5 °C, with the largest increases along coastlines. It also projects a delayed onset of rainfall (by 4–6 days) and a shorter rainy season over the western Sahel at 1.5 °C and 2 °C of warming, and changes in malaria transmission that vary between the Sahel and elsewhere in the region (Trisos et al., 2022). These are projected climate-change effects, not ENSO effects. They are slow-onset

changes that will interact with ENSO-driven seasons and add to the baseline vulnerability of rural and coastal populations.

5.3 West Africa and Nigeria: an ambiguous signal

Nigeria has a wide north–south climatic gradient, so its ENSO connection is harder to pin down than that of eastern or southern Africa. Studies of the Sahel link summer rainfall to ENSO (El Niño tends to coincide with drier conditions) but also show that Atlantic and Indian Ocean temperatures and the structure of the West African monsoon shape rainfall, so the Pacific signal is neither alone nor constant (Giannini et al., 2003; Janicot et al., 2001; Rodríguez-Fonseca et al., 2015; Rowell, 2001).

Three findings from this literature are relevant for Nigeria. First, Giannini et al. (2003) show that ENSO influence on Sahel rainfall is limited to interannual time scales and that the late twentieth-century multidecadal drying is due mainly to warming of the Indian Ocean, with the warm equatorial Atlantic contributing. They also note an observed dipole in rainfall between the Sahel and the Gulf of Guinea coast, related to equatorial Atlantic temperatures, which their model cannot reproduce. The relationship between the Pacific and the monsoon is therefore not the same along the coast as in the north, and it is not fully understood. Second, Janicot et al. (2001) show that the summer Sahel–ENSO teleconnection is not stable but varies with decadal changes in ocean temperature; Rowell (2001) examines the atmospheric pathways by which Pacific conditions are communicated to Sahel rainfall. Third, in their review, Rodríguez-Fonseca et al. (2015) list the stationarity of teleconnections among the open questions in West African rainfall variability.

This paper reads the literature as advising caution. El Niño in 2026–27 should increase the probability of anomalous seasons in parts of Nigeria, but it cannot be assumed that this will happen in any given state.

The recent record points the same way. The most damaging floods in recent years in Nigeria did not coincide with El Niño. The 2022 season was La Niña (NOAA Oceanic Niño Index between −0.7 and −0.9 from June to November) and the 2012 season was ENSO-neutral (index +0.3 to +0.4 over the same months) (NOAA Climate Prediction Center, n.d.). Both seasons were very wet (Global Facility for Disaster Reduction and Recovery [GFDRR], n.d.; United Nations Office for the Coordination of Humanitarian Affairs [OCHA], 2022), and neither can be explained by a single cause. Heavy rainfall and releases from dams, including Lagdo Dam in Cameroon, also contributed in 2012 (GFDRR, n.d.). In 2022, NEMA stated that the Lagdo release was not the sole cause of floods that affected states outside the Benue belt as well, and that heavy rainfall was the main cause (Usman, 2023). If so, ENSO phase is a weak guide to flood outcomes in Nigeria, and exposure, local rainfall and river conditions carry more of the explanation.

Table 6 sets out this comparison. It also shows a gap: the sources reviewed here do not document Nigerian outcomes for the 1997/98 and 2015/16 El Niños, and this is in itself a finding for the research agenda in Section 9.4.

Season	ENSO state (ONI)	Reported Nigerian outcomes	Source
1997/98	Very strong El Niño (peak +2.4, NDJ)	Not established from the sources reviewed; requires national records	NOAA Climate Prediction Center (n.d.)
2015/16	Very strong El Niño (peak +2.6, NDJ)	Not established from the sources reviewed; requires national records	NOAA Climate Prediction Center (n.d.)
2012	ENSO-neutral (+0.3 to +0.4, JJA–SON)	Severe floods from July to October; heavy rain and high flows in settlements downstream of several dams, including Kainji, Shiroro, Jebba, Lagdo and Kiri	GFDRR (n.d.)

