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Interactive Comment

Interactive comment on "Identification of spatial and temporal contributions of rainfalls to flash floods using neural network modelling: case study on the Lez Basin (Southern France)" *by* T. Darras et al.

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Interactive comment on "Identification of spatial and temporal contributions of rainfalls to flash floods using neural network modelling: case study on the Lez Basin (Southern France)" by T. Darras et al. Anonymous Referee #2, Received and published: 11 May 2015

First, authors want to thank the anonymous reviewer #2 for his (her) efforts to understand the paper and his (her) propositions to improve the readability and understandability of the paper. Comments of the reviewer are recalled in the following and the response of author is identified as “response”.

General comment: This paper applies KnoX methodology to extracting knowledge from a neural network model to better determine the contributions and time responses of several geographic zones of an aquifer. It is very interesting to read and learn how ANNs can be used to extract the geographical knowledge. The introduction section is nicely rewritten, which is interesting to read, while the remaining parts are difficult to follow and/or easy to lose the points. I do not see a solid conclusion about the extraction of knowledge from ANNs, instead the knowledge and/or inferences presented in the discussion section are mainly based on the authors’ geographical senses, not on ANNs. To increase the readability of this manuscript, I make a number of comments and/or suggestion for your consideration.

Response to general comment: One difficulty that was also stressed by the reviewer 1 is that the KnoX method and its validation were not sufficiently explained. This was a choice of the team of authors for 2 reasons: first the detailed explanation was provided in a previous paper (2013). This previous paper also addressed the validation of the method, using a fictitious aquifer with known contributions and known time responses. KnoX method was applied to found the contributions and times responses of this fictitious aquifer; after that, comparisons were done between extracted and known values of the fictitious aquifer. Results were perfect for time response, and jugged acceptable for contributions. Second, this previous paper was very long and it seems better to rewrite it as little as possible. Of course this choice can be discussed.

1. In Section 2 Artificial neural network modelling for better characterize processes: (1) There are many kinds of ANNs. It is suggested to mention what kind (type) of ANNs is used in the very beginning (Sec. 2.1) before going into details. (2) A brief presentation of the Knox method and why and how to implement the Knox method in this study should be provided.

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Response to comment 1. OK for the propositions. We will also add the equation implemented by the multilayer perceptron in order to make the description of KnoX method more understandable (as underlined by the reviewer 1).

2. In Section 4.1 From postulated model to neural network model: (1) The purpose (reason, logic) of this section should be given. (2) It will be of help to clearly present "The postulated model". (3) What is the point of "Application of the KnoX method would provide this quantification"? Why and how?

Response to comment 2. The postulated model is a conceptual model of how the watershed physically works. It is a block diagram representing the watershed behaviour. It can be drawn only if one has a "high level" idea of this behaviour. Regarding the Lez aquifer, the postulated model was built based on geology. 3 hydrogeological compartments were identified in previous works (during seventies), and a separation was operated on the east compartment regarding the ground properties (impervious or not impervious). This postulated model was indicated in grey boxes in Fig. 3. Starting from the postulated model, it is necessary to implement each box using neural networks. Also in order to make the simulation model better we added a state variable, which consisted in the values of the discharge at previous time step.

3. Figure 3 is crucial but difficult to follow (also not clear). For instance, what is the "elements used in Eq.4 and 5"? A more detailed description of the corresponding method and process would be helpful.

Response to comment 3. We are sorry if the Figures appear badly in the paper. Original files in png were good. It is possible to access to good figures through the printer-friendly version, and after a zoom of the figures. Elements used in eq. 4 et 5. are the parameters whose notations appeared in eq.4 and eq5. In a scientific paper, when previous works were published, it is always difficult to estimate what have to be re-explained or not. Maybe this point will be more understandable with a readable figure. Please note that figures in good quality are also posted in the response to reviewer 1.

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4. Model selection is done using cross-validation and a predefined number of training iterations. A more detailed description of cross-validation and the number of iterations should be given.

