Hydrol. Earth Syst. Sci. Discuss., 7, C1786–C1790, 2010
www.hydrol-earth-syst-sci-discuss.net/7/C1786/2010/

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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Received and published: 13 August 2010

Thank you for your helpful comments and suggestions. Obviously we need to explain some aspects of our work in more detail.

1. We have included the increase in computational performance because it is particularly relevant for the modern mapping technologies that can rapidly produce massive DEMs at high resolutions for large areas and the slow processing and analysis has become bottleneck in their application. Fast processing of massive DEMs opens their application to a new level of detail and spatial extent, for example in rapid response operations or for mapping in remote regions where the streams are covered by dense vegetation and no reliable stream data are available (as was the case in Panama). Also,

the speed increase makes the module useful even for users with limited resources (as is often the case in countries where the digital data are very limited) and an analysis that would have taken days is now performed in minutes. We chose to represent the speedup in general terms as "x times faster" because this x will be very similar across different systems (as opposed to "x minutes instead of y days").

To make the comparison easier to understand we will include information about the hardware on which the performance was tested (Linux 64bit, AMD AthlonX2 3GHz, 8GB RAM) and for which the actual times are given in Table 1. We will also describe the software in more detail and add a link to its free download (new GRASS64 release http://grass.osgeo.org/download/software.php and GRASS63 with the original version of r.watershed http://grass.osgeo.org/download/software_old.php) so that the test can be easily verified by other researchers. As mentioned in the paper, the performance comparison was done for modules implemented in GRASS GIS and the tests were run on Linux system, however, similar speedup has been achieved on MSWindows and MacOSX. We will also adjust the Table 1 and replace N/A by “computation cancelled by software” and explain the testing with “all in memory” and “data on disk”.

Finally, it is important to note that the improvement in the computational performance has been so dramatic that the relative speedup is on the order of at least hundred times on large DEMs (thousands of rows and columns), independent of the used hardware or operating system under which GRASS GIS was installed. The relative speedup is non-linear and increases with larger DEMs.

2. We fully agree that the issue of channel initiation is a complex one and we believe that accurate extraction of channel heads requires more than elevation data, because it is often significantly influenced by local geology, groundwater level and landuse/landcover (NCWQ 2010). According to the NCWQ 2010 “the stream origins usually occur as transition zones in which the location and length of the zone is subject to fluctuations in groundwater levels and precipitation. Frequently, streams change from ephemeral to intermittent and intermittent to perennial along a gradient or continuum

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âĂŤ sometimes with no single distinct point demarcating these transitions". Our selection of the terms channel initiation and channel heads was unfortunate and did not reflect the purpose of the stream extraction in the presented paper. We believe that the 90m or even 30m resolution SRTM DEM measured over 30m+ high canopy of dense tropical forest is not appropriate for mapping channel heads (or, more accurately, channel head zones) and therefore our focus was on mapping streams and rivers that have sufficiently large contributing area that an existence of a well defined stream can be expected. This was also in line with the original purpose of the stream mapping for the entire Panama that was to provide information for field research about the location of major streams and rivers that was not available on existing topographic maps. Therefore, the threshold was selected as 100,000 m2 to guarantee that all GPS field points were located on the extracted streams and, at the same time, that the extracted streams did not start above the real channel heads. As for using the same threshold for different resolutions we would like to point out that the threshold was given in square meters and the differences in area due to difference in resolution are negligible in terms of their influence on location of the stream extraction starting point.

To address the stream extraction starting point issue, we will thoroughly re-organize the methods section, include more detailed description of stream line extraction and its starting point, remove the reference to channel initiation and clarify the reasoning for the selection of the given threshold .

3. We did not use any improved sink filling method addressing the flat area issue approach for comparison, because first of all it is sink filling, i.e. elevation values are only increased instead of increasing some and decreasing some others. (If elevation values are increased and a gradient is added to resulting flat areas, why not use the gradient of the original DEM?)

4. Introduction: We will add the suggested references that are relevant to our work, thank you for the suggestions.

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5. Methods: a) see the answer above on the computational time issues and revisions. Thank you for the suggestion to add a flow diagram, we believe it will be helpful in explaining the algorithm. Also, the source code is available on-line at http://trac.osgeo.org/grass/browser/grass/branches/develbranch_6/raster/r.watershed making it possible to review the details of the implementation.

b) The information about the vertical accuracy of the SRTM and IFSARE data will be added, GPS was used only for horizontal positioning, no elevation measurements were performed that would require assessment of vertical accuracy. Detailed information about the IFSARE DEM processing was not available and the data were provided as a 10m resolution DEM by private contractor. To avoid confusion we will remove any references to 2.5m resolution data and their processing. The 10m DEM was the highest resolution DEM available for the entire Central Panama.

c) see the answer above on the threshold selection issue, this section will be thoroughly revised to avoid misunderstanding and relevant additional references will be added. We will include photos of GPS data collection as well as more detailed information (helicopter transportation and boats were used in the remote areas with no road access).

6. Results:

a) why blue lines were not considered as reference feature: several studies that have compared the blue lines on topographic maps with on-ground surveys of existing streams demonstrated that the blue lines were the least accurate source of stream location information in the study area (see e.g. Colson 2006 and the references therein), often based on old data digitized from aerial photographs with large errors in locations where the streams are not visible due to the presence of vegetation. One of the major motivations for deriving the stream network from the IFSARE data in Panama was the poor quality of blue lines with many larger streams missing and with errors in the mapped streams location. Although there are certainly cases where the blue lines are

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a reliable source of information about the horizontal stream location that has not been the case with this and other projects that we have been involved in and this was the main reason why the on ground data and data digitized from the Landsat imagery were chosen instead. Comparison with ground based point data (rather than blue lines) has become standard for quality assessment of stream extraction for the LiDAR-based floodplain mapping (see e.g. Watershed Concepts, 2006) and this study also highlights the low accuracy of the digital version of the blue lines.

References

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