

## ***Interactive comment on “A water availability and low-flow analysis of the Tagliamento River discharge in Italy under changing climate conditions” by L. N. Gunawardhana and S. Kazama***

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Comment 1 Pag 144 line 2-3. It is not clear what is the meaning of the range in daily minimum temperatures (i.e., 0.57-2.47). Is it referring to the minimum and maximum values of minimum temperature for that decade (2000-2009) or what else. A few more words on this aspect might vanish all the Readers doubts. Moreover, in general and if possible, the use of tables makes easier the comparison of different measurements, shorten the paper and increase its readability.

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Answer The range represents the variation of temperature change in all stations. In the revised manuscript, we changed the text as follows.

For example, during the 2000-2009 period, the average daily minimum temperature for all of the recording stations increased by 0.57-2.47°C in comparison to the average during 1980-1989.

Comment 2 Pag. 144 line 9. A simple picture (prepared by the Reviewer but not published so far) shows a nice (for the Reviewer) empirical relationship between yearly precipitation and distance from the 1000 m a.m.s.l. south contour line (figure 2). A similar empirical but less linear relationship can be found for the relationship between yearly precipitation and height a.m.s.l.(figure 1). It is interesting to see that the amount of precipitation decreases northward of the 1000 m a.m.s.l contour line with the same gradient of the southward decrease. This is interpreted by the barrier role played by the prealpine area.

Answer We very much happy to see the developed relationship. Unfortunately, we do not possess detail meteorological data in low elevation area to see such a nice relationship. We came to our conclusion based on following graph (Fig. A). Therefore, we do not intend to make further analysis or a comment about this relationship as the Reviewer's work is yet to be published. We kindly hope that our explanation is satisfactory for the objective of this study.

Comment 3 Pag 144, line 16 (pag. 152, line 18) Usually, in meteorology the frost day is considered as a day in which minimum temperature is below 0 °C. In this work the average temperature is instead considered. Of course, every definition can be used and internal coherence is the fundamental aspect, but this stressed just to reduce misinterpretations of the term. This definition, different from the meteorological standards does not affect the conclusions of the work

Answer We very much agree with Reviewer's opinion. However, some research used minimum temperature and others used daily averaged temperature as the base (Kindly

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see Salinger M.J. and Griffiths G.M., 2001. Trends in New Zealand daily temperature and rainfall extremes, *Int. J. Climatol.* 21: 1437–1452). We looked for both and used daily averaged as the base to compatible with some research and standards in Europe. For example European Environmental Agency defines it as a day with an average temperature below 0 °C.

<http://www.eea.europa.eu/search?Subject%3Alist=CSI012>

<http://www.eea.europa.eu/data-and-maps/figures/change-in-frequency-of-frost-days-in-europe-in-the-period-1976-2006-in-days-per-decade-1>

Therefore, we prefer to use our original definition for the frost days and as Reviewer mentioned, we hope that will not affect the conclusion of our work. We included some discussion about this in the revised manuscript as follows.

Here we used frost day as an indicator for determining water resources impacts. Among various definitions, we considered the frost day as a day with an average temperature below 0°C (Salinger and Griffiths 2001).

Comment 4 Pag 146 line15 - pag 147 line 15 The model used is not an original contribution of the Authors and, inserted here in the text, interrupts somehow the flow of the discussion. The fact that Authors describe in detail the model used is for sure appreciated, but probably if it would be insert in an Appendix of the paper, the readability of this work might be increased.

Answer We agree with reviewer's comment. In the revised manuscript we moved this section to the Appendix 1.

Comment 5 Pag 148, line 13. The years 2001-2003 are chosen to determine the temporal changes of snow cover. These years, in particular 2003, were characterized by relatively small amounts of rain and by high temperatures in winter and low temperatures in winter. How this peculiarity might affect the conclusions of the Authors?

Answer We used 15 Landsat images during this period to avoid possible effect of any

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particular extreme events. However, the main objective of the analysis of Landsat images in different months is to identify different elevation bands to account the temperature lapse rate on snow fall and snow melt processes. Therefore, it does not change any major conclusions we made. These images within 2001-2003 time period were selected because they provided much better cloud free images over all time periods.

Comment 6 One of the main characteristics of the Tagliamento river is its multicursal aspect. Even this is not an easy question, maybe the Authors might try to address the question of the persistence or fading of this aspect. In other words, the expected average increase in low-flow level together with the increasing of the low-flow events, will transform this multicursal river in a single cursal river or not?

Answer Our manuscript would have been much more complete if we could bring our discussion on this direction. However, we used only a lump hydrological model. To make such detail discussion on multicursal characteristics of the river and its response in the future, we will need a distributed hydrological model. However, we have river discharge simulation only in one station in downstream and therefore; it is extremely difficult to derive such conclusion based on analysis from a lump model. We kindly expect your understanding in this matter.

Please also note the supplement to this comment:

<http://www.hydrol-earth-syst-sci-discuss.net/9/C229/2012/hessd-9-C229-2012-supplement.pdf>

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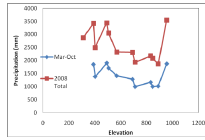


Fig. A: precipitation variation with elevation

Fig. 1.