2022	La Niña (−0.7 to −0.9, JJA–SON)	Floods in 34 of 36 states; at least 612 deaths; over 3.2 million people affected; 1.4 million displaced; over 569,000 hectares of farmland destroyed or damaged; a concurrent cholera outbreak	OCHA (2022)

Table 6. ENSO state and Nigerian flood seasons. ONI = Oceanic Niño Index; seasons are three-month averages. Historical values are conventional ONI values from the NOAA series cited and are not directly comparable with the relative index (RONI) used in NOAA's current event-strength statements.

5.4 Hazard modelling and the 2026 forecast update

Flood hazard in Nigeria is itself under-modelled. Umar and Gray (2023) find that the north of Nigeria is hit harder than the south, that remote sensing with geographic information systems is the most common modelling approach, and that Bayesian and machine-learning methods work well in data-poor settings. Nkwunonwo et al. (2020) likewise describe urban flood hazard in countries such as Nigeria as poorly understood and in need of calibration in data-scarce settings.

Two features of the 2026 season stand out. NiMet's 2026 Seasonal Climate Prediction was made when ENSO was expected to move from a weak La Niña to neutral conditions (Attah, 2026), but the Pacific has since moved into a developing strong-to-very strong El Niño (NOAA Climate Prediction Center, 2026b; WMO, 2026a). The prediction was not wrong; the system simply had no defined procedure for updating it when the driver changed. Second, NiMet's rainfall projections reached 74% accuracy, while NEMA officials stressed that forecasts need to be linked to action (Attah, 2026). The 2026–27 El Niño will test that link.

The paper therefore does not claim to know how a very strong El Niño will affect Nigerian rainfall, temperature, river flow, crops or health. It does say that Nigeria has a flood and data problem, a seasonal-prediction system, an agency moving towards anticipatory action, and several months in which preparedness can still improve.

6. THE DIGITAL EMERGENCY MANAGEMENT ERA

6.1 What the term means

Digital emergency management here means the use of digital data, networks and analytical tools across the disaster cycle: sensing hazards, forecasting, risk assessment, warning communication, response coordination and learning. Sakurai and Murayama (2019) show that information technology records, exchanges and processes information in ways that improve system performance, but that the discussion is fragmented and needs a strategy and data standards. The question is therefore less whether a tool exists than whether it is connected to a working system. Table 7 compares the main tools on that basis.

Tool	Contribution	Main limitation	Condition for use in Nigeria
Seasonal and ENSO forecasts, including machine learning	Longer lead time; low running cost once trained (Ham et al., 2019; Lam et al., 2023)	Reliability outside training data; no physical guarantee (Reichstein et al., 2019)	Validation against Nigerian observations; published verification
Satellite rainfall and gridded data	Monitoring where gauges are sparse (Funk et al., 2015)	Needs station data and ground validation	Rehabilitated gauge and river-level networks
Crowdsourcing and social media	Timely situational awareness (Goodchild & Glennon, 2010; Imran et al., 2015)	Credibility, overload, bias towards the connected	Verification rules; offline and community channels

Early warning dissemination	Reach and response (WMO, 2022)	Fails most often at the last mile	Multi-channel, local-language alerts; tracking of who is missed
Forecast-based financing	Funds released on a trigger (Coughlan de Perez et al., 2015)	Needs data, protocols and financing aligned (Wilkinson et al., 2018)	Pre-agreed trigger–action–funding tables

Table 7. Digital tools for El Niño-related DRR: contribution, limitation and conditions of use.

6.2 Forecasting and artificial intelligence

Deep-learning ENSO forecasts and minute-scale global weather forecasts (Ham et al., 2019; Lam et al., 2023) widen the window for anticipatory action, but there are three reasons for caution. These systems learn from historical reanalysis data, so an extreme event beyond that range is precisely where reliability matters most (Reichstein et al., 2019). Global models do not replace national validation; reviews of flood modelling in data-poor settings make the same point for Nigeria (Nkwunonwo et al., 2020; Umar & Gray, 2023). And skill statistics are not decisions: a forecast is useful only when its probability and magnitude can be tied to an action at a threshold.

