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Hydrology and Earth System Sciences Discussions

Interactive comment on "Accurate stream extraction from large, radar-based elevation models" *by* M. Metz et al.

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Reply to comment n.1

Our manuscript deals predominantly with stream locations derived from surface flow accumulation (total catchment area). We assumed that high TCA values should be located along streams, an assumption commonly used for stream network extraction (e.g. TAS, SAGA). We compared three methods of sink treatment, namely sink filling, least impact approach, and an informed search approach. The influence of each method on resulting surface flow accumulation, particularly the location of high surface flow accumulation and stream centers, was investigated. We are aware that there are different methods of stream network extraction, and stream network extraction in

itself is a very interesting topic with several aspects to contemplate. We were not interested in the location of channel heads, our main concern was that the chosen method for drainage network extraction provides streams also along the smaller rivers in hilly terrain where GPS points were collected, at the same time not extracting too many streams (e.g. with a resolution of 10m and a threshold of 100 square meters, every cell would be a stream cell). Altimetric parameters are surely important factors for drainage network estimation, but with regard to our study we would like to emphasize that 1) altimetric parameters are mainly of importance to properly identify channel heads, and the exact location of channel heads does not matter for our chosen accuracy metrics, 2) drainage direction is calculated using slope, 3) slope = 0 is not a problem, as long as realistic drainage directions can be assigned for slope = 0, e.g. with an informed search approach or the approach of Garbrecht & Martz (1997), 4) using MFD instead of SFD surface flow accumulation already accounts for convexity/concavity of hill slopes when determining channel heads using a constant threshold. Of course the determination of channel heads can be further fine-tuned, but for our accuracy metrics it is only important that channel heads are somewhere upstream of reference points.

Reply to comment n.2

There are various methods for each pit/sink treatment, determining flow directions, and channel head identification, and we feel that keeping these steps separate and the workflow modular allows more control over the whole analysis. Moreover, we would not have been able to conduct our study if all steps are combined, because we wanted to investigate the influence of different methods applied in the first step on the following steps. We agree that a fixed total catchment area threshold to identify channel heads is not the most sophisticated approach, but it proved to be sufficient for our purposes of comparing the three sink treatment methods. Further on, MM is co-authoring another submitted manuscript presenting a highly flexible way of drainage network extraction that can take into account any user-defined additional parameters to fine-tune drainage network extraction, e.g. channel slope, infiltration rate, local rainfall etc. Regarding

MFD for channel cells, we observed more realistic results using MFD instead of some SFD method for channel cells where the channel is several cells wide (see Figure 1 of this comment)

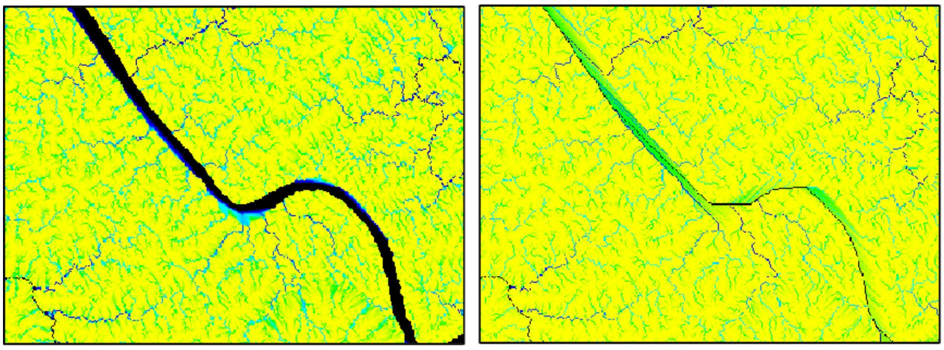
Reply to comment n.3

We are not sure if we understand comment no. 3 correctly where it is suggested that 1200 points are probably not enough to conclude that one method is better than another. We regard this as a statistical question. The number of points (338 GPS points and 995 Landsat points) was obviously enough since we found a number of statistically significant differences between methods with regard to stream locations. From a statistical perspective, 995 points are a bit much, potentially causing type 1 errors which could be alleviated by lowering α. In other words, we are of the opinion that 995 points are rather too many than too few for conclusions based on statistical significance. Thus the remark that 1200 reference points are not sufficient must apply to the non-significant test results. For methods comparison, non-significant tests where fill distance – LCP distance for SRTM 90m using Landsat points, IRA distance – LCP distance for SRTM 90m using GPS points, IRA distance – LCP distance for IFSARE 30m, SRTM 30m and SRTM 90m using Landsat points. Looking at the respective column with standard deviation in figure 2, the test with IRA distance – LCP distance for SRTM 90m using Landsat points might become significant using more points, but effect size would be quite small and the question would arise if the statistically significant difference would be meaningful, considering that for both IRA and LCP, the median distance of reference points to streams for SRTM 90m is about 120m (Table 2). The non-significant result for this test illustrates the increase in the accuracy difference with increasing detail for Landsat points, in other words, the improvement of LCP over sink filling with regard to the accuracy of stream locations apparently increases with increasing detail/resolution. For the comparison of IRA and LCP, it is unlikely that results will become significant with more Landsat points because mean values of distance differences are close to zero with rather large standard deviations despite the already large

sample size. Standard deviations shrink with increasing sample size, but here (Figure 3) it is safe to assume that distance differences are distributed around zero. IRA distance – LCP distance for SRTM 90 m with GPS points might become significant with more points, but since the corresponding results for SRTM 30m and IFSARE 30m are significant, we were able to show some improvement of LCP over IRA in two of three cases using GPS points. The improvement is not as strong as for sink filling, but this is as expected because IRA is a sink treatment method far more sophisticated than sink filling. Regarding the comparisons between IFSARE 30m and SRTM 30m as well as the comparisons between SRTM 90m and SRTM 30m, we argued in the discussion that the SRTM DEM does not provide sufficient detail for stream locations in relatively flat areas because of its low horizontal and vertical resolution. Landsat imagery indicates that streams with reference points are still narrower than 90m; if such streams are not located within a valley with defined slope, the location of these streams can only be approximated with SRTM. Regarding the example of Figure 1 in the comment, we refrain from any conclusions based on visual inspection and encourage using statistical analysis with accuracy metrics.

We suggest to do the following modifications to the manuscript: Justify more clearly why a fixed threshold for stream network extraction is adequate in this case; change for figures 2, 3, 4, 5 y-axis label from “distance difference [m]” to “distance difference [mean $\pm$ SD in meters]”; add T values to statistical test results.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 3213, 2010.



MFD flow accumulation along Chagres river   SFD flow accumulation along Chagres river

Fig. 1.