Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda

Research Application Summary

Participatory analysis of growing season: A key for understanding and copping drought risk in northern Ethiopia

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Abstract

Prolonged drought is one of the most serious climatic hazards affecting agricultural production and those most at risk are those countries currently vulnerable to climate variability. Barley is one of the economical and staple food crops grown in northern Ethiopia which is severely affected by drought stress. Given it's economically importance, understanding the efficient use of water for growing barley could contribute to the livelihood food security in the region. However, there is limited information as to what extent the water stresses that result from climate variability could be reduced by improving rainwater use efficiency. In addition there is limited understanding of rainfall and other associated factors that affect soil water variability in the study area. In this research an assessment is being carried out to study the causes of past crop failure, develop a suitable technique for assessing drought and explore site-specific need for copping with drought in northern Ethiopia. At the end of this research, a suitable and reliable method for assessing drought risk will be developed; the major agro-meteorological causes of most devastating drought including the famines of 1984 will be explicitly identified and ranked based on their importance. The extent the effect of water stress due to climate variability could be reduced by improving water use efficiency will be known and finally the most promising drought mitigation strategy will be proposed for the study area.

Key words: Barley, climate variability, northern Ethiopia, water saving

Résumé

La sécheresse prolongée est l'un des risques climatiques les plus sérieux affectant la production agricole et les pays le plus en danger sont ceux-là actuellement vulnérables à la variabilité climatique. L'orge est l'une des cultures alimentaires de base et économique, en croissance en Ethiopie du nord qui est sévèrement affectée par l'effort de sécheresse. Etant donné son importance économique, la compréhension de l'utilisation efficace de l'eau pour pousser l'orge pourrait contribuer à la

sécurité alimentaire de base dans la région. Cependant, l'information est limitée quant à l'ampleur de l'effort de l'eau qui resulte de la variabilité du climat et qui pourrait être réduit en améliorant l'efficacité d'utilisation de l'eau de pluie. En outre, il y a une compréhension limitée des précipitations et d'autres facteurs associés qui affectent la variabilité de l'eau du sol dans le milieu d'étude. Dans cette recherche une évaluation est effectuée pour étudier les causes de l'échec de récolte passée, pour développer une technique appropriée à l'évaluation de la sécheresse et pour explorer le besoin du milieu spécifique d'aborder la sécheresse en Ethiopie du Nord. A la fin de cette recherche, une méthode appropriée et fiable pour évaluer le risque de la sécheresse sera développée; les principales causes agro-météorologiques de la plupart de sécheresse dévastatrice comprenant les famines de 1984 seront explicitement identifiées et rangées selon leur importance. L'ampleur que l'effet de l'effort de l'eau dû à la variabilité de climat pourrait être réduit en améliorant l'efficacité d'utilisation de l'eau sera connue et finalement la stratégie de réduction de sécheresse la plus prometteuse sera proposée pour le milieu d'étude.

Mots clés: Orge, variabilité climatique, Ethiopie du Nord, économie de l'eau

Background

Agriculture is the main driver of the economy and livelihood in Ethiopia. It is the source of income for about 80% of the labour force in Ethiopia (Bewket and Conway, 2007). Agriculture is rainfed and therefore vary vulnerable to climate change and variability. Therefore, assessing seasonal or decadal rainfall characteristics based on past records is essential to evaluate drought risk and to contribute to development of drought mitigation strategies. The objectives of this study are to: (1) analyze the quality of past growing seasons in order to understand the main causes of crop failures; (2) develop a simple drought assessment technique; and (3) identify site specific time and recommendations for supplementary irrigation as a drought coping strategy. Four rainfall stations with 24-46 years of observation and barley (*Hordium vulgare*) are being studied.

Literature Summary

Rainfall variability has been reported to have significant effect on Ethiopia's economy and food production for the last three decades. Many reports showed drought associated food shortages (Tilahun, 1999; Meze-Hausken, 2004; Bewket and Conway, 2007). In most cases it is the distribution rather than the total amount of rainfall which determines crop production in

most semi-arid areas of Africa because dry spells strongly affect the yield (Barron *et al.*, 2003; Meze-Hausken, 2004; Segele and Lamb, 2005).

Dry spell analysis has been carried out in various parts of Africa. Many authors define dry spell as *n* consecutive days without considerable rainfall (Stern, 1980; Sivakumar, 1992; Ceballos *et al*., 2004). Severities of these dry spells depend on their frequency and duration and the crop stage during which they occur. However, this type of analysis does not effectively evaluate the drought risks for three reasons: (i) it dose not consider the evaporative demand of the atmosphere; (ii) daily rainfall without appreciable depth may be counted as wet day regardless of its importance, and (iii) effective rainfall is not considered. Hence there is need to develop a suitable technique for assessing dry spells for the region.

There are many definitions of drought. From the view point of local people drought occurs when there is relatively low rainfall in relation to crop water demand resulting into poor crop harvest or total crop failure and/or suffering or death of livestock from absence of adequate feed. Various types of drought assessing and predicting techniques have been developed in the past such as the Palmer Drought Severity Index (Palmer, 1965; Guttman, 1991; Heddinghaus *et al.*, 1991), Standard Precipitation Index (McKee *et al.*, 1993; McKee *et al.*, 1995; Guttman, 1998) and Crop Moisture Index (Palmer, 1968). Each of the methods has merits and limitations (Alley, 1984; Guttman, 1991; Heddinghaus and Sabol, 1991; Guttman, 1998). This study will develop a simple technique that can be used to asses occurrence of past drought (crop failure) years easily and adequately in the study area.

