Geophysical Research Abstracts
Vol. 13, EGU2011-13018, 2011
EGU General Assembly 2011

Intensity-duration-frequency curve for the agricultural drought

Francesca Todisco, Francesco Mannocchi, and Lorenzo Vergni
University of Perugia, Department of Civil and Environmental Engineering, Perugia, Italy (todisco@unipg.it)

The agricultural drought economic risk assessment model (ADERA, Mannocchi et al., 2009) studies agricultural drought not only in term of deficit soil water content and its frequency and severity (as in the traditional approach) but also in terms of net benefit reduction and vulnerability. The relationship between drought index, crop yield, and crop economic net benefit is modeled and three threshold levels are considered: the critical water content; the critical impact in terms of net benefit (NBcrit); and its critical return period (i.e. frequency) above which the soil climate unit is considered unsuitable for the cultivation of a specific crop. These critical levels are used in long term action planning as the triggers for different risk classes respectively: no risk of critical impact (the crop faces water stress and the profit decreases, potential agricultural drought); high risk of critical impact with low frequency (the profit drops below the critical level, actual agricultural drought); high risk of critical impact with high frequency (agricultural aridity). To follow the impact evolution and to pinpoint the time of occurrence of the potential and actual agricultural drought, real time impact monitoring is also implemented (short term actions). The rapidity with which the critical impact is reached can be considered an important index of the crop vulnerability. ADERA requires some complex statistical calculations, and the results obtained are strictly related to the specific unit and to the economic data, in particular the production costs. These characteristics of the methodology can be problematic from an operative perspective. In order to facilitate the use of ADERA, a modified operative procedure is proposed. It is based on the definition of the intensity-duration-frequency curves for an agricultural drought index. These curves are related to a specific soil-crop-climate unit, but are independent of the economic data and for a given return period (TR), they are the relationship between the maximum value of the index and the related duration (d) i.e they give the expected critical duration (d) of the potential agricultural drought necessary to reach a defined critical impact. They are quantified following the procedure used to define the "rainfall intensity-duration-frequency curves."
Knowing the value d can be useful to define the risk of the critical impact occurring within a given period (i.e. the growing season), once the potential agricultural drought onset date (t0) has been identified in real time. The t0 is indeed a normal occurrence event within the growing season and therefore its statistics can be easily determined.
In other words, the methodology makes it possible to evaluate the intensity of the agricultural drought phenomenon and to evaluate for a given risk (return period) whether the hazard will occur within or after the growing period, and therefore to assess the level of vulnerability.
As an example, the intensity-duration-frequency curves for the agricultural drought relative severity index (RSI) have been determined for some soil-crop units and for different return periods (TR). For the extreme-value distribution used to analyze the RSIt data, reliance was placed on Normal's analysis of annual-series data. The RSIcrit corresponding to the two critical values in terms of net benefit, NBcrit=0 and NBcrit=0.5NBmax, have been considered. The crossing of the critical level RSIcrit with the generic curve gives the d and the corresponding TR. Three levels of vulnerability (low, medium and high) have been considered and expressed in terms of t0 and d as follows: the vulnerability is low if t0+d>T, where T is the duration of the growing season; the vulnerability is medium if bT<t0+d<T; the vulnerability is high if t0+d<bT (where b is a constant). The results of the analysis are in accordance with that obtained by a frequency and a intra-seasonal analysis, but they also give the vulnerability for different levels of risk (i.e. for various return periods).