6.3 Satellite rainfall, crowdsourcing and last-mile warning

Remote sensing has changed monitoring where gauges are scarce. CHIRPS combines satellite imagery with station data into a daily high-resolution rainfall record (a preliminary product with about two days' latency and a final product after about three weeks) (Funk et al., 2015). Emergency managers can compare an evolving season with analogues such as 1997/98 or 2015/16 on consistent data, although satellite estimates still need local validation. Volunteered geographic information supplements authoritative data through the disaster cycle (Goodchild & Glennon, 2010), and social-media messages can carry timely, actionable information, but problems of credibility, overload and prioritisation arise (Imran et al., 2015). In SSA they are also biased towards the connected.

The Early Warnings for All (EW4All) initiative, launched by the UN Secretary-General in 2022, aims to cover everyone with early warning within five years (US$3.1 billion initial investment, 2023–2027), through four pillars: risk knowledge; observation and forecasting; preparedness and response; and communication (WMO, 2022). At launch it was reported that about 60% of people in Africa lacked coverage (Down To Earth, 2022). Warning systems fail most often at the last mile, in the communication and response pillar rather than in the forecast.

6.4 The digital divide as a risk factor

About 6 billion people (roughly three quarters of humanity) used the internet in 2025, and 2.2 billion did not (ITU, 2025). Africa had the lowest rate, at 36%, but 66% of Africans owned mobile phones, so affordability and skills are not the only barriers; urban use was 55% against 21% in rural areas (ITU, 2025). Because the households most exposed to El Niño drought and flood are disproportionately rural, app and social-media channels will miss them. Digital emergency management in SSA must therefore be multi-channel (mobile messaging, radio, local leaders) and should strengthen those channels, not replace them.

Nigerian data show the same pattern. The Nigerian Communications Commission reported 157.4 million active internet subscriptions in May 2026 (Okonji, 2026), but subscriptions count connections, not people. A survey of 13,251 respondents in 12 cities found that smartphone ownership was 75% in 2025, up from 64% in 2023 (Daniel, 2026). That sample is urban, so it cannot be read as a national or rural figure.

6.5 Nigeria's position

Nigeria already has the main components of an anticipatory system. NiMet produces an annual Seasonal Climate Prediction that it validates with sector stakeholders (NiMet, 2025), NEMA analyses the prediction

with partners, and NIHSA publishes an annual flood outlook (Attah, 2026). NEMA rehearsed flood response through full-scale simulations in Ogbaru, Anambra State, in June 2025 (NEMA, 2025b); in Wudil, Kano State, in July 2025 (News Agency of Nigeria, 2025); and in Dukku, Kebbi State, under Exercise Hadin Kai in August 2025 (NEMA, 2025a). In June 2026 the Vice President directed the Anticipatory Action Task Force, NEMA and other agencies to activate an early-action coordination platform (the Fusion and Trigger Room) set up within NEMA, although the report does not define the triggers (Elumoye, 2026a). NEMA and the World Bank started a review of the National Disaster Management Framework and the National Disaster Response Plan with an inception workshop in Abuja on 24 June 2026 (News Agency of Nigeria, 2026). Whether these assets work will be determined by the same conditions as elsewhere: validated triggers, funded actions, local reach and accountability.

6.6 From digital capability to institutional decisions and measurable outcomes

The preceding sections describe what digital tools can do. A claim that they improve DRR outcomes requires more: it must show which institutional decision each tool informs, what rule converts its output into action, and how the effect on losses will be measured. The sources reviewed document capability (forecast skill, speed, coverage; Ham et al., 2019; Funk et al., 2015; Lam et al., 2023) and the conditions under which early action works (Coughlan de Perez et al., 2015, 2016; Wilkinson et al., 2018). They do not, for Nigeria, document measured reductions in deaths, displacement or losses attributable to these tools. This paper therefore treats outcome gains as hypotheses to be tested, and Table 8 sets out how.

Table 8 translates each tool into a decision, a decision owner, an example decision rule and indicators at three levels. *Output* indicators show whether the tool performs (for example, published verification statistics). *Decision* indicators show whether information changes behaviour (for example, the time from a trigger to an action). *Outcome* indicators show whether people and assets are better protected (for example, deaths, displacement and farmland damaged in a flood season, compared with seasons of similar hazard such as 2022 in Table 6). The rules and indicators are illustrative proposals, not national standards.