Response to comment 4. The same problem than previously applies to the description of cross validation. If one wants the paper to be auto-sufficient it must be presented. If one thinks that this method is well known and reference provided, it must not be. Our preference is to not re-write it but we can synthetize it in few sentences.

5. What does the "window-width" mean? Where is the number of hidden neurons? Is there anything to do with the "Optimisation" of the rainfall temporal window widths?

Response to comment 5. Window width refers to the number of delayed rainfall data that are applied to the model. They will be presented at the beginning of the paper with the presentation of the multilayer perceptron. The number of hidden neurons was 5; it was provide in Table 3. The number of iterations was 12.

6. The symbol of variable (for instance, rz(k -d)) in Equation 4 is difficult to learn (read). It is suggested to re-design the symbol and formulation!

Response to comment 6. Sorry, we don't understand as the symbol seems readable in eq 4. But it was not in the Fig.3 (please, see response to question 3).

7. Page 3697: "The contribution of the previous measured discharges used as input to the model ranges from 21 to 30% (respectively 89 to 70% for total rainfall) depending on the considered model Tn (n = 1, 7). Nevertheless, only rainfall contribution values are considered (for a total of 100 %) because the measured input of discharge plays the role of state variable (Artigue et al., 2012)." How to verify those results?

Response to comment 7. In another life we experienced the design of automatic control schemes using neural networks. In automatic control, it is currently accepted that the values of the targeted variable (the output, here the discharge) can be applied as input at previous times to provide an idea about the state of the system. This is understandable by the simple following reasoning: if the model has the measured value of discharge at time k-1 as input in order to estimate the discharge at time k, it has the information about the level of the flood: schematically high level or low level. If 2 values of discharge are applied at inputs, the models can deduce the slope of the discharge curve and thus it knows if the discharge is increasing or decreasing. If 3 values are applied, the model can deduce the second derivative (acceleration), etc . . . the set of values of discharge, slope of discharge and second derivative is considered as a "state vector". In Artigues 2012, we showed that the feed-forward model (designed with previous values of discharge as inputs) was very good (this is well known). When designing the recurrent model without measured discharge but estimated discharge as input, this state vector was lacking (estimation of the state vector is not good), thus we had to replace it by another value. To this end we applied the cumulative rainfall from the beginning of the event and this information allows the model to be better. We can consider that the cumulative rainfall provides an information about the level of humidity of the basin: a state information. Our experience with KnoX method showed us that the purely recurrent model wasn't efficient to simulate the behaviour of the basin; thus knowledge extraction has no interest. But the feed-forward model fed by previous observed discharge was efficient, knowledge can thus be extracted.

8) Section 4.4 Time distribution of contributions: (1) Line 5 on Page 3698: "Figure 4 shows the time distributions ... ,", should it be Figure 5?

Response to comment 8. Yes, sorry. Thank you for the scrupulous reading.

9. Figure 5 displays the Median and total spread of time distributions of North-western, North-eastern, Southwestern and South-eastern rainfall inputs contributions calculated from parameters of the 7 designed models. The fluctuations of North-western and North-eastern parts seem small and flat. How to tell (prove) the difference?!

Response to comment 9. We are not sure to well understand the comment. For us only the contributions of inputs for North-western are small and flat. For North-eastern

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zone one can see 2 “peaks” (at k-2 and k-5). Each contribution is not very high, but considering the whole zone, the contribution of zone NE reaches 26% (Table 5) thus 3 times the contribution of NW zone.

10. This contribution calculus of Equation 5 is done for each exogenous input: rainfall or measured discharge, and for each designed model. However, in the Conclusion Section, I do not see “Moreover efficient new approaches were demonstrated to extract information from a set of parameters” and “Among these methods, the KnoX method can identify contributions from various geographic zones to discharge at the basin outlet”. More to address?

Response to comment 10. We are sorry, but we are not sure to understand the question. We think that the proposition of a method able to address processes characterisation in complex hydrosystems is very new and very promising for new research; maybe is it sufficient?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 3681, 2015.