Annex 7

Use of Geo-Spatial information

Remote Sensing (RS) data and Geographic Information System (GIS) products are increasingly available at affordable prices. They can provide baseline information (e.g. land cover, distribution of population density, mean annual rainfall) and up-to-date data on key environmental and man-made factors (e.g. current rainfall, urban expansion), and inform forecasts of rainfall and crop yields. Multi-temporal analysis of RS/GIS data is a particularly useful tool to detect anomalies from "normal situations" and evaluate degrees of deviations and/or duration of the anomalies for early warning purposes. Various indicators are regularly used to assess rainfall/vegetation conditions and to estimate impacts on agriculture and livestock. New techniques to derive crop area estimates from medium and high resolution sensors are constantly coming into use.

Satellite Remote Sensing

Satellite data are mainly used for the following purposes:

1. Monitor the state of vegetation in cultivated and rangeland areas;
2. Monitor the rainy season and identify areas which are likely to have suffered from, or might be affected by, drought or excessive rainfall;
3. Estimate yields for major crops; *and*
4. Estimate the extent of cultivated land.

Two sources of satellite data are regularly received and used for the CFSAM:

- Interpolated Estimated Rainfall (IER) images distributed by FAO/ARTEMIS and based on the Decadal Rainfall Estimates generated by the Climate Prediction Centre (CPC) of the National Oceanic and Atmospheric Administration (NOAA), Washington D.C., USA. This data is only available for Africa, its spatial resolution (pixel size) is 4.5-5 Km.
- Global Normalized Difference Vegetation Index (NDVI) images from the SPOT Vegetation Programme (product VGT S10). These images provide 10-day synthesis, based on the selection of the "best" measurement of the entire period. The VEGETATION Programme is developed jointly by France, the European Commission, Belgium, Italy and Sweden. It delivers satellite-based products tailored to monitor land surfaces' parameters with a frequency of about once a day on a global basis and a medium spatial resolution of one kilometer.

IER and NDVI images are received every 10 days and processed by the GIEWS Workstation team for deriving the following products by country:

- Estimated Rainfall (IER)
- Monthly Cumulated Rainfall (CR): Cumulated IER by 1 to 12 months

- Difference of the Cumulated Rainfall with long term average by 1 to 12 months: difference between the considered CR and the long term average of the same time interval (e.g. if CR is 2 months from 2nd dekad of March to the 1st dekad of May, the average will be calculated using all CRs of the same time interval for all available years)
- Standardized Precipitation Index (SPI) by 1 to 12 months: It is a relatively new drought index based only on precipitation and can be used to monitor conditions at different time scales. The temporal flexibility makes SPI useful for both short-term agricultural and long-term hydrological/agricultural applications. The SPI is an index based on the probability of precipitation for any time scale. Each time scale reflects the impact of drought on the availability of the different water resources. Soil moisture conditions respond to precipitation anomalies on a relatively short scale. Groundwater, streamflow, and reservoir storage reflect the longer-term precipitation anomalies. The SPI calculation for any location is based on the long-term precipitation record for a desired period. This long-term record is fitted to a probability distribution, which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero. Positive SPI values indicate greater than median precipitation, and negative values indicate less than median precipitation. Because the SPI is normalized, wetter and drier climates can be represented in the same way, and wet periods can also be monitored using the SPI.
- Normalized Difference Vegetation Index (NDVI): It is based on the principle that live green plants absorb solar radiation in the photosynthetically active radiation (PAR) spectral region. Leaf cells also scatter (i.e., reflect and transmit) solar radiation in the near-infrared spectral region. The NDVI is calculated as follows: NDVI = (NIR - RED) / (NIR + RED) where RED and NIR stand for the spectral reflectance measurements acquired in the red and near-infrared regions, respectively. By design, the NDVI itself varies between -1 and +1. The NDVI of an area containing a dense vegetation canopy will tend to positive values. Free standing water (e.g., oceans, seas, lakes and rivers), which have a low reflectance in both spectral bands (at least away from shores), result in very low positive or even slightly negative NDVI values. Soils, which generally exhibit a near-infrared spectral reflectance somewhat larger than the red, tend to generate rather small positive NDVI values.
- Difference NDVI with the previous dekad: it shows how the season is evolving indicating whether the vegetation is in good health or it is subject to stress
- Difference NDVI with the previous year: it compares the current vegetation state in respect to the situation of the same dekad of the previous year.
- Difference NDVI with the long term average: the long term average is taken as baseline information representing the “normal” situation. The difference highlights positive or negative anomalies that can impact on crop yield at harvest time.

The following products are being tested:

- Crop area estimates: GIEWS, in coordination with the European Space Agency is testing a new methodology to detect agricultural areas from images captured by radar and optical sensors at high and medium resolution (ASAR, MODIS, Landsat, SPOT). This technique uses multi-temporal images to identify vegetation activities which correspond to the growing of the seasonal crops. Baseline information such as land cover, crop calendar and information on local agricultural practices are used to fine-tune the model and focus on cropping seasons.

- Rainfall estimation for Asia and Central and South America: alternative data sources, ranging from satellite to ground station data are currently being used to generate decadal rainfall maps for regions not covered by METEOSAT.

GIS data

GIS data representing topography, roads, hydrology, built-up areas, etc. are important baseline information. Spatial characteristics have often an impact on the environment and/or agricultural/social/economic activities. Basic sets of these data are available in the GIEWS Workstation and are used for mapping purposes before and after the CFSAM.

The availability of geographic layers representing crop zones is of primary importance for the CFSAM. At the moment, generic crop maps, which can be overlaid on the satellite images and other GIS layers, are available in the GIEWS Workstation. However, action is being taken to update these maps using satellite-based products.

The use of GPS by CFSAM teams is outlined in section 3.9 of the guidelines.

Other spatially-related products

Spatial information is also used to derive products such as tables and charts describing temporal variations of certain parameters. IER multi-temporal images, for example, are regularly processed to calculate rainfall averages by administrative units at first and second levels (e.g. provinces and districts). In this process, all pixels of a satellite image falling within an administrative unit are averaged and stored in a database. The availability of this information for a sufficient number of years allows users to chart those values in many different ways, compare different time periods and/or areas or plot data against the average. This provides good indications about the evolution of the rainy season and possible implications on agriculture.