Digital capability	Decision informed (owner)	Example decision rule	Indicators (output → decision → outcome)
ENSO-conditioned seasonal and AI-assisted forecasts	Whether to advance readiness (stock review, surveillance, drainage maintenance) and revise the seasonal outlook (NiMet, NIHSA, NEMA)	A change in NOAA or WMO ENSO status requires a joint updated advisory within an agreed period	Verification statistics published each season → days from ENSO status change to updated advisory → share of high-risk LGAs with readiness steps completed before the rainfall peak
Satellite rainfall and gridded data	Whether observed rainfall departs enough from normal or analogue seasons to release pre-agreed actions (NIHSA, NiMet, state agencies)	Gauge-validated rainfall and river-level thresholds trigger the corresponding action list	Rainfall-estimate error against gauges → lead time between threshold exceedance and action → damage in basins with and without activated actions
Flood forecasts and nationally validated hazard models	Which communities to warn, evacuate or supply in advance (NIHSA, NEMA, state agencies)	Forecast probability and lead time linked to a graded action list, with explicit tolerance for acting in vain	Hit and false-alarm rates → time from trigger to action → deaths, displaced people and farmland damaged per flood season
Alert dissemination (SMS, voice, radio, community networks)	Which channels and languages to use and which groups are missed (NEMA, state agencies, telecom providers, broadcasters)	Minimum alert reach for at-risk households in each flood-prone LGA before the season	Share of at-risk households receiving alerts and rural reach gap → time from alert to receipt → share of warned households taking protective action

Crowdsourcing and social media	Whether a report is verified enough to inform response (NEMA, state agencies)	Unverified reports inform monitoring only; verified reports can inform action	Share of reports verified → time from report to verification → response time in affected areas
Forecast-based financing	Whether to release funds before impact (NEMA, finance authorities, humanitarian partners)	Pre-agreed trigger–action–funding table with a legal mandate and budget line	Number of actions pre-agreed and funded → time from trigger to funds released → losses compared with post-disaster response, with cost of acting in vain recorded

Table 8. Translating digital tools into institutional decisions and measurable outcomes.

Two conditions make such a test credible. First, triggers, actions and indicators must be fixed before the season, and every activation, action taken and result must be recorded, so that success is not defined after the event. Second, because ENSO is a weak guide to flood outcomes in Nigeria (Section 5.3) and seasons differ in hazard, one season cannot validate a tool. Evidence should accumulate over several seasons, with comparison between activated and non-activated areas where possible, and with post-event reviews that say what the tool did and did not change. The 2026–27 event can be the first such season (Section 9.4).

7. STRATEGIC IMPERATIVES

The evidence supports six imperatives. They are stated here as arguments, each with a rationale, and ranked in Table 9.

Imperative 1: Treat ENSO as a standing planning variable. ENSO is the dominant year-to-year climate signal, it is predictable several seasons ahead, and its influence on flood risk extends across basins covering 44% of the land surface (McPhaden et al., 2006; Ward et al., 2014). Yet societies are surprised every time by events whose recurrence is known (Glantz, 2001), and the economic costs last years (Callahan & Mankin, 2023). Treating each event as an emergency one-off therefore understates both the risk and the case for prevention. Plans and budgets should carry ENSO-conditioned scenarios (El Niño, neutral and La Niña years), and pre-positioning and surveillance budgets should be linked to ENSO state as rainy-season preparedness is linked to the seasonal outlook. In Nigeria the Seasonal Climate Prediction, the Annual Flood Outlook and the National Disaster Management Framework should say what changes when the NOAA or WMO ENSO status changes. Section 9.2 qualifies this: for Nigeria the ENSO state should shift readiness, not trigger costly action on its own.

