Spatial studies on environmental correlates of child malnutrition: examples from Guatemala, Burkina Faso, and Kenya

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Global maps of child malnutrition highlight countries where the malnutrition prevalence exceeds a threshold or average. Countries like Niger, Yemen, Somalia, Afghanistan and Guatemala often stand out as compared to their neighbors, because they report significantly higher levels of malnutrition. These global maps confirm what we know, when children reside in extremely poor countries, dependent on small-scale farming and (often) with a history of government oppression, their access to adequate amounts of nutritious food is limited so severely that they do not achieve expected growth standards. While informative on one scale, global-level maps conceal the malnutrition rates within countries. Scholars and policy makers with an eye towards spatial studies of child malnutrition, understand that child malnutrition is highly spatially variable within a country, not just between countries.

For example, malnutrition has been persistently high in Guatemala for decades and in global or regional maps Guatemala stands out from neighboring Central American countries. However, when considering malnutrition *within* Guatemala, spatial patterns are revealed. Pockets of high malnutrition exist in a band across the highlands through the middle of the country (see Figure 1) while in the capital and its environs, malnutrition rates look more similar to those in nearby capital cities. Burkina Faso and Kenya provide similar examples, from a country-level malnutrition rates appear to actually be less high than other countries in West and East Africa (respectively). When evaluating malnutrition within each country, however, areas with extremely high malnutrition appear.

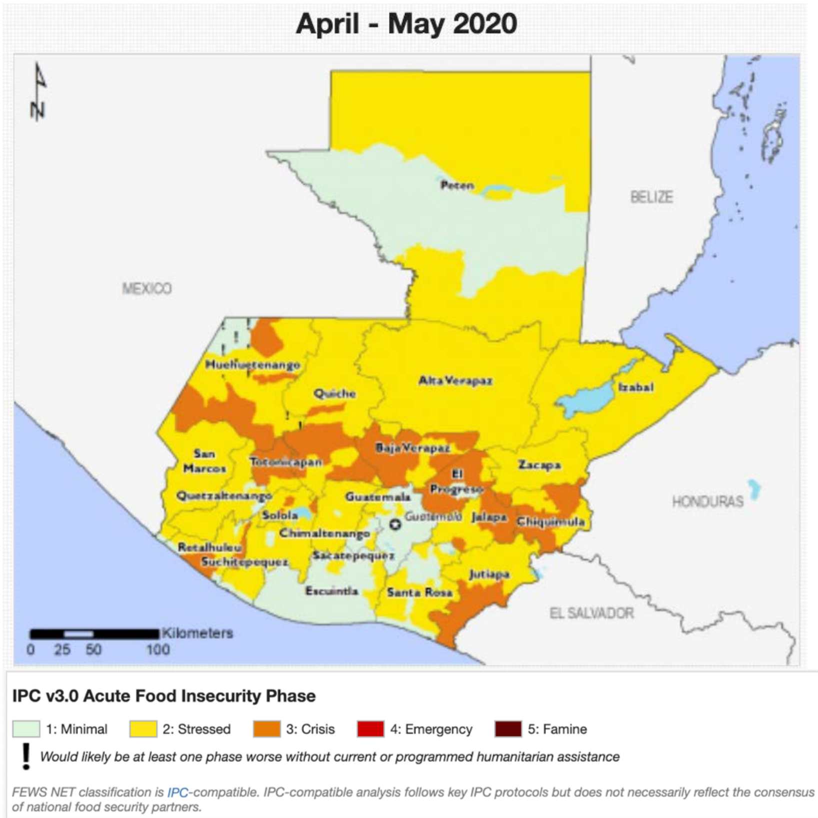
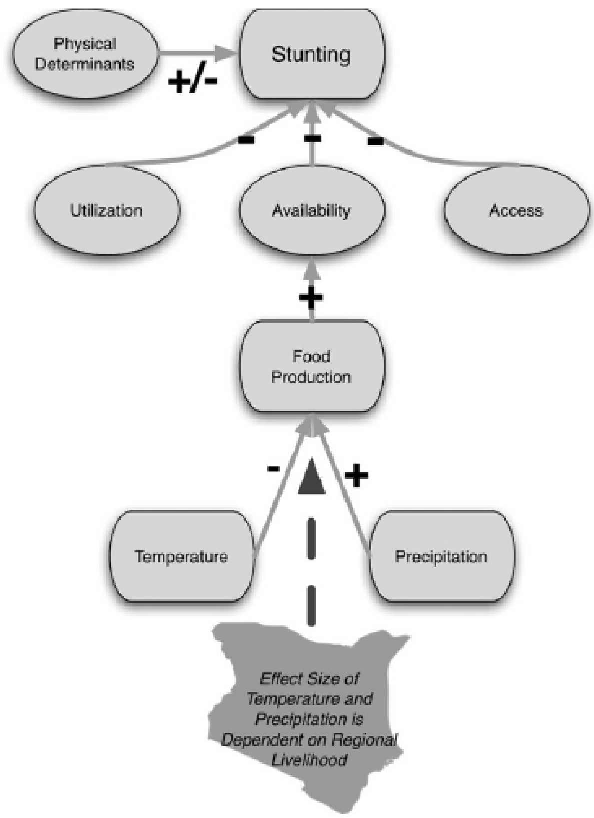


Figure 1. FEWS NET estimates of food insecurity in Guatemala in April-May 2020, on the IPC scale.

