

Interactive comment on “Hydrology of the Po River: looking for changing patterns in river discharge” by A. Montanari

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The paper “Hydrology of the Po River: looking for changing patterns in river discharge” by Montanari is a useful and fascinating reading. It is useful because of the big size (71 000 km²) and the great importance of the basin, as well as the relatively long time series (90 years of measurements plus some information of events of past centuries) which enables an overview of the overyear variability and uncertainty. It is fascinating because it is well written and accompanied with some very didactic animated graphics. One of the most important lessons is that the traditional ways of viewing and modelling long-term variability, such as in terms of linear trends, could be misleading and are hardly useful to predict future states, either deterministically or stochastically.

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I think the paper is a nice contribution, suitable for HESS, and I have only some minor suggestions which the author may wish to consider.

1. The long-term variability may be more accurately described by the term “fluctuations” rather than the term “cycles” often used in the paper. Rigorously speaking, these are not cycles, because the time length of fluctuations varies.

2. The term “memory” used throughout the paper is common in the related literature and has become a standard. However, I believe it is a misnomer and a misleading term. As explained in Klemes (1974) and Koutsoyiannis (2002), this behaviour, whose effect (not cause) is the high autocorrelation, could be interpreted as “change” that results in “absence of memory” or “amnesia”, rather than “memory”. In my view, terms better than “memory” are “persistence” and “dependence”, while terms better than “negative memory” (an expression which looks absurd) could be “negative dependence” or “antipersistence”. But this is just my view and I do not insist (noting, though, that the kind reference to my papers with the term “remember” in the phrase (p. 6692) “river flows may remember their past for a very extended period (Mudelsee, 2007; Koutsoyiannis, 2003, 2010)” may not be accurate).

3. I think that the water balance of the catchment, as summarized in Fig. 3 and pp. 6692–6693 needs some clarification: (a) Some references would be useful. (b) I would suggest replacing the unit “10⁹ m³” with the equivalent and simpler “km³”. (c) I guess the “discharge” of 47 km³ shown in figure is the “surface outflow” (to the sea). (d) For the control volume shown in the figure, the sum of outflows is 47 + 22 = 69 km³; it seems the “groundwater withdrawal” is already included in the “civil and industrial use” and in the “irrigation”, whereas the latter two seem to be parts of “evapotranspiration” and “discharge”. If this is the case, then there seems to be a deficit of 78 – 69 = 9 km³ considering the entire control volume, which includes the surface and subsurface water. Is perhaps this deficit a subsurface outflow to the sea or to adjacent catchments? Also, I am not sure if the partial balances of the two parts, surface and subsurface, close to zero.

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4. Some more clarification is used for the construction of climacograms of Fig. 8. Were the series somewhat “deseasonalized” before estimating variances? If not then perhaps the low slopes for scales < 100 days reflect more the periodicity of the annual cycle rather than correlation. Also, it would be useful to see in comparison, in the same graphs, plots derived from the annual series (for time scales > 1 year) in which the effect of seasonality disappears.
5. p. 6690 “the top observed values in Italy of minimum, average and maximum daily river flow, that are $275 \text{ m}^3/\text{s} \dots$ ”. Could the author clarify that “top” means “largest” in all three.
6. p. 6691. The definition of “hydro-ecoregions” is not clear enough. What does “limited variability” mean?
7. p. 6691. “story of the Po River” -> “history of the Po River”. Also, in “The 1705 flood is remembered . . .” is the author sure that “is remembered” is a suitable expression here? What about “registered”? Furthermore, the author could consider changing the Roman numbering of centuries to Arabic (throughout the entire paper; a few readers may have some inability in reading Roman numbers).
8. p. 6693, “The overall situation depicted in Fig. 3 reveals an intense exploitation of water”. Perhaps it could be mentioned that, since the major part of precipitating water outflows to the sea, the situation is far from critical and there is margin for further exploitation.
9. p. 6694, “loess” -> “LOESS” (this should be an acronym; http://en.wikipedia.org/wiki/Local_regression).
10. p. 6695. Could the author clarify if the confidence levels given are calculated assuming independence or otherwise mention the assumption made.
11. p. 6696, “25 and 10 days along the intra-annual and inter-annual direction”. Is it meant “adjacent values” instead of “days” (i.e. 25 days and 10 years)?

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