



Systematic review brief

Climate

Effects of El Niño and the positive Indian Ocean Dipole (+IOD) on health, food security, economics and conflicts in low- and middle-income countries in the Indo-Pacific: A systematic review

The theory anticipates cascading effects of climate drivers

Climate drivers, such as El Niño and the +IOD, impact various sectors in Indo-Pacific countries. During El Niño events, drier weather and lower sea surface temperatures persist in the region, leading to less rainfall and increased droughts. Conversely, +IOD brings a warmer sea surface temperature into the Western Indian Ocean region, and heavier monsoon rains and higher flood risk in South Asia.

Global warming may intensify these climate drivers, leading to more frequent and severe climate disasters such as droughts, floods and fires. This in turn affects sectors such as agriculture (through crop loss), health (disease outbreaks) and the economy (economic shocks). These changes can lead to displacement, land loss, income loss, food and nutrition insecurity, migration, and conflict, thereby threatening the progress made by low- and middle-income

countries (L&MICs) in the Indo-Pacific region.

The objective of this systematic review was to assess the historical effects of El Niño and +IOD on socioeconomic outcomes in L&MICs in the Indo-Pacific region as a means of informing policy actions to mitigate the cascading effects of these climate drivers. We considered outcomes related to health, economic indicators, food security, migration and conflict.

Main findings

We included 89 studies that used quantitative methods to assess the association between either El Niño or +IOD and at least one of the outcomes listed above. We did not find any qualitative studies that met the criteria for our review.

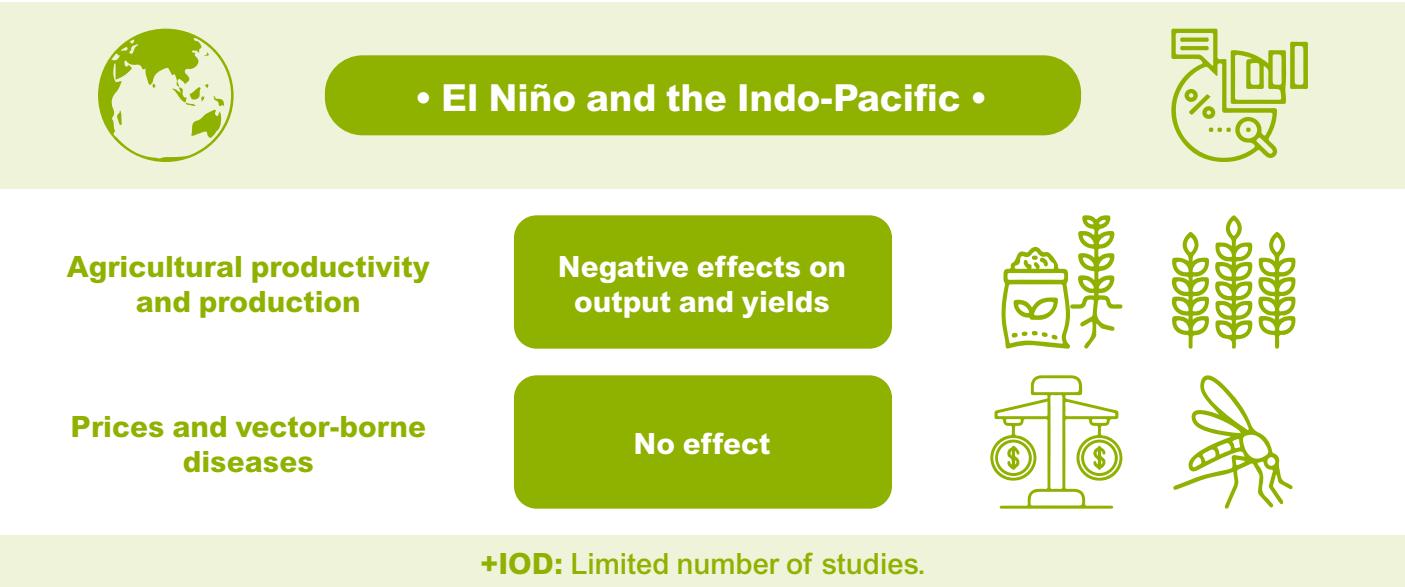
Results for the overall Indo-Pacific region suggested that El Niño events are likely to reduce agricultural production¹ and

productivity² in L&MICs, but unlikely to change the incidence of vector-borne diseases (e.g., dengue) and consumer and commodity prices in general. However, we found significant variability in the results from included studies for each of these outcomes.

