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Discussions

Interactive comment on "Complex networks, streamflow, and hydrometric monitoring system design" *by* M. Halverson and S. Fleming

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GENERAL COMMENTS:

This study assesses the utility of the concepts of complex networks for hydrometric networks. In particular, it examines daily streamflow data from a network of 127 monitoring stations in Canada. The study employs a host of network-based methods (including clustering coefficient, degree distribution, average shortest path length, betweenness, and community structure) to address some key problems associated with streamflow networks (including gage placement and grouping of stations). Based on the results, the study reports that the above streamflow monitoring network is a small-world network and also identifies ten separate communities of stations.

Applications of the concepts of graph theory, in particular complex networks, are gaining momentum in hydrology, and the outcomes are certainly encouraging. The present study, applying the network concepts for analysis of a streamflow monitoring network in Canada, is certainly an important contribution and advancement to this area of research. The study is extensive, with application of a number of methods, and the manuscript is well written. Therefore, The manuscript deserves publication. However, there is still some scope for improvement, and the comments below should help. In view of these, I recommend acceptance of the manuscript for publication subject to minor revisions.

SPECIFIC COMMENTS:

1. One of the deficiencies of this manuscript is an insufficient literature review. The manuscript cites a few studies on the applications of network theory in Earth sciences. While studies on climate, hurricanes, and earthquakes are cited, there is no reference to studies on hydrologic systems. In fact, the authors say [Page 13667, Line 1]: "To our knowledge, network theory has never been applied to hydrology." However, during the past several years, a number of studies have applied the concepts of complex networks to different hydrologic networks, including river networks (e.g. Rinaldo et al., 2006), virtual water trade networks (e.g. Suweis et al., 2011), rainfall networks (e.g. Scarsoglio et al., 2013), and streamflow networks (e.g. Sivakumar and Woldemeskel, 2014). The authors should thoroughly review the literature and cite/discuss such studies to put their analysis in a more proper perspective. Such a literature review will certainly result in some notable changes to the manuscript, including introduction, interpretation of results, and conclusions (see next).

2. The study by Sivakumar and Woldemeskel (2014) is particularly relevant for the present study, as it presents the analysis of a much larger streamflow network (639 stations in the United States). The study addresses a number of issues that are also discussed in the present study, including correlation threshold, strength of connections among stations, role of neighbors, all links, and actual links in the network.

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3. The application of the community structure concept to identify 'communities' of stations is certainly interesting. To my knowledge, this is the first such attempt on streamflow data in the context of network analysis. However, the analysis and results can be presented better and in a more proper context. The following aspects, among others, would help in this regard:

(a) Identification of groups ('communities') of catchments has been an important problem in hydrology. For instance, regionalization approaches have been widely used. There has also been particular interest in recent years on 'catchment classification,' especially in the context of predictions in ungaged basins (PUB). The 'community structure' analysis in the present study certainly addresses and contributes to research in this direction, but unfortunately this is not clearly recognized in the manuscript. Reference to a few publications in the above areas and discussion of results in such a context will definitely improve the manuscript.

(b) The manuscript presents application of eight different methods in the community structure analysis. However, as the methods are not described (but the reader is directed to other literature), it is somewhat difficult to appreciate the analysis and interpretations. As the network concepts, especially community structure, still are somewhat new to hydrology, it is important to describe the methods, at least briefly. The same goes also for the clustering coefficient, degree distribution, and shortest path length.

References:

Rinaldo, A., Banavar, J. R., and Maritan, A.: Trees, networks, and hydrology, Water Resour. Res., 42, W06D07, doi:10.1029/2005WR004108, 2006.

Scarsoglio, S., Laio, F., and Ridolfi, L.: Climate dynamics: A network-based approach for the analysis of global precipitation, PLoS ONE, 8, e71129, doi:10.1371/journal.pone.0071129, 2013.

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Sivakumar, B., and Woldemeskel, F. M.: Complex networks for streamflow dynamics, Hydrol. Earth Syst. Sci., 18, 4565–4578, 2014.

Suweis, S., Konar, M., Dalin, C., Hanasaki, N., Rinaldo, A., and Rodriguez-Iturbe, I.: Structure and controls of the global virtual water trade network, Geophys. Res. Lett., 38, L10403, doi:10.1029/2011GL046837, 2011.

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