Hydrol. Earth Syst. Sci. Discuss., 6, C3586–C3590, 2010
www.hydrol-earth-syst-sci-discuss.net/6/C3586/2010/

Hydrology and Earth System Sciences Discussions

Interactive comment on "Evaluation of catchment connectivity and storm runoff in flat terrain subject to urbanisation" *by* O. V. Barron et al.

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Received and published: 7 September 2010

Comment Response Review 1, Q1 I would like more justifications of runoff being driven by filling depressions in the estimation of catchment runoff. This is not always the case in semi-arid regions in intense rain and hence should be better justified.

We believe it is a good suggestion and we will include some discussion about specifics of runoff generation in the paper. Briefly the catchment DEM analysis indicated that the topography of the catchment present a mosaic of surface depressions (see Fig. 6) in the paper as it is located within dune type of landscape. Routing the runoff based on cell to cell surface gradient (as in Olivera and Maidment, 1999) is not directly applicable to such catchment. Hence our approach described in our paper allows considering

cascading surface depressions in flat and highly permeable landscape, presuming that their contribution to overland flow only possible when internal storage of depression is filled.

Review 1, Q2: I have only given this a 3 because I am not convinced about the way the term connectivity is used within the paper. I understand the concept of hydrological connectivity to be more about the ways in which runoff is connected and transmitted in river catchments (see Bracken LJ and Croke J 2007 for more details). I see this paper much more about exploring changes in contributing area. This is obviously related to the development of hydrological connectivity within a catchment and hence implicitly related and hence could be discussed in this way later in the paper. As similar comments came from two reviewers it is obvious that we need to define to clearly what definition of hydraulic connectivity was used.

It appears that as stated in Brachen and Croke (2007) there is "much confusion" in how the term "hydrologic connectivity" is used.

In this paper we follow James and Roulet (2007) defining hydrologic connectivity as hydrologically relevant spatial patterns of properties (e.g. permeability or soil or land cover) or state variables (moisture content of soil) that facilitate flow and transport in a hydrologic system", which was adopted after Westen at el (2001). This definition is broadly similar to that by Braken and Croke (2007) in their conceptual framework within the concept of "landscape position" and "delivery pathways". However in most of these applications classic surface hydrology is considered as a single direction algorithm using pit-free DEM (Beven and Kirby, 1979 or Aryal at el 2003). In some cases the surface depressions are recommended to be excluded when the "effective" contributing area is estimated (Olivera and Maidment, 1999). In this application we considered how topographically cascading surface depressions in flat and highly permeable landscape can be connected (or linked together) by the transfer of overland flow during individual rainfall events. In the approach a greater contributing catchment area under various conditions is a measure of a greater hydrologic connectivity between landscape and

the river. As James and Roult (2007), we investigated the change in contributing area as a result of different moisture condition and event rainfall. Many studies also consider a small area with a significant slope and limited length (20-300 m as is Western et al (2004)), while in our research we are considering a mostly flat relatively large catchment of 150 km2. Review 1, Q3: I am not convinced that the title accurately reflects the content of the paper and would suggest a title of 'Evaluation of changes in catchment source areas and storm runoff in ...'. We agree with the comment and will adjust the title accordingly

Review 1, Q4: There are also statements, for example in the abstract, that urbanisation increases connectivity. I'm not sure this is known yet and don't think that the papers reports this and so would be happier if using this phrasing was revised/removed.

In a light of receiving comments, we believe that it may be more appropriate to rephrase some sentences in the abstract and the paper from "connectivity" to "a catchment contributing area" when the effect of urbanisation is discussed.

Review 1, Q5: In the introduction notions of pathways of water transfer are introduced, but connections between expansions in urban area need to be more explicitly related to increases in connectivity. For instance a new housing estate could be built a long way from any streams and on top of a hill surrounded by areas of high infiltration. This would increase contributing area, increase runoff from this area but is not necessarily well connected into the drainage network and will therefore have limited contribution to flood flow.

The comment is quite correct, and in Perth (Western Australia) there are regions where urbanisation of the large dune systems does not lead to increase in runoff. But in a flat catchment with a high groundwater table as in the considered case it is likely that any urban development will result in surface depression "smoothing" and increased runoff. These will likely to provide a sufficient flow to fill the surface depression volumes enough to connect the development sites to drainage network. However the

effect of a distance from urbanised area to the surface water network was not tested in the reported data as the modelled future urban sites are located in close proximity to surface water network. As such the appropriate changes will be made in the text.

Review 2, Q1: The literature review has very few citations (6 citations). The total number of citations for the manuscript is 11, of which only 5 are peer-reviewed publications. Given the body of knowledge in hydrology, hydrological connectivity and landscape ecology, it should be possible to assemble a very good review of the state of the knowledge in these topics. There are no citations in the case-study section or other relevant sections (sections 6, 6.1, 6.2 and 7).

We agree with the comment and more references will be introduced to the paper (see the response to the first comment).

Review 2, Q2: It is not clear if the methodology was developed by the author; if so, what are the theoretical bases for this development? If not, it would be great to cite the source of the CCAA methodology.

The reported method was developed by authors. The approach included previous available development: USDA runoff curves (1986) to define a runoff under a range of land use and soil conditions, and definition of the hydrological network (Maidment, 2002). Land cover analysis, surface depression delineation and identification of hydrological connection between the individual surface depressions were undertaken within GIS environmental and automated using the Python scripting. As such the model input included some results, obtained based on the previous published approaches, while the main overall data processing was based on developed GIS model.

Review 2, Q3: The term connectivity was not clearly defined. This term brings the idea of the development or the use of a metric similar to the metrics used in landscape ecology to measure connectivity, flow or percolation in a landscape. Therefore changes in values could potentially help us understand how land use/land cover changes (in this case urbanisation) can affect runoff in a catchment. It would be really beneficial for the

manuscript if urban connectivity could be explicitly linked to hydrological connectivity.

See the response to Review 1, Q2.In addition, the aim of our research was not directly related to identification of ecological significance of the catchment hydrologic connectivity in a wider term as discussed in Pringle (2003). However it may be useful to consider this aspect in the following research.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 6721, 2009.