We did not find enough evidence on other outcomes to make conclusions on the effects attributable to El Niño












in the region. There was also not sufficient evidence on the effects of +IOD on the outcomes of interest to draw firm conclusions. We did not find studies assessing the impact of either of these climate drivers on migration, conflicts, food security and nutrition in the Indo-Pacific region. Findings from studies in individual countries in the region are presented below.

Figure 1: Results for the Indo-Pacific region



¹ Production outcomes include any measure of the disaggregated economic output such as total volume of agricultural production or outputs, (share of) land/area cultivated or harvested.
² Productivity outcomes include measures of agricultural productivity (yields) and for one study only: fish catch per unit effort.

Figure 2: El Niño-related findings from narrative synthesis

Country/ region	India	Indonesia	Phillippines	Malaysia	Bangladesh	Lower Mekong River Basin	Oceania
							
Outcome							
 Agricultural productivity	May vary by crop, season, and time since the event	Varies by crop and geography	Varies by irrigation system	Varies by crop	Limited number of studies	Varies by crop	Limited number of studies
 Agricultural production	May vary by state	Varies by crop	May decrease Varies by crop and region	Varies by crop	Limited number of studies	Some suggestion of no effect	Limited number of studies
 Vector-borne diseases	May vary by state and disease type	Some suggestion of reduced incidence	Limited number of studies	Limited number of studies	Contrasting findings	Contrasting findings	Varies by island size and population
 Other	Enteric disease may vary by state and disease type	Aggregate output may fall Contrasting findings for prices	No effects on aggregate output	No effects on GDP Stock returns may fall	Contrasting findings for cholera	Contrasting findings for prices and aggregate production	Agricultural export may vary by country
+IOD: Limited number of studies.							

Note: The full report provides more information at regional or state levels, and for other contextual factors such as time horizon, type of crop, disease, and climate-driver metric employed.

Country focus

India

The effects of El Niño on agricultural productivity varied by crop, season, and time since the event. Its effects on agricultural production varied by state, with decreased output more likely in western and northwestern states. El Niño was associated with wide geographical variation in the incidence of some vector-borne and enteric diseases, accounted by the frequency of monthly precipitation. We identified little evidence of the effect of +IOD.

Indonesia

The effects of El Niño on agricultural production and productivity vary by type of crop (and geography for productivity). There was some evidence of negative effects on rice production but conflicting findings for rice yields and maize. While six studies found contrasting findings for prices, there is some suggestion of El Niño being associated with decreased aggregate measures of economic output. Most studies indicated that

both El Niño and +IOD conditions were associated with a reduced incidence of vector-borne diseases, such as dengue and chikungunya. We found little evidence on the effects of +IOD on other outcomes.

Phillippines

The effects of El Niño on agricultural productivity may vary depending on the type of irrigation system used. Rain-fed fields were more negatively affected by El Niño compared to irrigated fields, as the former are more reliant on rainfall.

The evidence suggested that El Niño may be associated with reduced agricultural production, though the effect varies by region and crop. We found no systematic effects of El Niño on aggregate measures of economic production (such as GDP). As these findings are drawn from a limited sample of studies, new evidence might suggest something different. We found limited evidence for vector-borne diseases. We did not find any studies reporting on the effects of +IOD.

Malaysia

The effects of El Niño on agricultural production and productivity may vary by crop type. Specifically, palm oil production and yields are particularly damaged by the rainfall reduction and droughts induced by El Niño events, as oil palm trees are a rainfall-sensitive crop. The evidence also pointed to a negative impact on investment—though not necessarily during winter—and no systematic effect of El Niño on Malaysia's GDP.

Studies on El Niño and vector-borne diseases suggested that effects may vary by region and disease type. Two studies reported an increase in dengue incidence rates in the central region and the Malaysian peninsula, while another found a decrease in Japanese encephalitis in Sarawak. These results are too insufficient to determine the effects of El Niño on health outcomes, and new studies may produce different findings. We did not identify any studies reporting on the effects of +IOD.

Country focus

Bangladesh

The effects of El Niño on agricultural production might be negative; however, there were too few studies to strongly corroborate this conclusion, and new studies may produce different findings.

El Niño and +IOD may be associated with an increase in cholera incidence in Dhaka and Matlab. However, findings at the national level suggested that the negative effects of El Niño were not generalizable as one study found a reduced incidence associated with El Niño conditions. Further, another study suggested that the negative effects of +IOD in Dhaka might revert over time (i.e., an increased incidence of cholera observed during the first quarter after +IOD but a reduction four to seven months after). This latter finding was based on a single study, however, and new evidence may lead to different conclusions. Finally, two studies

found that El Niño is associated with increased vector-borne disease incidence, which contrasted with another study that used a more robust research design and found no effect.

