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Reflections on Global Food Security, El Niño, and the Strait of Hormuz

Thomas J. Papadimos[1], Stanislaw P. Stawicki[2]

[1]Departments of Anesthesiology and Surgery, The University of Toledo College of Medicine and Life Sciences, Toledo, Ohio, USA
[2]Department of Research & Innovation, St. Luke's University Health Network, Bethlehem, Pennsylvania, USA
Email: Tjpapadimos@gmail.com, Stawicki.ace@gmail.com

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Abstract

Food security is essential to our planet's inhabitants. It requires a solid supply chain, which includes energy (oil and natural gas) and fertilizer (ammonia, sulfur, and phosphate sources). The current geopolitical dispute in the Strait of Hormuz is causing a disruption of important supply chains. This difficulty may be compounded by the Super El Niño that has been predicted. Under Super El Niño conditions, there will be a substantial rise in the waters of the Pacific Ocean causing a global effect. Normally, trade winds blow from east to west thereby directing the warm surface waters of the Pacific towards Asia and allow cool waters that are nutrient-rich to engulf the Pacific coast of South America. However, at this time, these trade winds are weakening, and the warm waters will instead head to the Americas. This will lead to climate changes throughout the planet, and these effects will be felt the most by the poorest of nations. Here we summarize our concern regarding the interaction of these two major events: the difficulties of supplies transiting the Strait of Hormuz and the predicted Super El Niño.

Keywords

Weather, Armed Conflicts, Economics, Food Supply, Food Security

View Point

The media is ripe with the news of various downstream economic and social effects of the Strait of Hormuz conflict which is involving an increasing number of local, regional, and global stakeholders (Kaya, 2026; Mangu, 2024). Energy disruption will affect fertilizer availability, crop production, food prices, and household food access. These effects can be global; however, there may be region-spe-

cific effects. With any shuttering of access to the strait, a projected scenario would include the effective severed global distribution of approximately 20% of the world's oil and roughly 25% of liquefied gas, especially as it pertains to low and middle-income countries (and where they are located geographically in relation to specific regional climatic changes) (Nasr, Kubursi, & Zviovich, 2026; Rashid, Zulkifli, & Ismail, 2026). While associated prices in the US and other high-income countries will certainly rise, the essential energy products will continue to be available, albeit at a higher cost. Experts indicate that "standard trade models underestimate the impact because they miss the bottleneck mechanism: energy disruptions cascade through chemicals and fertilizer production into food prices, amplifying losses for the world's poorest countries (Hinz et al., 2026)." In fact, as much as one-third of the world's entire fertilizer supply is thought to be affected directly by the ongoing tensions (Nasr et al., 2026). The cumulative consequences of these drastic supply shocks may be significant. Developing countries in Southern Asia, Sub-Saharan Africa and the Middle East may see steeper food prices and welfare losses. In this context, a "welfare loss" is defined as the reduction in a country's total economic efficiency and social welfare when an equilibrium for services or goods is not achieved (Xu, Zhu, Samanta, & Horton, 2026). In other words, when a country's markets are not working as they should, there is a total surplus loss to society; this includes losses to consumers and to producers alike. Asia and Africa face a potential welfare loss that is approximately 10 to 20 times that of the welfare loss that may be experienced by the US (Hinz et al., 2026). Additionally, given the critical nature of crop timing, planting seasons could be severely affected without adequate fertilizer availability, both quantitatively and qualitatively speaking (Buheji, 2026; Gull, Zulfiqar, & Abbas, 2026). More specifically, as to the necessity of fertilizer, the Gulf states provide 44% of the sulfur exports, 23% of ammonia exports, and provide an extensive portion of the phosphate production (Arita et al., 2026; Hinz et al., 2026). When a blockade is prolonged, the lack of seaborne sulfur supply increases the cost of phosphate production/products in China, Morrocco, and Indonesia; and a country such as Brazil which imports over 80% of its fertilizers will be very severely affected (Arita et al., 2026; Hinz et al., 2026). On the other hand, the US is relatively well-equipped because it produces 94% of its ammonia, and its domestic nitrogen stores offset its import needs. Geopolitical and military strategy formulation process often fails to take a more comprehensive perspective on potential downstream effects of specific actions, no matter how well thought-out and planned.

