Rule set used to define global agroecological zones (GAEZ) – 2009

Major Climate Divisions:

Temperature zones are one of the governing factors in the selection of what crops can be cultivated in what areas. The major climate divisions, as defined for the Global Agroecological Zones (GAEZ) project (FAO/IIASA 2002), represent major latitudinal thermal (or temperature) shifts and are defined as follows:

Tropics:mean monthly temperature adjusted to sea-level[1] greater than 18^{o} C for ALL months

Sub-tropics: mean monthly temperature adjusted to sea-level less than 18^{o} C for 1 or more months

Temperate:mean monthly temperature adjusted to sea-level less than 5^{o} C for 1 or more months

Boreal: mean monthly temperature adjusted to sea level less than 5^{o} C for all months

In creating the revised AEZ surface for Africa, we used monthly average minimum and maximum temperature data at a resolution of 0.00833dd (approximately 1x1km) from WorldClim (2009) and SRTM30 elevation data also at a resolution of 0.00833dd (USGS 2007). Mean monthly temperature adjusted to sea level was calculated for each cell as follows:

Tmn_*m* = (tmin_*m* + tmax_*m*) / 2
Tmnsl_*m*gl = tmn_*m* + (0.55 * elevation / 100)
where m represents individual months

The monthly data were then analyzed and the climate regions identified according to the above definitions. In the database the climate zone classes are:
0 = boreal / 1 = tropical / 2 = subtropical / 3 = temperate

Warm/Cool distinction:

The climate zones are further divided based on temperature during the growing season as follows:

Moisture zones

Moisture zones are identified using the *length of growing period (LGP)* concept which identifies the time with both moisture and temperature are conducive to crop growth. Length of growing period is defined as the period during the year when average temperatures are greater than or equal to 5^{o}C (Tmean >=5^{o} C) and precipitation plus

[1] Temperature was adjusted to sea level using a normal lapse rate of 0.55^{o} C per every 100meters of elevation change. This was done in order to obtain unfragmented geographical areas.

moisture stored in the soil exceed half the potential evapotranspiration (P>0.5PET). A normal growing period is defined as one when there is an excess of precipitation over pet (i.e. a humid period). Such a period meets the full evapotransiration demands of crops and replenishes the moisture definite of the soil profile. An intermediate growing period is defined as one in which precipitation does not normally exceed PET but does for part of the year. No growing period is when temperatures are not conducive to crop growth or P never exceeds PET (FAO 1978).

Determining LGP is a difficult process that requires extensive calculations based on precipitation, evapotranspiration and soil moisture holding capacity. It also requires an understanding of the moisture requirements of specific crops since the growing period for many extends beyond the rainy season. Coarse resolution LGP data is available as part of IIASA/FAO's initial GAEZ project (IIASA/FAO 2001). For this project the moisture zones were defined using LGP data at a resolution of 0.08333dd (approximately 10x10km) (Fischer 2009). *This length of growing period data was provided via personal communication from IIASA (Fischer 2009) and is not yet available for distribution.*

The specific moisture zone classes are:

Arid: less than 70 days length of growing period (LGP)
Semi-arid: 70-180 days LGP
Sub-humid: 180-270 days LGP
Humid: >270 days LGP

Highland / Lowland (i.e. Cool / Warm)
The major climate and thermal zones provide a broad understanding of the agroecologies of Africa but it is equally as important to take into account the effect that changes in elevation have on crops. Certain plants thrive in cooler climates and could possibly be adapted to the highland regions of the tropics but for the most part higher altitudes produce adverse conditions that can restrict agriculture.

For IIASA/FAO's GAEZ project this distinction is made using temperatures during the growing season. This cool/warm distinction requires using daily mean temperature data in conjunction with the start and end dates of the growing season for each cell. Since these data were not available at a resolution of 0.00833dd we used elevation data, or highland/lowland as a proxy measure of the cool/warm zones.

The SRTM30 elevation data was first classified into 3 zones as follows:

1: -50 – 800m
2: 800 – 1200m
3: >1200m

Different cutoff values were used for the tropics and subtropics since it takes a greater elevation change for the temperature in the tropics to drop into what is considered a cool zone. For the tropics, areas with greater than 1,200m elevation were classified as cool; for the subtropics areas with greater than 800m elevation were classified as cool.

The cool/warm assigned classes are:
0 = Cold/Boreal (*not applicable for Africa)*

1 = Cool (highland)
2 = Warm (lowland)

Each cell was classified as cool or warm using the following criteria:

Climate	Elevation	Cool/Warm
0	1-3	0
1	3	1
1	<3	2
2	>=2	1
2	1	2
3	1-3	1

Final AEZ classification:
The major climates, moisture zones and warm/cool surfaces were combined together and each cell was classified into Agroecological Zones classes using the following three digit combinations:

Climate	Temperature/ elevation	Humidity
Temperate : 1	Warm/Lowland : 1	Arid : 1
Subtropic : 2	Cool/Highland : 2	Semiarid: 2
Tropic: 3	No distinction: 0	Subhumid : 3
Boreal : 4		Humid : 4

The final classes are:

101 Temperate / arid
102 Temperate / Semi-arid
103 Temperate / sub-humid
104 Temperate / humid
211 Subtropic - warm / arid
212 Subtropic - warm / semiarid
213 Subtropic - warm / subhumid
214 Subtropic - warm / humid
221 Subtropic - cool / arid
222 Subtropic - cool / semiarid
223 Subtropic - cool / subhumid
224 Subtropic - cool / humid
311 Tropic - warm / arid
312 Tropic - warm / semiarid
313 Tropic - warm / subhumid
314 Tropic - warm / humid
321 Tropic - cool / arid
322 Tropic - cool / semiarid
323 Tropic - cool / subhumid
324 Tropic - cool / humid
400 Boreal

Sources:

FAO. 1978. Report on Agro-Ecological Zones Project. Vol 1. Methodology and Results for Africa. World Soil Resources Report #48. FAO: Rome.

Fischer, G., H. van Velthuizen, M. Shah, F. Nachtergaele. 2002. *Global Agro-ecological Assessment for Agriculture in the 21st Century: Methodology and Results.* IIASA: Austria & FAO: Rome.

Fischer, G. 2009. *Length of Growing Period Data.* Personal communication. Data not available for distribution.

USGS. 2007. SRTM30 Elevation data. http://eros.usgs.gov/products/elevation/.

WorldClim climate and elevation data downloaded from web. January, 2009. http://www.worldclim.org/current.htm.