Imperative 2: Convert forecasts into pre-agreed action. The anticipatory-action literature agrees that forecasts alone do not prevent disasters (Coughlan de Perez et al., 2015). DRR has focused on long-term prevention or post-disaster response, but the interval between warning and impact, when evacuation and similar actions are possible, has been neglected. Forecast-based financing addresses this by matching forecast probability thresholds with actions, releasing funds when thresholds are met and embedding procedures with a mandate to act. Coughlan de Perez et al. (2016) show how forecasts can be selected for specific actions, allowing for each action's lifetime and for willingness to act in vain, in data-scarce Uganda. Wilkinson et al. (2018) add that limited capacity, weak planning structures and data gaps are recurrent obstacles. A preparedness plan therefore names the trigger (which forecast, at what probability and lead time), the action, the money and the person accountable. It also states a tolerance for acting in vain, because action on a forecast that does not materialise is not a failure but the cost of a working system.

Imperative 3: Integrate adaptation and DRR and plan under uncertainty. Thomalla et al. (2006) and the IPCC (2012) argue that the adaptation and DRR communities have overlapping concerns with vulnerability and should work together; Kelman (2015) warns against treating climate change as the only driver. Institutional integration has two sides in this setting. NEMA, NiMet, NIHSA, the agriculture and health ministries, and state and local agencies need joint planning cycles, shared data and a common calendar.

Methodologically, because the projected increase in extreme El Niño is model-supported but hard to detect (Cai et al., 2014, 2021), strategies should favour measures that pay off under El Niño and other hazards (drainage maintenance, safe water and sanitation, warning communication, grain reserves, social protection). The Sendai priorities (UNDRR, 2015) provide the structure.

Imperative 4: Build inclusive digital infrastructure and last-mile reach. Only 36% of Africans are online, and 21% of rural residents (ITU, 2025), so digital tools will not reach the most exposed unless they are designed for that purpose, and the EW4All plan focuses on communication and preparedness as well as forecasting (WMO, 2022). Forecasting investment must therefore be matched by investment in dissemination and response: SMS and voice messages in local languages; radio; community networks and religious and traditional institutions; partnerships with telecom providers for targeted alerts; offline tools for local committees; and explicit tracking of who is not reached. Mobile phone ownership exceeds internet use (ITU, 2025), so message-based services are a more realistic backbone than apps.

Imperative 5: Invest in local data, validation and hybrid models. Global data and models are a good start, but their value in any basin depends on local calibration. Blending satellite and station data improves rainfall monitoring (Funk et al., 2015), Nigerian flood modelling is held back by sparse data and little use of modern methods (Nkwunonwo et al., 2020; Umar & Gray, 2023), and physics-aware machine learning is preferable to purely data-driven models (Reichstein et al., 2019). The practical consequence is a national data programme: rehabilitated gauge and river-level networks; common data standards across agencies (Sakurai & Murayama, 2019); global AI models validated against Nigerian observations before operational use; and published verification statistics. NiMet's practice of reporting rainfall accuracy (Attah, 2026) should be extended to flood guidance and ENSO-conditioned guidance.

Imperative 6: Govern digital tools for equity, credibility and accountability. Digital tools carry their own risks: credibility and overload in social-media streams (Imran et al., 2015), uneven quality in crowdsourced data created by non-specialists (Goodchild & Glennon, 2010), and fragmented data standards (Sakurai & Murayama, 2019). The 2022 global assessment calls for governance that works across silos and is designed with affected people (UNDRR, 2022). Digital emergency management therefore needs explicit rules for verifying crowdsourced data, correcting misinformation, protecting privacy, ensuring interoperability between agencies and receiving community feedback. Vulnerability includes the capacity to adapt (Adger, 2006), so equity is a design requirement. Indicators from the DROP approach (Cutter et al., 2008) can show whether digital investments are building resilience for the most vulnerable.

Ranking the imperatives

Not all six can be done at once with limited funds. Table 9 shows the author's proposed ordering, based on how quickly each can be done with assets Nigeria already has and how much risk each reduces if the 2026–27 event is as strong as forecast. It is a judgement to be tested, not a finding.