Lower Mekong River Basin region

Most studies in this region were conducted in Thailand. El Niño may decrease agricultural productivity in the country; one study found reduced cassava yields and others found a decrease in rice yields (and no effect on sugarcane). We found no consistent evidence of El Niño negatively affecting agricultural production. One study suggested that rice production in Thailand might decrease due to droughts and lower rainfall levels during El Niño, but this was contradicted by another study. Additionally, three studies found no effects on aquaculture, sugarcane, maize or cassava production. There were mixed findings on aggregate

production, prices and vector-borne disease. We did not find enough evidence on the effects of +IOD in the region.

Oceania

El Niño may increase dengue cases on larger and more populated islands where the disease is endemic. However, its effects varied based on each country's rainfall and temperature. Two studies reported the effects of El Niño on trade: in Papua New Guinea, agricultural exports were found to vary by type of crop, and in Samoa, overall agricultural exports did not change but agricultural imports increased. A study in Papua New Guinea found that +IOD decreased pneumonia cases in children under five, while El Niño increased cases. There is insufficient evidence on the effects of El Niño and +IOD on other economic and health outcomes in the Pacific Islands.



El Niño studies focused on a limited number of Indo-Pacific L&MICs

Most included studies were published after 2013 (67%), indicating an increasing volume of empirical literature. More than half of the studies were conducted in South East Asia, approximately 33% focused on the Indian subcontinent, and 6% were conducted in Oceania. The studies were concentrated in five countries: India, Indonesia, the Philippines, Malaysia and Bangladesh. Less than 20% of included studies evaluated other L&MICs in the region.

El Niño is the more studied of the two climate drivers in the Indo-Pacific region (88 studies), with wide variation in how it was measured among studies. Sixteen of these studies also examined the effects of +IOD, though only one study focused on it exclusively.

No evidence was found on outcomes other than health and economic conditions. We found evidence on the effects of El Niño and +IOD on economic and health outcomes but no evidence on the effects on migration,

conflict or food security and nutrition. Fifty-six studies reported effects on economic outcomes, while 33 focused on health outcomes. 'Production' and 'productivity' were the most frequently reported economic outcomes (40 studies). Among health outcomes, the incidence of vector-borne diseases (such as dengue) was the most reported outcome (20 studies), followed by other enteric diseases (7 studies) and cholera (5 studies).

