Hydrol. Earth Syst. Sci. Discuss., 10, C6623–C6630, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C6623/2013/

Hydrology and
Earth System
Sciences
Discussions
Open Access

Interactive comment on "Droughts and floods over the upper catchment of the Blue Nile and their connections to the timing of El Niño and La Niña Events" *by* M. A. H. Zaroug et al.

M. A. H. Zaroug et al.

modathir_23@yahoo.com

Received and published: 5 December 2013

Anonymous Referee #2

Received and published: 5 November 2013 Review of "Droughts and floods over the upper catchment of the Blue Nile and their connections to the timing of El Niño and La Niña Events" by Modathir Zaroug and coauthors.

Summary

The manuscript presents an evaluation of low and high discharge conditions (drought and floods) over the upper catchment of the Blue Nile Basin is their connections to

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

the timing of El Nino and La Nina Events. This is an observational study that found several interesting relations, e.g high probability of flood events when an El Nino event is followed by a La Nina event. However, the authors do not provide further insight to the mechanisms responsible for these findings. Therefore, I recommend major revisions, listed below, in particular: (i) clarifying the limitations of the current analysis, and (ii) providing s ome suggestions for future work that could lead to a better understanding of the role of the Pacific sea surface temperatures on the rainfall/discharge anomalies in the Blue Nile Basin.

Comments

Fig 6 results: I suggest replacing the panels of Figure 6 by scatter plots of Nino 3.4 versus discharge anomalies for each of the seasons. The time series only show the period 1982-2009, while there is data since 1965 to 2012. Along with the scatter plots, the values of the coefficient of determination (or R squared) could be also calculated for the linear fit between Nino 3.4 and discharge anomalies in each season. This would quantify the relation between the SST anomalies in the discharge in the different seasons, and support the author's discussion in Page 10977 (Lines 3 to 14). The correlation and coefficient of determination are calculated for the linear fit between Nino 3.4 and discharge anomalies in each season as illustrated in table 1. Figure 6 shows examples of the relation between SST anomalies in the Nino 3.4 region in different seasons and JJAS discharge anomalies at Eldiem station. The scatter plots are made for Nino 3.4 versus discharge anomalies for different seasons as shown in figure 7. The period extended from 1965 to 2012. A negative correlation between the Nino 3.4 SST anomalies (in JFM, AMJ and ASO) and the JJAS discharge anomalies at Eldiem is evident in the panel of Figure 6 and table 1. For example the large El Nino of 1987 is associated with below average discharge and the La Nina of 1988 is clearly associated with above average discharge. This negative correlation is less evident in the case of JFM (upper panel of figure 6 and table 1) and, to a lesser extent, AMJ (middle panel), and higher in ASO (lower panel) SST anomalies. The same plot was made with SST anomalies for other seasons; FMA, MAM, MJJ, JJA and JAS (not shown here), and FMA and MAM also showed lower correlations compared to the MJJ, JJA and JAS anomalies. The highest correlation was found during JJA and JAS (-0.56, not show here). Figure 6 thus illustrates that the rainfall in the upper Blue Nile River catchment is highly sensitive to the SST during AMJ to ASO. In this analysis we look at the correlation and coefficient of determination for the whole period (1965-2012) regardless of El Nino, La Nina or normal years. These results are not far from the results of Eltahir (1996) who used the annual flow in the Nile River at Aswan from 1872 to 1972, he found the highest correlation (-0.5) during SON and -0.45 during JJA with different SST regions. Amarasekera et al., (1997) calculated the correlation of the Blue Nile and same SST index as Eltahir (1996), he found it -0.44 for JJA and SON. Although in this study we used Nino 3.4 index and the period is also different, but our results are in line with the other studies.

Table 1. The coefficient of determination and correlation for the linear fit between Nino 3.4 index in different seasons and the JJAS discharge anomalies at Eldiem station for the period 1965 – 2012. JJAS precipitation SST index R2 Correlation JFM 0.006 -0.08 AMJ 0.150 -0.39 ASO 0.286 -0.53

Fig. 7. The scatter plots for the discharge anomalies at Eldiem station versus Nino 3.4 during a) JFM, b) AMJ and c) ASO, for the period 1965 - 2012.

