The Global Yield Gap Atlas Extrapolation Domain (GYGA-ED)

The goal of the Global Yield Gap Atlas (GYGA) project is to estimate the yield gap for major food crops in all crop-producing countries based on locally observed data. Unlike past efforts to estimate Yg that rely on gridded weather data as described above, GYGA seeks to use a "bottom-up" approach with location-specific observed weather data. To extrapolate results from location-specific observed data to larger spatial areas, the GYGA approach utilizes a hybrid zonation scheme, called the GYGA Extrapolation Domain (GYGA-ED). GYGA-ED is constructed from three categorical variables:

1. growing degree days (GDD)
2. temperature seasonality
3. an annual aridity index (AI)

Grid cell size for the underpinning weather data was 5' grid (roughly 100 km^2 at the equator).

The GDD were calculated as in Licker *et al.* (2010) with:

$$\mathrm{GDD} = \sum_{i=1}^{365} \max(0, T_i - T_b)$$

in which T_i is the temperature (°C) for each time step and is T_b the base temperature (0 °C for our calculations). Licker *et al.* (2010) used mean monthly temperatures for the period 1961-1990 from the CRU CL v. 2.0 dataset at 10' grid (http://www.cru.uea.ac.uk/cru/data/hrg/tmc/, (New *et al.*, 2002)) and downscaled it to a 5' grid.

Temperature seasonality was taken from WorldClim (http://www.worldclim.org/current , data for current conditions (~1950-2000), Bioclim4 at 5' grid, (Hijmans *et al.*, 2005)), calculated as the standard deviation of the 12 mean monthly temperatures × 100. Please note that the mean monthly temperatures are in °C × 10.

The annual aridity index values were taken from CGIAR-CSI (http://www.cgiar-csi.org/data/global-aridity-and-pet-database, at 30'' grid, (Trabucco *et al.*, 2008; Zomer *et al.*, 2008)), calculated as:

$$\mathrm{AI} = \frac{\mathrm{MAP}}{\mathrm{MAE}}$$

in which MAP is the mean annual precipitation (mm × 100) and MAP the mean annual potential evapotranspiration (mm × 100). We aggregated these AI values to a 5' grid.

Following Mueller *et al.* (2012), only terrestrial surface covered by at least one of the major food crops (maize, rice, wheat, sorghum, millet, barley, soybean, cassava, potato, yam, sweet potato, banana and plantain, groundnut, common bean and other pulses, sugar beets, sugarcane) was considered in this zonation scheme. To avoid inclusion of areas with negligible crop production, only grid cells with sum of the harvested area of major food crops > 0.5% of the grid cell area were accounted for, based on HarvestChoice SPAM crop distribution maps (You *et al.*, 2006; You *et al.*, 2009), which update geospatial crop distribution data of Monfreda *et al.* (2008).

The resulting range in values for GDD and aridity index were divided into 10 intervals, each with 10% of grid cells with harvested area of the major food crops, and combined in a grid matrix with 3 ranges of temperature seasonality to give a total of 300 classes. Of these, only 265 occur in regions where major food crops are grown.

This resulted in the following ranges:

GDD (°Cd)	GYGA ED Value
0 - 2670	1000
2671 - 3169	2000
3170 - 3791	3000
3792 - 4829	4000
4830 - 5949	5000
5950 - 7111	6000
7112 - 8564	7000
8565 - 9311	8000
9312 - 9850	9000
>= 9851	10000

AI (-)	GYGA ED Value
0 - 2695	0
2696 - 3893	100
3894 - 4791	200
4792 - 5689	300
5690 - 6588	400
6589 - 7785	500
7786 - 8685	600
8686 - 10181	700
10182 - 12876	800
>= 12877	900

Temperature seasonality	GYGA ED Value
0 - 3832	1
3833 - 8355	2
>= 8356	3

The value for each cell indicates the climatic characteristics for that cell. The value is constructed by the sum of the GYGA ED Value of the three variables. A few examples:

- value = 1001 = GYGA ED Value GDD 1000 +
  GYGA ED Value AI 0 +
  GYGA ED Value Temperature seasonality 1
- value = 6801 = GYGA ED Value GDD 6000 +
  GYGA ED Value AI 800 +
  GYGA ED Value Temperature seasonality 1
- value = 10402 = GYGA ED Value GDD 10000 +
  GYGA ED Value AI 400 +
  GYGA ED Value Temperature seasonality 2

Citation: Van Wart, J., van Bussel, L.G.J., Wolf, J., Licker, R., Grassini, P., Nelson, A., Boogaard, H., Gerber, J., Mueller, N.D., Claessens, L., van Ittersum, M.K., Cassman, K.G., 2013. Use of agro-climatic zones to upscale simulated crop yield potential. Field Crop Res. 143, 44-55.

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