Hydrology and
Earth System
Sciences

Discussions

Open Access

EGU

Interactive comment on "Watershed classification for the Canadian prairie" by Jared D. Wolfe et al.

Hayashi (Referee)

hayashi@ucalgary.ca

Received and published: 20 January 2019

GENERAL COMMENTS

This study aims at classifying the Canadian Prairie region into seven categories based on the information on climate, surficial geology, landform, soil type and texture, land use, wetland occurrence, and other factors. It is a land classification exercise, but presented as watershed classification because watersheds are used as elementary polygons. The study applies a suite of advanced statistical techniques to an array of spatial information data to come up with the classification that is consistent with the current understanding of the ecological and hydrological conditions of the Canadian Prairie. This is an impressive achievement resulting from a tremendous amount of time and efforts, and I can see the attractiveness of such approach. However, I am not sure what new scientific knowledge and insights we can gain from this study. The

C1

authors try to demonstrate the usefulness of the new classification system in water management practices in the discussion section, but most of the findings have been qualitatively known to the community for a long time. Then, the usefulness must be in how the new classification can contribute to improving quantitative understanding or predictive capability, which is not explicitly demonstrated. It will be useful to examine the validity of the new approach using the 11 study watersheds, which I assume have hydrological data set. The data from the study watersheds are only used in Figure 8, and seem to be under-utilized. Aside from the issue above, I feel that the manuscript could use some clarification in methodology. Please see my specific comments below.

SPECIFIC COMMENTS

Line 102, 108. How is "watershed" defined? Is it straight forward to define watersheds in an unambiguous manner? Please clarify that here, or in the methods.

Line 117. How is the Canadian Prairie defined? Please present a brief definition, and the source of the ecozone boundary shown in Figure 1.

Line 119. The upper bound of precipitation (650 mm) seems to be too high. For example, mean annual precipitation in Winnipeg (wettest part of the Prairie) is only 601 mm for 1970-2000 according to the quality-controlled dataset (Mekis and Vincent, 2011. Atmosphere-Ocean, 49: 163-177). Similarly, the range of mean annual air temperature (5.7-7.4 C) seems too high. Based on the quality-controlled dataset, mean temperature for 1970-2000 is 2.9 C in Winnipeg, 2.5 C in Saskatoon, and 4.3 C in Calgary. It is well known that CANGRID dataset (ECCC 2017) has substantial errors and biases. I strongly recommend that the authors check the validity of CANGRID dataset at a few reference locations and discuss the potential implication of data bias.

Line 128. Related to my comments on Line 102 and 108, how are these watershed outlet selected? Please explain.

Line 136-138. As it is written, the sentence indicates that the watershed of the

Saskatchewan River is excluded from the analysis, which is clearly not the case. Please re-write the sentence to indicate more clearly what is excluded.

Line 140. Please indicate roughly how many kilometers are equivalent to 15 arc-second in the Canadian Prairie.

Line 141. The authors describe watersheds by referring the reader to Figure 1. However, Figure 1 does not show watersheds. Please refer the reader to Figure 5 instead, or add watershed boundaries to Figure 1.

Line 145. What is the total area of 4175 watersheds? How does that compare to the total area of the Canadian Prairie?

Line 156. Please see my comments above on CANGRID.

Line 161. Temperature-index methods such as Thornthwaite do not give reliable estimates of "potential evapotranspiration" compared to more physically based methods such as Penman-Monteith. There is nothing wrong with using the Thornthwaite method as a temperature index, but please explicitly acknowledge its limitation.

Line 162. The balance between precipitation and evapotranspiration is reflected in ecoregions of the Prairie, as plants are good indicator of long-term water balance. Ecoregions have been used by Prairie ecologists and hydrologists as a process-based framework for understanding the eco-hydrology of the region for many decades. It would have been very useful to use ecoregions as an element of classification, but the authors have chosen not to use them. Please provide an explanation.

Line 167. How were these non-effective areas determined? Please briefly explain the method and cite a reference. This is well known to Canadian Prairie hydrologists, but HESS is an international journal.

Line 177. Please change the wording to "seasonally flooded prairie potholes". Potholes are permanent landscape features, whereas flooded areas can be seasonal.

Line 180. Is (wetland density) needed here?

Line 191. Please briefly explain the meaning of mu and beta, and indicate the dimension or unit. These must have a unit of area to maintain the dimensional homogeneity.

Line 195. Is it true that all pixels in the Canadian Prairie have "monthly" satellite images? I do not think that is the case. Please clarify that in the texts.

Line 197. What do you mean by "the median area of the largest wetland"? Please re-phrase so the reader can understand what you mean.

Line 205. Surficial geology is mapped by geologists in each province using different terminologies. I am not sure if the "comparison across provincial boundaries" is straight forward. Please add a brief explanation on how the difference in terminology and mapping methods was reconciled.

