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Hydrology and Earth System Sciences Discussions

Interactive comment on "Monitoring temporary ponds dynamics in arid areas with remote sensing and spatial modelling" *by* V. Soti et al.

Anonymous Referee #4

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The paper of Soti et al. introduces a very old hydrological model of lakes in order to model the temporal behaviour of the pond dynamics. Remotely sensed precipitation is used to force the model.

My main concern on this paper is the model that is used: it seems to have some major shortcomings or physically irrealistic presentations such that the study based on this model could be doubted. Following will list the peculiar issues in the model:

- The time dependent soil moisture variable M_t as defined according to equation 3, should always become zero after some time t. This is easily shown through introducing equation 4, which calculates the Antecedent Precipitation index, into

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equation 3. This yields:

$$M_t = M_0 - \sum_{i=1}^{t-1} k^i P_{t-i} \quad (1)$$

Since $k > 0$ and $P_{t-1} \geq 0$, M_t is a decreasing function which finally reaches zero once $M_0 - \text{API}_t < 0$. Apparently, the moisture content M_t can never increase, even when rainfall occurs.

- evapotranspiration at the catchment is not taken into account
- the pond emptying model is extremely simple as it assumes that the water level decreases constantly in time, i.e. L m per time step. This does not account for temporal changes in evapotranspiration or changes in groundwater-pond interaction (fluxes can change from groundwater is draining into the pond to the groundwater being recharged with pond water).
- V_0 is defined as the volume for 1 m water height in the pond. Formula 7 calculates this volume as $V_0 = S_0(\alpha + 1)$, where S_0 is the area of the water surface for 1 m water height in the pond. Suppose that the pond would look like a cylinder, then the volume V_0 would become $(S_0 \cdot 1)$ m^3 for one meter of water in the pond. Given the shape of natural ponds (as sketched in figure 2) one should expect the volume to be less than S_0 m^3. However, since $1 < \alpha < 3$, equation 7 calculates this volume to be at least twice to maximum 4 times the volume of the irrealistic cylinder (meaning thus that the bottom of the lake is much larger than the cross section at 1 meter height...). According to formula 7, V_0 is indeed the volume at 1 m height, but $V_0 = S_0(1 + \alpha)$ cannot be correct.
- It is not clear how the water balance of the catchment area is coupled to the water balance of the lake.

Other remarks with respect to the methodology:

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- How valid is it to use S_0 and α values obtained from two ponds with a detailed bathymetry, as being representative for the two sets? Some sensitivity analysis with respect to both parameters would be necessary to validate on whether an error on this assumption does not significantly change model results.
- Why was the runoff surface arbitrarily set to 3 times the maximum radius of the pond? Is there any reason to restrict this to 3? Is this value based on some GIS analysis? In what formula is this radius used? I assume that CA (equation 1) is calculated as a circle with radius R_t (equation 10)? The text (last line section 3.3.) mentions that the negative buffer radius value used was $R_t - R_{\mathrm{max}}$: where is this used, and whatfor?
- Figure 3 demonstrates errors with respect to catchment area up to 5 ha. Given the fact that the larger catchments have an area of 30 ha or more, this error seems to be very large.
- How was the calibration, as mentioned in section 4.2, performed? What technique was used? The validation was performed against what data?
- How valid is it to use the same Kr, M_0, k, and L parameters (as obtained from calibration) for all ponds? Again, a sensitivity analysis is required.
- The validation of the pond area is only based on one Quickbird image? Isn't this validation insufficient to demonstrate whether the methodology is able to mimick the temporal behaviour?
- The discussion part on the behaviour of the model is very short and only mentions where errors occur without investigating why TRMM data results in worse simulation of the smaller ponds. It would have been interesting to see a comparison of rainfall statistics between the rain gauge data and the TRMM estimates. The discussion is also lacking sensitivity analyses on the model parameters, but also on the DEM derived relationships.

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- The authors are fairly satisfied with the results. However, isn't the accuracy obtained to coarse to be used in ecological and epidemiologic studies?

Some minor comments:

- More information on the four ponds used in the study is needed. Instead of mentioning this in section 2.3, the explanation should be in section 2.1.
- Equation 8: sum is taken over i: please put index in the variable(s) between the brackets.
- Equation 9: use an index running from 1 to n, and indicate this index in the variable(s) between the brackets.
- In Table 2, the runoff coefficient is indicated in %, however, it should read $0.15 < Kr < 0.40$.
- In Table 2, k should be unitless.

Given the doubts on the hydrological model, the assumptions on the robustness of the model parameters and the very brief discussion of the results, I believe this paper is not ready to publish but should undergo additional research.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 103, 2010.