Start date of El Nino/ La Nina in ASO : Considering that the main rainy season extend from June to September, would it be expected that when El Nino / La Nine starts latter in the year, during ASO, the impact in discharge to be reduced ? The authors could discuss this point when analyzing the results in table 1 and 2. Furthermore, the El Nino and La Nine events starting in ASO tend to have shorter lengths when compared with the other starting dates. The authors should also discuss this in more detail. Was this documented before? when El Niño starts late in ASO, it tends to be relatively short (1976, 1977, 1994 and 2006), and for the years available there is no drought event (in the same year) for four times (while there were one case of flood and one of extreme flood). However, when the correlation was calculated for the all years of ASO regardless of El Nino, La Nina and normal years during ASO, it was -0.53 as illustrated in table 1. Eltahir (1996) and Amarasekera et al., (1997) found also high correlation during this season, but when El Nino starts on this season, it has no impact on the Blue Nile flow .The results of Table 2 thus suggest . . . ., while no effect is found when El Ninos start late in the year in ASO. When La Niña started late in ASO, it tends to be also relatively short (1983, 1995 and 2011), there were no floods recorded, and in one case (2011) there was even a strong drought. Similar like the analysis of the start of El Nino during ASO, there is no impact on the upper Blue Nile flow.

Pag 10978, Line 15-18: “Therefore, in general, when La Niña started in AMJ, JJA and JAS, 67% of the times there was a flood or extreme flood, showing that the rainfall and the monsoon in this catchment is sensitive to AMJ, JJA and JAS SST in the Pacific Ocean.” How was the value of 67% calculated? It s not clear how the conditional probability was calculated. From my understanding, the authors want to calculate the conditional probability of extreme flood or flood in the first year (P(F)) given a La Nina event (that started in AMJ,JJA or JAS) (P(La)): P(F|La) = arP(Fâ′LI’La)/P(La) = 4 (extreme flood or flood events during the first year of a La Nina event) / 6 (number of la Nina events) = 67%. If this is the case, the authors should clarify the calculation, and highlight the reduced number of samples to calculate this conditional probability. The 67 % is calculated as follow: (4 (extreme flood or flood events during the first year of a La Nina event))/(6 (number of La Nina events))=67% In this analysis it is important to mention the limited number of events to calculate this percentage.

Following the previous comment, the relation between flood events and El Nino followed by La Nina years (in table 3), is based on very few cases, and the authors do not provide any other evidence of such a relation. Is there some known relation in terms of strength of El Nino when followed by La Nina? Other anomalies in SST outside of the Pacific ? Maybe in the Indian Ocean ? The discussion of these results should include the limitations of the reduced number of cases, and provide some other evidence of those relations. This last point might be out of the scope of the manuscript, but the authors could at least include in the conclusions the potential for future work to investigate these relationships (for example suggesting configurations for idealized experiments with a general circulation model). This study highlights for the first time the record flood flow in the upper catchment of the Blue Nile when El Nino followed by La Nina. We will mention in the text the limitation of the cases. The strength of El Nino seems to have no impact on the extreme flood, because, for example, 1997-1998 El Nino was one of the highest El Nino, but 2006-2007 El Nino was a normal El Nino. Other SST anomalies outside of the Pacific Ocean may have an impact in the Blue Nile flow; they may enhance or reduce the precipitation in the upper Blue Nile. The earlier studies which found the connection between the Nile floods and summer monsoon rainfall over India was examined in Bhatt (1989) and Whetton and Rutherfurd(1994). Camberlin (1997) found a teleconnection between the Indian monsoon and the summer rainfall in east Africa, and the predictors for the Indian monsoon can themselves be used as predictors for east African rainfall. Negative sea level pressure anomalies in Bombay are followed by abundant rainfall in Ethiopian highlands, while positive sea level pressure anomalies lead to below average rainfall. Awadalla and Rousselle (1999) attempted to predict the Nile River inflows to the High Aswan Dam (HAD) in Egypt. They found significant improvement in model skill by incorporating beside the Pacific and Atlantic SST, the Indian SST. Eldaw et al., (2003) showed that the Indian Ocean's SSTs and the Blue Nile River flows are generally negatively correlated; but sometimes, certain regions of the Indian Ocean (e.g., the Arabian Sea and the sea north of Australia) are positively correlated. Seleshi (1991) found that one of the causes of Ethiopian rainfall is the strong movement of moist air from the high southwest Gulf of Guinea to the low northeast center of Arabia. Gray et al., (1992) found that extra ASON precipitation at Guinea may lead to more rain in the Sahel during the following year, and on the other hand, a dry ASON period may lead to drought in the Sahel several months later. Vizy and Cook (2001) found that both warming and cooling of the Gulf of Guinea in summer suppress convection over the northeast Africa. Eldaw et al., (2003) found that the Blue

Nile River JASO flow is significantly and positively correlated with the previous year ASON Guinea precipitation, and the Guinea precipitation is another potential predictor of the Blue Nile River flows with 11 months of lead time and r = 0.63 for the period 1953 to 1989.