Imperative	Tier	Reason
2. Convert forecasts into action	Immediate	Uses thresholds and platforms NEMA already has; cheapest way to reduce loss in this season
4. Last-mile reach	Immediate	Can be tested within existing simulation exercises; message-based services need no new infrastructure
1. Standing planning variable (updating rule)	Immediate for the updating rule; 12 months for budgets	A rule for revising outlooks costs little; scenario budgeting takes a planning cycle
5. Local data and validation	12 months and beyond	Essential but slow; needs funding and inter-agency agreement
6. Governance of digital tools	12 months	Rules and standards can be drafted alongside the framework review

3. Integrate adaptation and DRR	Medium term	Requires institutional change across ministries and tiers of government

Table 9. Proposed priority of the six imperatives.

8. IMPLICATIONS FOR SSA AND NIGERIA, AND A PROPOSED FRAMEWORK

8.1 Regional implications

SSA is not one climate or risk zone. Eastern Africa has an ENSO signal that varies across the long, short and summer rains (Nicholson, 2017); the southern African crop evidence in this review is the Zimbabwe maize finding (Iizumi et al., 2014); and the evidence for West Africa is thin and mixed. Three regional implications follow. First, regional institutions and national meteorological services should translate global ENSO updates into sub-regional and national outlooks quickly, as the WMO (2026a) itself advises. Second, early-warning investment should follow the four pillars of the EW4All plan, with particular attention to the communication and preparedness pillar, where Africa's gaps are widest (ITU, 2025; WMO, 2022). Third, financing should move from post-disaster appeals towards pre-agreed, forecast-triggered instruments (risk pools and anticipatory funds) across the region, with national governments progressively taking more ownership of financing (Wilkinson et al., 2018).

8.2 Nigeria: assets, gaps and priorities

Assets. NiMet produces a seasonal forecast and reports 74% rainfall accuracy; NIHSA publishes an annual flood outlook; and NEMA holds technical sessions on the outlook, runs simulations, is setting up a trigger-based early-action platform and is reviewing the national framework and response plan (Attah, 2026; Elumoye, 2026a; News Agency of Nigeria, 2026). A federal structure with state agencies and local committees gives a route to the last mile, and engagement with the Nigerian Army and traditional institutions suggests that preparedness is now multi-sector (Aliyu, 2026).

Gaps. The academic literature notes poor hydrological data and little use of modern flood modelling (Nkwunonwo et al., 2020; Umar & Gray, 2023). The seasonal prediction was made when El Niño was not expected and no formal update procedure existed (Attah, 2026; NOAA Climate Prediction Center, 2026b). Commentary on the 2026 alerts says that warnings are not being converted into timely action (Aliyu, 2026), the same problem seen internationally (Coughlan de Perez et al., 2016). And Africa's internet-use pattern means that digital channels will leave many rural households unreached (ITU, 2025).

Priorities for the 2026–27 window. El Niño is expected to continue through at least February 2027 and to peak towards the end of 2026 (WMO, 2026a), and NOAA judges a strong-to-very strong event likely through January–March 2027 (NOAA Climate Prediction Center, 2026b). There is therefore a short window in which to put the imperatives into practice. Four things should be done. First, NiMet, NIHSA and NEMA should issue a joint ENSO-updated advisory that updates the seasonal outlook, makes uncertainty explicit and says which regions and sectors should watch for which hazards. Second, the health and agriculture ministries, with state agencies, should review surveillance, stocks and advisory services, using seasonal and ENSO forecasts to target scarce resources (Kovats et al., 2003). Third, trigger-and-action tables should be drawn up for hazards where Nigerian institutions already hold thresholds, and funding sources identified. Fourth, multi-channel dissemination should be tested in the simulations NEMA already runs.

8.3 A proposed strategic framework

Table 10 organises the imperatives on the four pillars of the EW4All plan plus a cross-cutting pillar of governance and learning. It names a strategic action, indicative lead institutions in Nigeria and example indicators, and shows which imperatives each pillar serves. The framework is conceptual, and the indicators are suggestions, not a national standard. Outcome-level indicators for the digital tools are given in Table 8.

