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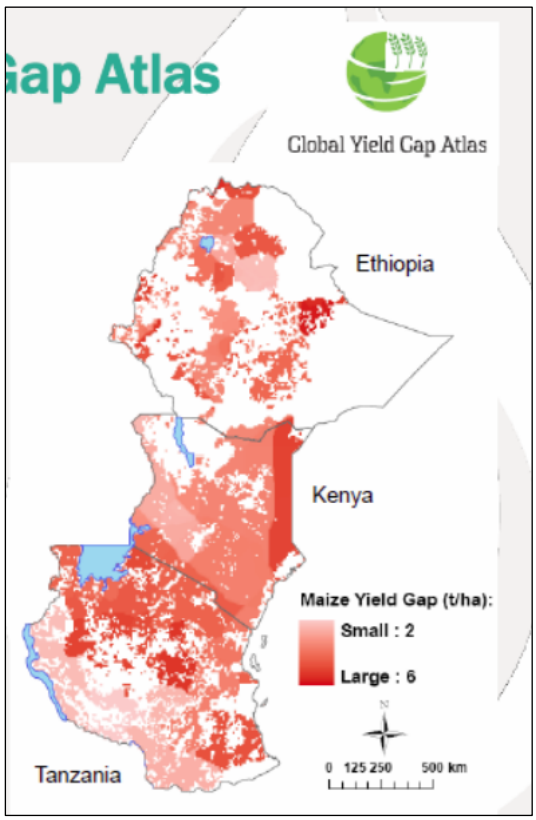
Closing Water and Agricultural Productivity Gaps

The Robert B. Daugherty Water for Food Global Institute builds on the pioneering work of the Global Yield Gap and Water Productivity Atlas, as well as the University's expertise in plant breeding and biotechnology development, to reduce productivity gaps in crop and livestock systems.

What if farmers could obtain data calculating the potential of their fields, so they would know exactly how to increase yield? What if governments could identify producers who were making the biggest strides in crop production—and then arrange to have them teach others their methods and close the gap? If these what-ifs were reality, some of the most arid regions of the world might make substantial progress optimizing their use of water to produce food.

These what-ifs are becoming a reality, thanks to production of a new satellite-based geospatial mapping tool using cutting-edge technology developed at the University of Nebraska and funded by the Food and Agriculture Organization of the United Nations (FAO). The tool measures evapotranspiration, the movement of moisture from the earth's surface to the atmosphere through combined evaporation and plant transpiration. The tool is used to assess the need for irrigation and calculate potential and attainable yield of crops at three levels: farm, climate zone and country.



This tool is being activated right now by the Water for Food Global Institute and others in one of the world's most tenuous water and food security regions: the Middle East and North Africa (MENA). In a five-year project that began in 2015, the evapotranspiration products are being produced and served through the FAO's collaborative network in the region, with the involvement of government institutions and regional/local water and agricultural agencies to deploy the products on the ground.

The same tool is being used to monitor drought in the MENA region and provide an early warning system that will help farmers and governments make effective decisions, including determining where agriculture production can be intensified without risk to water resources.

The complex challenges of this project range from gaining field access and training farmers to extensive capacity building with local organizations and overcoming political and social issues. The ultimate goal is to create a continually-available data system used by all countries of the world to improve water and crop management and provide better water and food security well into the future.

In 2015, WFI and FAO published a joint global yield gap analysis report reviewing methods for analysis and clarifying definitions and techniques to measure and model potential yield using biomass production and the FAO's harvest index. In FY2016, the contract was signed and a very successful kickoff meeting was held in Cairo, Egypt, with participants from all countries in the region. The project began in earnest last January.

After the grant money was received, WFI contracted with the University of Maryland to generate satellite-based estimates of daily evapotranspiration. It is expected to go public the first part of 2017, with the ALEXI water and energy budget model running on the UNL Holland supercomputing center.

The next steps for fiscal year 2017 are ground truthing in MENA fields and verification of the evapotranspiration product, satellite downscaling for remote sensing in selected agricultural regions, and then estimation of water productivity in the first selected regions: Morocco, Tunisia, Lebanon, Jordan and Egypt.

The MENA three-year drought monitoring and early warning project that began in FY2015, funded by the United States Agency for International Development (USAID), will result in a composite drought index, management policy and drought monitoring workshop. In March 2016, the science working group for the project's water productivity sub-tasks met at WFI offices in Nebraska to discuss methodology and use of the evapotranspiration product. WFI and the National Drought Mitigation Center at UNL also are co-leading a $4 million, one-year drought monitoring project with the Dubai-based International Center for Biosaline Agriculture (ICBA).

A central tool of all of these initiatives is the graphically intuitive Global Yield Gap and Water Productivity Atlas (GYGA), which is being developed by an international team, led by the University of Nebraska in the United States and Wageningen University in The Netherlands, and funded by USAID. A science meeting was held with all partners at WFI in March 2016 and a goal was established to work toward adding 20 more countries to the 30 already incorporated into the atlas.

Currently, the atlas focuses on estimating crop yield gap for eight crops at field, regional and national scales, ranging from subsistence crops in sub-Saharan Africa to high-yield irrigated corn in the United States. So far, GYGA has been a big hit, with more than a million visitors reviewing the public data on the website (www.yieldgap.org). The atlas is used not only by researchers, but by crop consultants and commercial crop producers who want to benchmark themselves against the data-backed yield gaps in their regions.

> *"Our aspiration is to have complete global coverage of all global farmland. To feed billions in the future, we need to have not only the knowledge, but also the know-how."*
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> --Kenneth G. Cassman, GYGA Project Leader

MENA isn't the only region where there is a critical need to close the gap between water and agricultural productivity, overcome drought and prepare for the world's population explosion. Last year, WFI and the University of Nebraska continued work under a 2013 Memorandum of Understanding (MOU) with the Indian Council of Agricultural Research to collaborate with one of its four institutes to create solutions for Indian agriculture and natural resources management.

Our partnership with the India Agricultural Research Institute (ARI) is an excellent example of expanding the reach of WFI through strategic partnerships with the ultimate goal of producing true impact on the ground. India is a perfect place to study and test our ideas and methodologies, because it has both a very large population and many challenges in the supply, management and use of water to produce food. In addition, India is one of the University of Nebraska's selected key partners for global engagement on many fronts, including agriculture, early childhood and public health—all areas affected by water and food security.

Last year, The United States-India Educational Foundation in Delhi approved WFI's proposal to the Indo-U.S. 21st Century Knowledge Initiative competition to support the first initiatives of the partnership: an agricultural drought monitoring and early warning system, satellite-based evapotranspiration estimates, and water-conserving sensor-operated irrigation systems. The grant will help advance the MOU, as well as WFI collaborative programs in India as a whole.

So, how will we know we are making the progress we hope to make with all of this gap-closing activity? WFI is in process of producing what we hope is the first of many annual water productivity reports focusing on this question. The Global Water Productivity Report will define and test methodologies to determine gaps between actual and attainable water and energy productivity in both crop and livestock production.

The report will begin with a pilot demonstration of the methodologies and indicators for Nebraska farm, watershed and state scales, identifying the best management options associated with the maximum attainable water productivity level. Post-doctoral researchers have been hired and are establishing details of the method to be used for water productivity assessment. Once the methodologies and results are vetted within the Nebraska pilot, lessons learned will be used to develop global water productivity indicators and offer the benefits of gap analysis to the rest of the world.