To support the discussion of Figure 7, the correlations between the discharge anomalies and the precipitation anomalies should be added (e.g. in the Figure legend) The correlation is added GPCP & discharge CRU & discharge UDEL & discharge Correlation 0.64 0.56 0.74

Figure 9 could be removed, and the critical value for 95% significance of the correlations added in Figure 8 has an horizontal line. Figure 8 and figure 9 have different scales. The critical value for 95% significance was obtained from a certain table for the t test only. Normally, the critical value is not calculated for the correlations.

Pag 10972, Line 5: replace: “to occurrence of floods and droughts in rainfall and river flow over the Nile basin” by: “to occurrence of meteorological and hydrological droughts in the Nile basin”. Done, thanks.

Pag 10972, Line 23: replace: “and contributes about 67% to the main Nile discharge.” By: “contributing to about 67% of the main Nile discharge”. Done, thanks.

Pag 10973, Line 21: “which has a return period of about 4 yr”: I recommend adding: “ (varying from 2 to 7 years) Done, thanks.

Pag 10974, Line 17/18: Since most of the analysis is done on river discharge, I suggest clarifying at this point that flood and drought in the context of this paper refer to high and low flows, respectively. Done, thanks.

Pag. 10976, Line 24: Replace: “and in line with the classification” by: “as well as with the classification” Done, thanks.

Pag 10990, Fig. 4 caption: replace “2994” by “2004”. Done, thanks.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

âĂČ References AMARASEKERA, K. N., LEE, R. F., WILLIAMS, E. R. & ELTAHIR, E. A. B. (1997) ENSO and the natural variability in the flow of tropical rivers. Journal of Hydrology, 200, 24-39. Awadalla, A. G., and J. Rousselle, 1999: Forecasting the Nile flood using sea surface temperatures as inputs: A comparison between transfer function with noise and neural networks. Proc. 19th AGU Hydrology Days, Fort Collins, CO, American Geophysical Union, 23–36. Camberlin, P. (1997). Rainfall anomalies in the source region of the Nile and their connection with the Indian summer monsoon. Journal of Climate, 10(6), 1380-1392. Eldaw, A. K., Salas, J. D., & Garcia, L. A. (2003). Long-range forecasting of the Nile River flows using climatic forcing. Journal of Applied Meteorology, 42(7), 890-904. ELTAHIR, E. A. B. (1996) El Nino and the natural variability in the flow of the Nile River. Water Resources Research, 32, 131-137. Gray, W. M., W. L. Christopher, P. W. Mielke Jr., and K. J. Berry, 1992: Predicting Atlantic seasonal hurricane activity 6–11months in advance. Wea. Forecasting, 7, 440–455. Seleshi, Y., 1991: Statistical analysis of the Ethiopian droughts in the XXth century based on monthly and yearly precipitation totals. M.S. thesis, Vrije Universiteit, Brussels, Belgium. Whetton, P., and I. Rutherfurd, 1994: Historical ENSO teleconnections in the Eastern Hemisphere. Climate Change, 26, 221–253. Vizy E, Cook K (2001) Mechanisms by which Gulf of Guinea and eastern north Atlantic sea surface temperature anomalies can influence African rainfall. J Clim 14:795–821

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/10/C6623/2013/hessd-10-C6623-2013-supplement.pdf

---

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 10971, 2013.

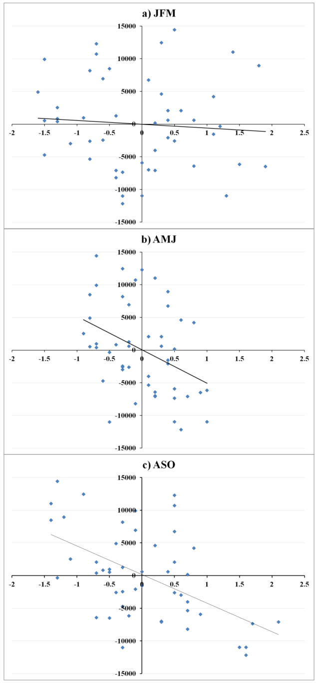

Fig. 7. The scatter plots for the discharge anomalies at Eldiem station versus Nino 3.4 during a) JFM, b) AMJ and c) ASO, for the period 1965 - 2012.

Fig. 1.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper