

Interactive comment on “Estimation of flooded area in the Bahr El-Jebel basin using remote sensing techniques” by M. A. H. Shamseddin et al.

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General Comment.

The paper presents a reanalysis of flooded area of the Sudd swamp area in Sudan bases on the analysis of satellite images. It is in agreement with earlier estimates of the flooded area by Suttcliffe et al. (1999), but obtains different results from the conclusions by Mohamed et al. (2005), who provided a water balance based on detailed evaporation through remote sensing and climate modeling. Although it is appreciated that the authors add to the research into this important but poorly gauged area, their paper does not contribute much to the perceptions that existed until the end of the 1990s.

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The paper briefly describes how the Sudd area has been defined based on the unsupervised classification of the MODIS images. The estimated verified based on earlier satellite images. However, the verification data sources were not clearly described, nor how the verification is done. As a result, the verification itself is not justified since it is based on the same data source. The methodology given in the paper is already published in the literature as early as the beginning of 1990's, e.g. by Mason et al. (1992), and Travaglia (1995). More recently further refined maps, as quoted in the paper, provide land coverage from different sources.

The final result obtained of the size of the Sudd swamp is not realistic, and in clear contradiction with the average hydro-meteorological condition over the Sudd area.

Moreover the water balance calculations do not agree with the image unsupervised classification. The paper claims to obtain compatible results with open water evaporation (Sutcliffe and Parks, 1999) . This implies that the paper must have used open water surface as the criteria for classification. The fact is that the Sudd wetland is not an open water surface. It is a mixture of open water, green vegetation, and seasonal swamps in the fringes. The latter dries out seasonally.

The paper concentrates on the Sudd wetland. While the title, and the text frequently refers to Bahr el Jebel flooded area. The two are different. The Sudd is only part of the Bahr el Jebel. This creates unnecessary confusion while reading the paper.

The conclusion that the Sudd area follows Lake Victoria outflow is not correct, because outflow from the lake is rather steady over the year, while the seasonal torrents in between the Lake and the Sudd, accounting for about 25% of the inflow to the Sudd, are responsible for the seasonal pattern of the inflow.

The English of the manuscript needs to be improved.

Detailed review:

P 1852, line 19 moisture recycling is one of wetlands advantages. If this statement

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true, it would be good to be supported by examples.

P 1853, line 2, Nehouse 1929, not in reference list.

P 1853, line 14: subtitle Study area literature: what is given is a description of the study area. No detailed review of literature has been given, would be good if it has been done.

P 1853, line 14, where is Annex 1, not given

P 1854, line 14: poor and confusing description of the study area. Bahr el Jebel flood plain, starts from the Sudan/Uganda border, several hundred kilometers southward. In fact Fig.1, and as given by the caption, only shows the Sudd area. So the title of the paper should be estimating flood area in the Sudd, and not the Bahr el Jebel flooded area.

P 1854, line 14: Previous studies (Mohamed, 2005; Ě) have divided the area into distinctive basinsĚĚĚ.. these basins constitute the whole Nile Basin in the southern part of Sudan, and not part of the study area (Bahr el Jebel flooded area).

P 1854, line 17: In terms of topography ĚĚĚ...: here the authors refer to the Sudd wetlands, as quoted from Howell, 1996.

P 1854, line 20: how can the mean of three stations 500 km apart, all of them outside the Sudd, represents the mean climatic condition over the Sudd. There are earlier records of climate data that would be more representative for the mean climate conditions (e.g. Bor station).

P 1854, line 21: Better describe source of rainfall mean, and for which years.

P 1855, line 3: Table 2 on evaporation, need also to show accompanied areas, and methodologies.

P 1855, line 10: the Bahr el Jebel river swamps specified by the given coordinates are in fact the Sudd wetlands or the Sudd swamps. Better make it specific as the Sudd, to

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avoid unnecessary confusion.

P 1855, line 27. where is Appendix A?

P 1855, line 28. where is Appendix B?, Table B1, better to give day/month/year

P 1856, line 28: avoiding cloud contamination. images in the rainy season are: Year images 2001 26/05, 09/11 2002 09/05, 12/06, 29/08, 29/09 2003 07/05, 12/09, 19/10 2004 05/05, 05/05, 23/10 2005 10/05

This show that, except for year 2002, it hardly captures any image in the rainy season. How does this influence the results need to be discussed. Also mention the percentage of cloudy pixels for each image.

P 1856, line 3: UTM projection which projection used for the Sudd?

P 1856, line 5: The method is based on unsupervised classification of the pixels, based on which parameter is not given.

P 1856, line 10: four levels of verification. Using NDVI value will not be independent from the calibrated values, since it uses the same satellite spectral signals. Vegetation map of Jonglei in 1983, does the map shows the Sudd boundary? What is the sources of vegetation map of Howell 2002 (this reference not listed?), hopefully not based also on satellite NDVI, because again this will not provide an independent source for verification. The 3rd verification data is Landsat WTM+. Does this map confine the Sudd area, how much, and on what basis? The 4th verification data is MODIS natural color image, also not an independent source for verification.