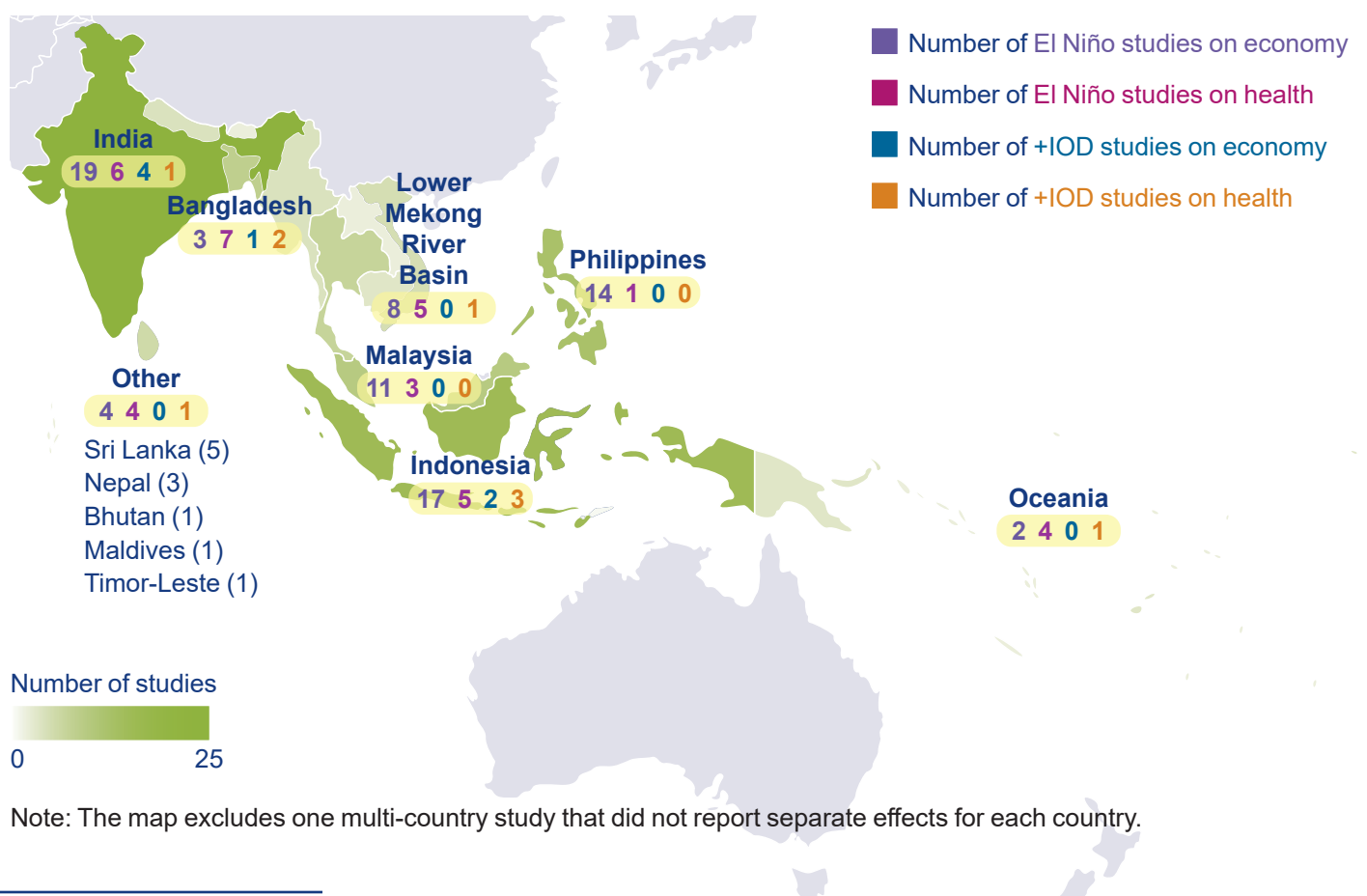
There was a high risk of bias in included studies. We assessed seven out of every 10 included studies as having a high risk of potential bias. For example, while some studies pointed out that many factors might influence the effects of climate drivers, 38 studies did not consider that results could be potentially confounded by contextual factors such as local soil moisture or technological improvements, and 24 did not consider the cyclicity of the climate driver in the analysis.³ For example, the lack of effects on vector-borne disease could be the result of countries adopting

mitigating strategies (e.g., the use of artesunate combination therapy, insecticide-treated mosquito nets, and indoor residual spraying may have reduced the effects of diseases like dengue and malaria). Impacts on agricultural outcomes might also have been mitigated by water management (e.g., irrigation schemes and improved control and management systems). Future studies should consider these issues.

Do results vary with time?

Correlational studies that evaluated the time delay between the occurrence of an El Niño climate event and an observable change in outcomes (e.g., production, productivity, or incidence of disease) reported a recovery in agricultural output and yield after the initial reduction. For health outcomes, however, there was a reduced incidence of vector-borne disease and enteric infections both during and after El Niño. Data were insufficient to explore changes through time for +IOD effects.

Figure 3: Studies by country



³ The quality of a study comprises diverse and intricate factors. However, we consider that limitations related to potential risk of bias in the findings directly affect the quality of a study. Therefore, we interpret the risk-of-bias score as a proxy for the study's quality.



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Key research gaps

- Absence of evidence on migration, conflicts, food security and nutrition
- Insufficient evidence to conclude on effects attributable to +IOD
- Limited availability of high-quality evidence

Future research implications

- Future research should fill evidence gaps: investigate cascading effects of +IOD, the combined effects of +IOD and El Niño, and the effects of climate drivers on migration, conflict, food security and nutrition; and disentangle the effects on economic and health outcomes.
- Future research should ensure minimum quality and methodological criteria: identify and control for potential confounding factors, consider the cyclicity, temporality and non-linearity of climate drivers and outcomes.

What is a systematic review?

Systematic reviews appraise and synthesise the available high-quality evidence to answer specific research

questions in a rigorous, objective and stepwise process. These reviews follow scientifically recognised review

methods, and they are peer-reviewed and quality assured according to internationally accepted standards.

About the review

This brief is based on the systematic review, *Effects of El Niño and the positive Indian Ocean Dipole (+IOD) on health, food security, economics*

and conflicts in low- and middle-income countries in the Indo-Pacific: A systematic review, 3ie Systematic Review, by Andrea Floridi, Tomasz

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About this brief

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