In addition to geopolitical-military events, a compelling concurrent event is looming on the horizon, which when combined with the ongoing set of global circumstances, has the potential to synergistically exacerbate the already disadvantaged situation of the poorest around the planet. More specifically, our global society is being confronted with a set of parallel threats that could result in a loss of capacity that is required to sustain human life at current levels. We are referring

to El Niño (which means "little boy or child"), a macro weather cycle often referred to as El Niño-Southern Oscillation (ENSO), which occurs in the south-central Pacific Ocean. El Niño is the warm phase of an observed periodic duality (La Niña is the cool "opposite" phase of this oscillation). Normally trade winds blow from east to west thereby directing the warm surface waters of the Pacific towards Asia and allow cool waters that are nutrient-rich to engulf the Pacific coast of South America. At this time, these trade winds are weakening and the warm waters will instead head to the Americas (Xu et al., 2026). This singularity can be extremely problematic, especially if the predicted 2.8˚C - 3.0˚C temperature increase in the Pacific waters occurs (Liu et al., 2026; Noll, 2026). This may result in higher world-wide temperatures causing heat waves and increasing the risk of wildfires. Asia and Australia would potentially have much less rainfall and possibly experience drought conditions. South America's Pacific coast may experience major storms, including torrential rains and floods. El Niño's wind reversal substantially affects South American ecosystems. This may significantly impact local fishing capacities by the reduced upwelling of the ocean (an upwelling is a process where deep, cold water full of nutrients rises to the surface and replaces the nutrient depleted surface waters) (Liu, Cai, Lin, Li, & Zhang, 2023; Xu et al., 2026). The Southern US may experience more rain, and the Northern US could be drier. This may result in fewer Atlantic hurricanes while the eastern Pacific Rim may endure more tropical storm conditions (Liu et al., 2023; Xu et al., 2026). What is expected currently, though, is a Super El Niño.

A super El Niño occurs when there is an increase of 2.00˚C in the south-central Pacific waters (Noll, 2026; Yoon, Park, & Cheoun, 2025). This year's El Niño could exhibit a rise of 3.00˚C thereby driving extreme global conditions (Noll, 2026). Recent El Niño conditions occurred in 1982-1983, 1997-1998, and 2015-2016 and resulted in extreme climate changes, contributing to trillions of dollars of economic losses and regression in life-expectancy improvements (Callahan & Mankin, 2023; Liu et al., 2023; Xu et al., 2026). All the operational criteria for a super El Nino can be found elsewhere, including ocean thresholds, atmospheric coupling, and multi-year ENSO oscillations (Hameed, Jin, & Thilakan, 2018; Li, Yu, Ding, Xu, Ji, & Wen, 2025). It is estimated that in 1877 nearly 50 million people perished because of that year's El Niño (here there is a historical association without a firm attributable causation) (Aceituno et al., 2009; Zhang & Liu, 2012). While it is true that monitoring and detection capabilities for changing climate conditions and events are much more effective today compared to 150 years ago, and that there are certainly better scientific, economic, and social resources than in 1877, we still may face prospects of famine if deliberate actions/interventions are not planned. A Super El Niño, which is a distinct possibility this year, could exacerbate the existing disparities in living conditions, affecting the planet's poorest populations the most, and especially so in view of the additional losses of essential products that cannot transit the Strait of Hormuz.

While commentary on the current conflict's blunting of the global economy has

been considerable, certain important points need to be mentioned about its unique nature in the context of other contemporary wars. For example, the conflagration in the Gulf of Hormuz differs from the Russo-Ukrainian conflict in that in 2022 certain critical Russian products (e.g., wheat and other agricultural items) could be easily directed through alternate routes of commerce. With the Strait of Hormuz closed, or at least a substantial curtailment of ship movements, there is no alternate route for sea-locked vessels. Additionally shipping insurance has been effectively cancelled by major protection and indemnity associations (Arita et al., 2026; Hinz et al., 2026). Because the added threat of the Super El Niño is beyond human control at this time (Ji et al., 2025), the superimposition of the anticipated climate-related effects onto the dramatic disruptions secondary to fertilizer and energy product supply from the Middle East can result in truly catastrophic conditions, up to and including famine. Additional effects of a "negative feedback loop" involving declining biodiversity and the abandonment of carbon-neutral energy approaches may further exacerbate the magnitude of the overall impact of the mutually augmenting human- and climate-driven adversities (Ji et al., 2025; Miao & Nduneseokwu, 2025).