Pillar	Strategic action	Lead institutions (Nigeria)	Example indicators	Imperatives
1. Risk knowledge	ENSO-conditioned hazard, exposure and vulnerability assessments; data-sharing standards	NEMA; NIHSA; NiMet; universities; state agencies	Share of flood-prone LGAs with ENSO-conditioned risk maps; data-sharing protocol in force	1, 5
2. Observation and forecasting	Joint ENSO-updated outlooks; validated hybrid models; published verification	NiMet; NIHSA	Verification statistics published each season; updating rule triggered by ENSO status change	1, 5
3. Communication	Multi-channel, local-language, last-mile alerts; tracking of unreached groups	NEMA; state agencies; telecom providers; broadcasters; traditional institutions	Percentage of at-risk households receiving alerts; rural reach gap	4, 6
4. Preparedness and response	Trigger–action–funding tables; forecast-based financing pilots; simulations	NEMA; health and agriculture ministries; humanitarian partners	Number of actions pre-agreed and funded; time from trigger to action	2
5. Governance and learning	Integrated adaptation and DRR planning; rules for digital data; post-event review	Federal and state governments; NEMA; legislatures	Joint planning cycle in place; post-event reviews published; community feedback channels	3, 6

Table 10. Strategic framework for El Niño-informed DRR in Nigeria and comparable settings.

Implementation should be staged. Until the end of the 2026–27 event, Pillars 2 to 4 can be advanced through the advisories, trigger tables and dissemination tests described above. Up to 2030 (the end date of the Sendai Framework; UNDRR, 2015), data, financing and governance reform should be the focus. After 2030 the framework can be reviewed against evidence on whether the projected increase in extreme events has become detectable (Cai et al., 2021).

9. DISCUSSION

9.1 What the findings add

The anticipatory-action literature has shown that forecasts must be tied to triggers, funds and responsibilities (Coughlan de Perez et al., 2015; Wilkinson et al., 2018), and the EW4All plan established the four pillars (WMO, 2022). The Nigerian case adds three things. First, a country needs a rule for updating national outlooks when the global driver changes. NiMet's seasonal prediction was good on the information available, but it became out of date within months and nothing in the system forced anyone to revise it. Second, the quality of an ENSO signal varies between countries, so the design of the information-to-action chain has to be built around that quality. Third, the digital divide is a risk factor in itself and should be built into trigger and alert design, not treated afterwards as a communication issue. A fourth contribution is methodological: by linking each digital tool to a decision rule and to output, decision and outcome indicators (Table 8), the paper turns general claims about digital benefit into testable propositions.

9.2 When the signal is ambiguous: ENSO as a prior, not a trigger

The evidence in Section 5.3 poses a design problem. If ENSO is only a weak predictor of Nigerian flood outcomes, then a plan that fires on the ENSO state would trigger action in some seasons for no good reason

and miss seasons in which floods arrive under neutral or La Niña conditions. The argument here is that ENSO should be used to shift probabilities and prior readiness (for example, earlier review of stocks, surveillance and drainage in vulnerable areas), while triggers for costly action should rest on observed and forecast hazard variables (rainfall thresholds, river levels, flood outlooks and similar).

This preserves the advantage of long lead times without tying action to a teleconnection that Nigeria may not show reliably. It also makes tolerance for acting in vain (Coughlan de Perez et al., 2016) an explicit policy choice: cheap, reversible readiness steps can be taken at low probability, but expensive, hard-to-reverse actions only at high probability. The argument is untested and needs to be checked with Nigerian data.

9.3 Capacity and political economy

The framework assumes that agencies can share data, pre-allocate funds and act on thresholds, but Nigeria's federal structure makes this harder than it sounds. NEMA coordinates at national level, but execution is largely left to state emergency management agencies whose capacity, funding and risk differ widely (Wilkinson et al., 2018). Pre-agreed financing needs a budget line and a legal mandate, not only a protocol (Wilkinson et al., 2018).

Recent financing practice illustrates the point. In June 2026 the National Economic Council approved ₦83.2 billion for the Anticipatory Action Task Force, half of the ₦166.42 billion requested (Elumoye, 2026b). The approval was welcome, but it was not tied to a pre-agreed trigger, and the remainder may depend on later decisions. The strongest early gains are therefore likely to come from measures that need little new money (the updating rule, the joint advisory and tested dissemination), while data and financing reform will take longer and depend on political commitment.