Study Description

The study site is located in northern Ethiopia (longitude 39^{o} 5'-39^{o} 8' and latitude 12^{o} 3'-13^{o} 7') and includes four climate stations. The climate is characterized as dry semi-arid climate (Araya *et al*., 2010). The site was chosen due to availability of relatively long periods of climate observations and occurrence of recurrent drought. The farmers in this area have been experiencing drought regularly, so their perceptions of drought and crop failure would be valuable to consider when analyzing climatic data.

Agriculture consists of peasant farmers with crop and livestock mixed farming. Land degradation and deforestation are some

of the major problems caused by human factors in the area (Hurni, 1990; Nyssen *et al*., 2000; Meze-Hausken, 2004). The major crops grown are barley, tef, sorghum, chick pea and wheat. Crop cultivars that are relatively early maturing and drought resistant are widely grown (Meze-Hausken, 2004).

About 500 farmers in the study area are participating in the study as teams or as individuals in characterizing and classifying past growing periods and in studing the major agrometeological factors that have caused crop failure over the last 40 years. In addition, data are being gathered from the Ministry of Agriculture and the statistical authority offices. The onset, cessation and length of growing period (LGP) are being analyzed based on predetermined criteria as well as from the information gathered from farmers. The farmers' information will be compared with the analyzed data. Dry spell analysis and inter and intra-seasonal drought analysis is being carried out using various techniques and models. Seasonal water deficit periods and site specific crop water requirements are also being analyzed.

Research Application

It is hoped that the information generated will be used to develop a simple but reliable method for assessing drought in the area. The frequency of drought seasons over the past seasons in the study area will be known. The study will also provide insight into the causes of the devastating drought of 1984. Possible drought mitigation strategies will be established for each site and recommendations for reducing impacts of drought made.

Acknowledgement

The author expresses sincere appreciation to the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for funding the research.

References

Alley, W.M. 1984. The Palmer Drought Severity Index: Limitations and assumptions. *Journal of Climate and Applied Meteorology* 23:1100-1109.

Araya, A., Keesstra, S. D. and Stroosnijder, L. 2010. A new agro-climatic classification for crop suitability zoning in northern semi-arid Ethiopia. *Agric. Forest Meteorol.*150: 1047-1064.

Barron, J., Rockstrom, J., Gichuki, F. and Hatibu, N. 2003. Dry spell analysis and maize yields for two semi-arid locations in East Africa. *Agric For. Meteorol.* 117:23-37.

Bewket, W. and Conway, D. 2007. A note on the temporal and spatial variability of rainfall in the drought-prone Amhara region of Ethiopia. *Int. J. Climatol.* 27:1467-1477.

Ceballos, A., Martinez-Fernandez, J. and Luengo-Ugidos, M. A. 2004. Analysis of rainfall trends and dry period on a pluviometric gradient representative of Mediterranean climate in the Duero Basin, Spain. *J. Arid Environm.* 58: 214-232.

Guttman, N.B. 1991. A sensitivity analysis of the Palmer Hydrologic Drought Index. *Water Resour. Bull.* 27:797-807.

Guttman, N.B. 1998. Comparing the palmer drought index and the standardized precipitation Index. *J. Amer. Water Resour. Assoc.* 34:113-121.

Heddinghaus, T.R. and Sabol, P. 1991. A review of the palmer drought severity index and where do we go from here? Proceedings, 7th Conf. on Appl. Climatol., 10-13 September 1991, Boston: American Meteorological Society. pp. 242-246.

Hurni, H. 1990. Degradation and conservation of the resources in the Ethiopian highlands. *Mountain Res. Dev.* 8:123-130.

McKee, T.B., Doesken, N.J. and Kleist, J. 1993. The relationship of drought frequency and duration to time scales. Preprints, 8th Conference on Applied Climatology. pp. 179–184. January 17–22, Anaheim, California.

McKee, T.B., Doesken, N.J. and Kleist, J.1995. Drought monitoring with multiple time scales. 9th Conference on Applied Climatology, Dallas,Texas. pp. 233–236.

Meze-Hausken, E. 2004. Contrasting climate variability and meteorological drought with perceived drought and climate change in northern Ethiopia. *Clim. Res.* 27:19-31.

Nyssen, J., Poesen, J., Mitiku Haile, Moeyersons, J. and Deckers, J. 2000. Tillage erosion on slopes with soil conservation structures in the Ethiopian highlands. *Soil and Tillage Research* 57:115-127.

Palmer, W.C. 1965. Meteorological drought. Research paper No. 45. U.S. Weather Bureau. [NOAA Library and Information Services Division, Washington, D.C. 20852].

Palmer, W.C. 1968. Keeping track of crop moisture conditions, nationwide: The new crop moisture index. *Weatherwise* 21:156-161.

Segele, Z.T. and Lamb, P.J. 2005. Characterization and variability of Kiremt rainy season over Ethiopia. *Meteorol. Atmos. Phys.* 89:153-180.

Sivakumar, M. V. K. 1992. Empirical analysis of dry spells for agricultural application in West Africa. *Climate J.* 5:532-539.

Stern, R.D. 1980. Analysis of rainfall at Samaru, Nigeria, using a simple two-part model. *Arch. Met. Geoph. Biokl., Ser. B*. 28:123-135.

Tilahun, K. 1999. Test of homogeneity, frequency analysis of rainfall data and estimate of drought probabilities in Diredawa, eastern Ethiopia. *Ethiopian Journal of Natural Resources* 1:125-136.