Food security is best described using four pillars – access, availability, utilization, and stability (see Figure 2). Access refers to the ability to buy food or inputs to produce food, availability captures the presence of food (at a local market or store, or the land/inputs to grow food), utilization is the body's ability to process nutrients but can also include the knowledge/experience with preparing/storing a particular food. Figure 2 highlights the linkage between these factors and food insecurity outcomes like chronic stunting, highlighting the roll of climate and local context. The final pillar, stability, is not explicitly captured in the graphic but indicates the seasonality of food security – if there are annual periods when a household, for example, does not have sufficient food access or availability then the household is said to be food insecure. If, at any point, any of there is a failure in the food system and any of these pillars is not sufficient, then an individual, household, or community is said to be food insecure.



(source: Grace et al. 2012)

Figure 2: Conceptual diagram connecting food insecurity outcomes and local conditions

Like most of the poorest countries in the world, each of these example countries, **Guatemala, Burkina Faso, and Kenya**, has an economic and food system that is heavily dependent on small scale agriculture. In general, a small-scale farming household's livelihood is heavily dependent on seasonally and annually varying weather conditions (rainfall and temperature). Household labor and agricultural inputs (like fertilizer, or drought resistant seeds) can sometimes be used to buffer against poor growing season weather conditions. In many cases, however, a poor season results in lower income and household food shortages, food insecurity and, ultimately, leads to child malnutrition. In addition to the impact of climate conditions on a household's food security, drought, flooding, heat waves, and disease, are also associated with child malnutrition through indirect pathways. Many of these climate/weather events are often experienced at a relatively local level. This means that a poor growing season or a series of heat waves in one area may have a relatively small geographic footprint, indicating that these conditions will likely not be captured in aggregate-level analysis. Put simply, to best understand childhood malnutrition – scholars must consider the spatial and temporal variation of childhood malnutrition and how this variation corresponds to environmental and climate variation.

In Grace et al. 2014 and Brown et al. 2015, we examined the relationship between maize prices, rainfall deficits and low birthweight as an indicator of household food insecurity in **Kenya**. By combining data from demographic and health surveys, maize prices, livelihood classifications and a vegetation index data that captures the growing season productivity, we sought to show how and whether local maize prices, an indicator of food accessibility, was linked to food insecurity. We showed that spatially explicit information on the quality of the growing season from satellite data of vegetation help to distinguish between those households that are dependent on the market for food versus those households that rely on very local household or community-level production. Implying that price may act as a barrier to food for only those families without access to locally produced food (maize, in this case). Because our nested model approach accounted for variations in livelihood zone, we were able to show that regardless of where the household is located, when the remotely sensed vegetation signal increases then nutrition seems to be better – and this is especially the case in the presence of low prices. The research suggests that when food prices change we may see negative impacts on the very youngest members of a population if there are also constraints to production at a local level. Additionally, our results suggest that increases in the cost of maize do not happen in isolation – people may adjust their selling behavior, purchasing habits or rely on other networks (social networks, international and domestic aid support) to meet their food needs.

In Grace et al 2017, we examined how access to clean water affected child health in **Burkina Faso**. Spatially differentiated access to clean water can affect the health of children after they are weaned from their mother, since contaminated water may cause diarrheal disease that affects a child’s nutritional status. While the cross-sectional data from the Demographic and Health Survey data cannot distinguish the causal effects relating to inadequate food and unclean water, we can use the data to investigate the role of potential factors. Evaluating the relationship between food, water, and children′s health outcomes is necessary to determine the reasons for, and the potential solutions to, chronic malnutrition in this context. We found that the source of a household′s water seemed to have a limited relationship to the height and weight outcomes of children. The models indicated that, in some cases, when children live in households that source their water from shallow wells (protected or unprotected) or from surface sources, the children have less healthy growth outcomes. The heights and weights of the very youngest children, those 6 months of age and younger, were positively related to community-level food production. This spatial specificity is critical to get these kinds of relationships. Improved information about water sources, particularly if the information can be obtained from within the household instead of from the community would improve the study significantly.

In **Guatemala**, food insecurity is concentrated spatially as seen in Figure 1. Using micro-level household nutrition data, Sweeney et al. 2012 highlight that this spatial concentration of chronic food insecurity partially reflects ethnic divisions in Guatemala. These ethnic divisions which resulted in violence against the large Maya population during the extended civil war of the last half of the 20th century, have impacted land use practices as well as resulted in significant health, education, and economic barriers for Maya households and communities. Considering general trends in education and socio-economic status are not sufficient for capturing the observed concentration of chronic and persistent food insecurity as seen in the middle of Guatemala.

Communities and countries cannot achieve sustainable economic growth and meet developmental targets without attending to food insecurity. Acute and chronic food insecurity have dramatic impacts on short- and long-term health and development exhausting financial resources and taxing individuals physically and psychologically. Ongoing health and policy investment focused on reducing food insecurity is a vital component of all developing and developed societies. Micro-level research that allows us to consider the individual in context is essential for understanding and quantifying food insecurity. Traditional cross-sectional survey data, like those used in these analyses have been useful but much more detail is required to reduce the global burden of malnutrition. Going forward and in all settings, we need to have a socioeconomic baseline derived from current data collection approaches which include complementary high-frequency community-based assessments. More frequent engagements, potentially via mobile devices, would require a re-thinking of how to collaborate with rural communities, so that individuals remain engaged in reporting, even when there is little to report. An additional advantage of community-based self-reporting is that mobile devices can be used to submit and receive data to inform decision-making at the local, regional, and national level. Information about where to get income assistance, health care, education programs, and agricultural support could also be provided via the same mechanism.

Citations

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