The Greater Caucasus Glacier Inventory (Russia/Georgia/Azerbaijan)

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The paper by Telidze and Wheate presents an assessment of changes in areas of over 2000 glaciers and rates of glacier terminus retreat in the Caucasus Mountains using remote sensing and topographic maps. Two time steps 1960s-1980s and 1980s-2000s are used and comparisons with 1911 pop up at the end. Limited analysis of the detected changes is provided focusing on the north and south macroslopes, different river basins and, for terminus retreat, on aspect. Temperature and precipitation time series are presented providing context for the observed change.

The Caucasus Mountains and their glaciers are relatively well researched and there is a considerable amount of literature devoted to the regional glacier change (See Shahgedanova et al., 2014 for a reasonably comprehensive although by not exhaustive review). In comparison with the existing studies, and especially those published in English, this paper makes two not quite novel but useful contributions: (i) it assesses changes in comparison with the 1960s (unlike other recently published studies which mostly consider changes from the 1980s except for Khromova et al., 2009; 2014) and (ii) it examines changes in the extent of glaciers in the eastern Caucasus which is not fully covered by GLIMS and is missing from the recently published assessments. From the perspective of water resources, changes in the eastern Caucasus are important and much more so than in the western and central Caucasus because in the foothills, precipitation drops from about 2000 mm per year in the west to about 200 mm per year in the east. Detailed analysis what happens in this region would be valuable. Regrettably, the paper does not provide in-depth analysis building on the strengths of the data it generated and it is not clear what new contribution it makes in comparison with the earlier studies.

With regard to the data for the 1960s, derived from the topographic maps and the Catalogue of Glaciers of the USSR, the data presented here suffers from the problem faced by many other papers – there is no reliable accuracy assessment. Representation of glaciers on the 1:50000 maps is questionable as they were compiled by geodesists rather than glaciologists and issues of snow or debris cover were often neglected. The quality of data presented in the Catalogue also varies. So one can't just assign a 2.1% error to glacier areas as in the 1960s (p. 8; line 3); it is likely to be higher. The way to deal with this problem is either to re-map areas of a decent sample of glaciers of different size and type using aerial photographs or to use Corona instead. I don't know if aerial photographs are available in Georgia but some are available at the Institute of Geography, Russian Academy of Science with which the lead author is in contact. Corona can be obtained by anyone. This will be quite a lot of work but then the authors would have a clear idea of data quality and, in case of using Corona, will develop a new and valuable data set.

Another important issue with error analysis is that errors due to mapping by individual operators are not quantified. I suggest that glaciers of different sizes should be mapped by several operators to quantify the error.

In my view, the paper has a wrong balance between the introduction, description of study area and review of previous studies. I would place a review of the existing literature first and write it in a critical way showing which new or under-researched questions this paper addresses. I suggest that the authors should substantially cut the description of the study region as it contains a lot of information that is not directly relevant to the paper. There is no need to describe what is where, just show the western, central and eastern sectors on the map.

Surging glaciers are mentioned: have they been excluded from the analysis? There are a few particularly in the eastern sector (see Rototaeva et al., 2006 and a chapter on surging glaciers in the same volume). Either exclude or analyse as a separate group. If the published data are insuffiecient, maybe you can detect surging glaciers in the region?

Meteorological stations: The authors should exclude all those located in urban areas such as Vladikavkaz. The authors mention stronger temperature trends at this site which is most certainly due to an urban effect.

Debris cover: There are a substantial number of debris-covered glaciers in the region although not as much as in the south-eastern Asia. These are specifically described by Rototaeva et al (2006).

I suggest that these are analysed separately and some comparison with the recession of the debris-free glaciers is provided.

Specific comments

Tables 2 is too long and should be included as a Supplement at best. Can you present data on a map somehow?

Table 3: Show data for west-central-east as well as north and south. Changes in the eastern sector is your contribution so bring them out.

Tables 4 and 5: Again too much for the main text. It may be better to show changes in glacier areas rather than absolute values (which can go to a supplement). You comment about differences between the Elbrus and the Kazbek massifs but it is not easily seen from the tables which present glacier areas rather than change. If you show the changes in graphical format, it will illustrate your statements better.

P. 14, line 5: I would omit Kolka from this assessment; it's a catastrophic loss of ice which is not comparable with gradual area reduction.

You might want to comment more on the differences between the rates of glacier area reduction in the Elbrus and Kazbek massifs. While there were several publications about the Elbrus (Shahgedanova et al 2014; Holobaka 2013; Zolotarev and Kharkovets, 2007; 2012) to which your data do not add much, less is written about the Kazbek so you may want to explore the data further. Again, this will highlight west-east gradient in glacier area reduction.

Retreat of glacier termini: Why only 14 glaciers? This does not give you very good statistics.

P. 21 Line 5: Why is geology important?

P. 21 Lines 10-15: Not all of your comparisons make sense. Glaciers in the European Alps are much larger, in the Kodar they are much smaller and these are cold-based glaciers. In Kamchatka, they are altogether different and affected by volcanic activity. Looks like a random selection of papers for comparison.

P. 22 Line 20: I am not sure how geology affects faster loss of glacierized area in the east. I also can't see the difference in the warming rates between west and east (especially given that the only really high-altitude station, Klukhorsky Pereval, is in the west). It is more likely to be an effect of (i) drier climate in the east especially in comparison with the very humid western sector; (ii) lower elevations in comparison with the central sector) and (iii) size and type of glaciers prevailing in the regions. That's were insufficient data analysis shows: you need to analyse your changes in glacierized area according

to glacier type, size and elevation and compare these categories for western central and eastern sectors as well as north and south (to account for the influence of the North Atlantic Oscillation).

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