Line 208. In the Canadian System of Soil Classification, colour indicates more than just an appearance of soil. For example, Black Chernozem and Dark Brown Chernozem are distinct soil types developed under distinctively different climatic conditions. The distribution of these soil types often coincides with ecoregions (e.g. Black Chernozem is associated with Aspen Parkland). Please consult with local soil scientist to give a better context to soil classes. Also, somewhere in the paper, perhaps near the beginning of the method section, it will be useful to present a process-based framework to understand the eco-hydrological functions of the Canadian Prairie landscape (see my comment on Line 162).

Line 223. Please indicate the unit of DSF. It must be the inverse of length.

Line 255. Please indicate these prairie stations in Figure 5. I assume these are the "study watersheds" described in Line 472. Please point that out here.

Line 265. Please explain how V1 and V2, and W1 and W2 are defined. Please note that most readers of HESS are not familiar with CCA. You do not have to present detailed explanation of CCA, but you need to give a brief outline so that the reader can

understand the basic concept.

Line 266. What are "the original variables"? Please explain, using a table if appropriate.

Line 290. "... attributes and is the basis ..." for matching the tense.

Line 301. Please define alpha.

Line 310. What does this mean? Based on Line 269, does it mean that the result was very useful for V1-W1, and barely useful for V2-W2? Please explain.

Line 311. What correlation value would indicate "strong"? Does it have a statistical level of significance, like in the standard correlation analysis? Does a negative value indicate negative correlation? Please explain.

Line 311-312. It is true that the correlation value is strong between Q100 (1:100 flow) and W2, but it is weak for Q2 (mean annual flow) and W2. On the other hand Q2 and W1 has a strong correlation. Also the lambda value is much greater for V1-W1 combination than for V2-W2 combination. Given that, why was W2 chosen? Is it because the classification is designed for 1:100 flood prediction? Please provide an explanation.

Line 322. How is rock fraction area calculated? I cannot imagine there are many areas of exposed bedrock in the Canadian Prairie. Please explain.

Line 326. Please list the classes of surficial geology used in the analysis.

Line 347. What are the "PCs from compositional datasets"? Are these different from PC1-PC6 in the header of Table 3? Please explain.

Line 358. "Weaker", not "less strong".

Line 389. The Canadian Prairie has now been divided into seven classes, which seem to be consistent with our current understanding of eco-hydrology. For example, C1 roughly coincides with the ecoregion "Lake Manitoba Plain (162)" in the Ecozones and

Ecoregions of Canada (Ecological Stratification Working Group, 1995). Then, what new knowledge and insights can we learn from this exercise? It will be nice to see a clear demonstration of the contribution of this study to new advances in "Hydrology and Earth System Sciences". Please try to present that in the discussion section.

Line 412. Glacial till and hummocky landforms. Does this refer to one thing, or two separate things (till and hummocky landforms)? Hummocky landform is a sub-class of glacial till terrain. Please clarify.

Line 453. Brown Chernozem is associated with the "Mixed Grass (159)" ecoregion, which covers much of the driest part of the Canadian Prairies, commonly referred to as the "Palliser Triangle". Accordingly the outer boundary of C5 roughly coincides with the outer boundary of Mixed Grass. However, Figure 5 shows a patch of C6 in the core of the Mixed Grass, which is the driest part of Alberta having distinctly different eco-hydrological characteristics compared to the band of C6 parallel to the western boundary of the Prairie. Is the new method picking up new information, or is it erroneously classifying watersheds? Are there too many classes in the system? These are worth discussing in this section.

Line 472. Are there 11 study watersheds, as indicated in Line 255? If so, is that a high enough number to examine all seven classes? Please explain.

Line 490-493. It is true that few studies have classified "watersheds" in the prairies, but there have been numerous studies examining the spatial distribution of eco-hydrological functions of the Prairie landscape. For example, ecoregions are an integral measure of hydro-climatology. Please acknowledge previous efforts and highlight the newness of this work.

Line 502. This is an example demonstrating the strong effect of ecoregions on hydrology.

Line 633. Yes, but the delineation has been available for many decades in the form of

ecoregions. Please acknowledge it.

Line 637. Geography may not be an appropriate term here, because geography encompasses many things, not just landforms. I would say topography or landform is more appropriate.

Line 661. Figure 8 just shows wetland density and area delineated in satellite images, which is dependent of climatic factor (wetness) in addition to depressional storage capacity. Overall, I believe that the data from the 11 study watersheds can be utilized more to demonstrate the validity and usefulness of the new classification method. For example, are there distinct differences in the hydrological characteristics of seven classes of watersheds?

Reviewer: Masaki Hayashi