The cumulative and combined impacts of economic turmoil, critical energy and fertilizer supply shocks, and a coincidental climate mega-event may likely be very challenging to control and equally difficult to navigate. Within the realm of downstream consequences, while it is less likely that immediate starvation and deaths will occur, it is more probable that the long-term effects of existing improvements in population well-being and life expectancy will be curtailed (Xu et al., 2026). Food supply chains are complicated and vulnerable. The development of two significant events coinciding, the Strait of Hormuz closure and an impending El Niño, will have an effect on small farmers and export-oriented economies in our globalized food-chain. The input of seeds, chemicals and fertilizers will affect cultivation, animal husbandry and harvests with concomitant problems with storage, transport, and problems with retail availability (Xue, Yan, Mohsin, & Mehak, 2025).

As mentioned above, experts believe that there will be less mortality improvement than normally expected over time in high income Pacific Rim countries, but also among lower income countries across the rest of the globe (Callahan & Mankin, 2023; Liu et al., 2023; Xu et al., 2026). Estimated losses in improved life expectancy and the economy for the El Niño of the 80s and 90s were as follows:

> "0.5 years (monetary equivalent loss of US$2.6 trillion) for the 1982-1983 El Niño and 0.4 years (US$4.7 trillion) for the 1997-1998 event. Climate projections under moderate emissions pathways suggest a cumulative decline of 2.8 years of life expectancy by 2100, amounting to US$35 trillion losses, with most of the monetary burden falling on the middle aged population (Xu et al., 2026)."

It is important to realize that a severe combined economic-climatic event will

affect the very young and the elderly promptly (e.g., within months). However, the working population will have to work through heatwaves and increased pollution. Consequently, the Super El Niño effects may persist for some time into the future through the generation of "lag effects" which may span over a period as long as 10 to 15 years beyond the index event (Armstrong et al., 2017; Gasparrini et al., 2015; Young & Hsiang, 2024). This translates into loss of income and productivity through ill health and the inability to pay taxes; making governments also feel the pressure. Of further concern, although not fully explored or known at this time, is the likelihood that any future El Niño or Super El Niño events may have additive or compounding effects on the overall population health and economic viability.

Looking at the historical record, the 1877 Super El Niño was estimated to be the strongest one on record, although this is disputed by some (Kiladis & Diaz, 1986). Sources claim that it contributed to tens of millions attributable deaths (Ormaza-González et al., 2025). What is to be said about a temperature surge in 2026 of the same or greater magnitude in the face of the current Strait of Hurmuz conflict? What can be done to ensure food security? First and foremost, the current geopolitical disagreement must come to a peaceful, preferably negotiated resolution. But even if the conflict were to end today, the ripple effect(s) of the supply chain disruption will persist for an extended time.

In the face of a conflict with truly global reverberations and a pronounced weather event that could have repercussions for a large segment of the earth's population over the next decade, nations will need to have: (1) shorter and more manageable supply chains, (2) encourage collaboration between governments and private entities, (3) provide crop insurance to small farmers, (4) provide microcredits for small farmers and small businesses, (5) innovative positioning of agricultural supplies, (6) alternate trade routes with different or creative modes of transportation, (7) redundant undersea cables to protect economic digital technology from sabotage, (8) incorporation of block chain technology, (9) investment in resilient seeds and soil additives, and (10) make sure digital technologies are available to the farming industry and small businesses of low-income countries (Chandan, John, & Potdar, 2023; Marzęda-Młynarska & Kięczkowska, 2026; Rowan, 2023; Soria-Lopez et al., 2023; Sumardi & Haris, 2024; Xue et al., 2025).

In conclusion, the current geopolitical concerns, combined with a once-in-a-generation global weather event, may contribute to serious social, economic, health, and other yet-unknown adverse consequences around the planet. Humanity should re-evaluate the current systems responsible for planning and mitigation of massive, planetary-level events, with specific recommendations for general approach strategies proposed herein.

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Conceptualization, TJP; investigation, TJP, SPS; validation, TJP, SPS; writing original draft preparation, TJP; writing review and editing, TJP, SPS. All authors have read and agree to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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