9.4 Limitations and research agenda

The analysis is conceptual and based on purposive evidence; the ENSO evidence is stronger for eastern and southern Africa than for West Africa; the review is narrative, not systematic, and limited to English-language sources; the 2026 operational information is time limited and will be superseded; and the outcome evidence for digital tools is thin in the sources reviewed. Five questions follow. How does El Niño affect rainfall, river flow, crops and health in Nigeria when tested with local data? How well do global machine-learning models perform in Nigerian basins, and which hybrid designs work best? Which trigger thresholds and action lists are cost-effective for floods and drought in Nigeria? Which mixes of digital and non-digital channels reach rural and low-income households best? And do forecast-based early-action programmes in Nigeria reduce losses relative to post-disaster response, as measured by the output, decision and outcome indicators in Table 8? The 2026–27 event will be a natural experiment for these questions, and its lessons should be recorded systematically.

10. CONCLUSION AND RECOMMENDATIONS

10.1 Conclusion

This paper asked what El Niño in a warming climate and a digital era means for DRR strategy in SSA, with Nigeria as the focal case. Four conclusions emerge. First, El Niño is a recurrent and forecastable risk driver, and the 2026–27 event is forecast to be exceptional (NOAA Climate Prediction Center, 2026b; WMO, 2026a), but its human consequences are set by exposure, vulnerability and institutional capacity. Second, climate models suggest more intense ENSO extremes while detection remains uncertain (Cai et al., 2014, 2021); the sensible response is no-regret investment, not waiting. Third, digital tools extend what is possible (longer-lead forecasts, satellite monitoring, crowdsourced information), but they do not close the warning–action gap by themselves, they bring risks of exclusion, misinformation and unvalidated models (ITU, 2025; Reichstein et al., 2019), and their effect on losses has still to be measured. Fourth, in Nigeria, where the ENSO signal is less clear than elsewhere in Africa, the outcome will be decided by how strong the information-to-action chain is: updating rules, pre-agreed triggers, funded actions, last-mile communication, local data and accountable governance.

The outlook for Nigeria is cautiously positive. It has a seasonal prediction, a hydrological outlook, an emergency agency that knows the language and some of the tools of anticipatory action, and a window of several months in which to apply them (Attah, 2026; Aliyu, 2026; WMO, 2026a). The main risks are scarce hydrological data, outlooks that do not change when the driver changes, and warnings that do not reach or move the most exposed households.

10.2 Recommendations

1. **Issue an ENSO-updated national advisory and adopt an updating rule.** NiMet, NIHSA and NEMA should jointly revise the 2026 outlook, state the uncertainty, name the regions and sectors at risk, and specify what changes (and who issues the update) when ENSO status changes.

2. **Write trigger–action–funding tables for each priority hazard, with indicators.** Each table should state what triggers the action, the lead time, the pre-agreed action, the responsible agency, the funding source and the tolerance for acting in vain (ENSO to raise readiness; observed hazard thresholds to trigger costly action). Output, decision and outcome indicators should be fixed in advance, and every activation recorded and reviewed (Table 8).

3. **Invest in data and validation.** Repair gauge and river networks, use common standards, validate global models on Nigerian observations and publish verification statistics.

4. **Design for the last mile.** SMS, voice, radio and community networks in local languages should be the alert backbone; groups not reached should be tracked; and dissemination should be tested in simulations.

5. **Protect health and food security and integrate planning.** ENSO and seasonal forecasts should guide surveillance, stocks and advisories (Iizumi et al., 2014; Kovats et al., 2003) through a joint NEMA, NiMet and NIHSA planning cycle, with health, agriculture and state agencies, that favours no-regret measures.

6. **Govern digital tools and pilot forecast-based financing.** Adopt rules for verifying crowdsourced data, protecting privacy and correcting misinformation, and open community feedback channels (Imran et al., 2015; UNDRR, 2022). Pilot pre-agreed financing for flood and drought triggers in selected high-risk states, moving from donor-led to government-owned mechanisms (Wilkinson et al., 2018).

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