The authors briefly described how they defined the Sudd area based on unsupervised image classification. They have verified it based on earlier satellite images. Since verification data sources were not clearly described, nor how the verification has been done, the verification itself is not justified being based on the same data source. These type of results have been published as early as the beginning of 1990's, e.g. Mason et al. (1992), and Travaglia (1995). Mason, I.M., Harris, A.R., Moody, J.N., Birkett, C.M.,

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Cudlip, W., Vlachogiannis, D. 1992. Monitoring Wetland Hydrology by Remote Sensing: a Case Study of the Sudd Using Infra-Red Images and Radar Altimetry. Proceedings of the International Space Year Conference, Munich, 1992, pp. 1-6

P 1856, line 23: for the initial storage volume, the study assume one meter depth. 1 m in the flat terrain of the Sudd, will give erroneous volume results. I hope this is not mixed up with Sutcliffe's assumption of schematizing a linear relation between the volume and flooded area over the Sudd. Sutcliffe assumed that $V = (1/k)A$, where $1/k$ equals 1m.

The methodology is not clearly described. Which parameter is used to define the Sudd area? How does it varies spatially and temporarily? What are previous results (verification data)? How has the comparison been done? And what is the result of the comparison? How does this compared to earlier results using the same methodology? Answer to these questions will make the article very useful and of better quality, otherwise it is not complete and has no added value.

P 1857, line 8: The derived results shows unrealistic temporal variability of the Sudd area. The maximum is in August and the minimum in Nov. This is in clear contradiction with the mean hydro-meteorological condition over the Sudd. Net radiation over the Sudd shows almost steady variability (net effect of the position of the Sun, and clouds over the Sudd), the atmospheric demands (vapor pressure deficit) has a canceling effect with surface roughness over the wetlands. These three factors results in steady temporal variability of evaporation from the Sudd. Therefore, the influence of water inflow (river flow plus rainfall) would have a direct impact on the flooded area. All previous results of the Sudd area by Sutcliffe, Mohamed, Travaglia, etc, show a large Sudd area immediately after the rainy season in Oct/Nov decreasing to a minimum in Mar/Apr just before the rain starts.

P 1857, line 16: Lake Victoria (plus Kioga and Albert) supplies about 75% of the Sudd inflow, one quarter (highly seasonal) is provided by the torrents between Lake Albert

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and Mangala (just upstream the Sudd). The comparison should be made with the Mangala flow series and not to Lake Victoria outflow. The Lake Victoria outflow shows steady seasonal variability, while the flow at Mangala depicts clear seasonality of the river flows. Highest in Aug to Oct and minimum in Feb to April (refer to mean records in Sutcliffe and Parks, 1999).

P 1857, line 20: Large differences between this results and Travaglia? Should be reviewed for all months. Justification is not clear (flooded area vs. wetland), even if accepted, the flooded area should be bigger than wetlands. As wetland definition is more precise than the flooded area. The very first confusion of the authors about their study area (Sudd wetlands vs. Bahr e I Jebel flooded area) is creating more contradictions in the analysis.

P 1858, line 2: two evaporation methods, why? The first method treats the Sudd as an open water surface, which is not representative. The Sudd wetland is mixed of water surface, green vegetation, and seasonal swamps. Furthermore, it is in contradiction with their image classification used earlier to define the Sudd boundary. To be compatible, the classification should have been based on open water surface.

P 1858, line 4: SEBAL is used to compute total evaporation, the paper should give description of the SEBAL application, what images used, parameters, assumptions, etc.

P 1858, line 7: Figure 5 shows the results of the two scenarios. However, Fig 5 shows three lines, why? What could have happened is that, the author used evaporation from Sutcliffe, and evaporation from SEBAL and using their defined area to compute change in storage volume. What is the difference between the three lines of Fig 5?

P 1858, line 23: Fig. 7, and 8. How the authors did the comparison using data from different years. Sutcliffe used mean data (1961-1983), while authors are using evaporation from 2002 and 2004. What about the other component of the balance (inflow, outflow, evaporation)?

P 1859, line 2: estimate Swamp area (Sudd). This is not compatible with the title and the frequent text about Bahr el Jebel flooded area?

P 1859, line 7: variability of the Sudd area depends on Lake Victoria outflow. This is not true. Lake Victoria outflow is relatively steady in the year (further filtered in Kioga and Albert), while the real seasonality of the flow series is provided by the torrents contributions just upstream the Sudd, and the rainfall over the Sudd itself.

P 1859, line 7: annual storage change open water evaporation ǂǂǂǂ.: this is not compatible with the earlier results of 96%, and 53% differences.

P 1859, line 12: using the open water evaporation the comparison process is in serious contradiction of the assumptions used. Sutcliffe's own results on the Sudd area are in agreement with their original definition of the Sudd, and accordingly to their methodology of computation. Similarly, SEBAL's definition of the Sudd area (not as an open water surface) is compatible with their ctachment delineation (based on evaporation characteristics) and subsequent calculations. The problem of this article is that it starts with one assumption, and contradicts it in the following computation.

P 1866: what is the difference between Table A1 and Table 2? one of them is enough, and better Table A1.

References: Mohamed, 2005, There are two references to Mohamed et al. in 2005 and one to Mohamed. These should be distinguished in the text. Savenije is wrongly spelled as Saveniji.

Sutcliffe et al., should be Sutcliffe and Parks.

English needs to be improved, and spelling to be checked.

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