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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Potential ecological risk assessment and prediction of soil heavy metal pollution around coal gangue dump" *by* X. Jiang et al.

X. Jiang et al.

jiangxue100@163.com

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Dear anonymous referee, Thank you very much for your valuable comments that will improve the quality of the paper. The paper has been thoroughly and carefully revised according to your comments. The reply to each comment is following: (C=Comment; R=Reply) 1ãĂĄGENERAL COMMENTS (1) C=English-writing Printer-friendly Version is not as clear as desirable. I would suggest an in-depth English revision of the text Interactive Discussion in order to gain clarity in the exposition. R=Thank you very much for your kind comment. The English expression of the text Interactive Discussion has been double checked and improved as suggested. Some parts have been revised. (2)

C= Introduction (Why to perform such a study? What is what the authors pretend to contribute with their research?...). R=Thank you very much for your kind comment. The objectives and contribution of the present study has been clarified in the Introduction of the paper. The objectives of the present study were: 1) to determine total concentrations of heavy metals (Cd, Pb, Cu, Cr and Zn) in soils around coal gangue dump; 2) to evaluate the extent of heavy metals pollution in soils impacted by coal gangue dump based on pollution index (PI) values and the Nemerow integrated pollution index (NIPI); 3) to identify the source of heavy metals by pearson correlation analysis and corresponding analysis; 4) to evaluate the potential ecological risk and predict the trend of soil heavy metal pollution around the coal gangue dump.The contribution of the present study was to provide useful insights for seeking appropriate management strategies to prevent and decrease soil heavy metals contamination around coal gangue dump in Yangcaogou coal mine and other similar areas. (3) C=What kind of materials have been investigated-ashes, slags, mixed rock-coal of big/medium/small grain size-? R=Thank you very much for your kind comment. The samples were collected through drilling, and the materials of coal gangue samples were mixed rock-coal of big/medium/small grain size, and the materials of some soil samples were mixed with some coal gangue. The soil and coal gangue samples were dried and grinded in laboratory, and then were sieved using a 1 mm sieve for pH measurement experiment and 0.075 mm for heavy metals measurement experiment, respectively. (4) C=What are the expected contaminant transport processes–solid particle wind-driven, solid particle gravity-driven, and soil retention...-? R=Thank you very much for your kind comment. The dissolution transport by the atmospheric precipitation eluviations, weathering, solid particle wind-driven, and soil retention are the expected contaminant transport processes. (5) C=How many reference "background" samples? R=Thank you very much for your kind comment. There were eight reference "background" samples (depth=0.15m, 0.4m, 0.8m, 1.2m, 1.6m, 2.0m, 2.5m, 3.0m). (6) C=Which was the reference composition of the coal dump? R=Thank you very much for your kind comment. The mineral compositions of coal gangue were determined by X-ray powder

diffraction techniques (XRD), and the main mineral phase was kaolinite, and also contains a small amount of quartz. (7) C=Moisture conditions of the samples? R=Thank you very much for your kind comment. The samples had much moisture. (8) C=Soil mineralogy and corresponding exchange capacity? R=Thank you very much for your kind comment. The main objectives were to understand the characteristics and extent of heavy metal pollution in soils impacted by coal gangue dump, to evaluate the potential ecological risk and predict the trend of soil heavy metal pollution around a coal gangue dump. Soil mineralogy and corresponding exchange capacity were not the main research contents in this paper, so we didn't do further research about them. If possible, we would take into consideration of the soil mineralogy and corresponding exchange capacity. (9) C=Why a 1:2.5 solid: liquid ratio? R=Thank you very much for your kind comment. We determine the ratio according to the agricultural sector standard (NY/T 1377-2007) of People's Republic China. (10) C=What are the justifications of the selected predictive contamination models -uniform vs. non-uniform forecasts-?) R=Thank you very much for your kind comment. Some soil scientists think that the higher industrialization degree, the greater "contribution" to the soil pollution (Yan et al., 2007; Fan et al., 2005), and the pollutants accumulation in the soil is not uniform, but with an accelerated speed. Of course, the impact of industrial development on soil quality does not change if people have strong sense of environmental protection, and the pollutants accumulation in the soil is uniform. On the contrary, it will develop with an increasing speed (Yang et al., 2010). (11) C=results/discussion (interpretation and significance of the observations, for instance to explain what is described in page 1990, lines 16 to 21) and conclusions (that should not be a summary of the paper) R=Thank you very much for your kind comment. The results/discussion had been revised as suggested. 2ãĂĄSPECIFIC COMMENTS (1) C=In page 1979, line 29. The selected mine dump appears to be rather small (6300 m3). What are the properties of this mine dump in terms of grain size, composition, etc.? To what extent is it affected by active erosion and particle redistribution due to the action of gravity (plus water, etc.)? A cross section sketch/cartoon illustrating its main features would be advisable. R=Thank you

very much for your kind comment. In fact, there is a hole filled with coal gangue under the coal gangue dump. The materials of coal gangue samples have been investigated were mixed rock-coal of big/medium/small grain size. The main mineral composition of coal gangue was kaolinite, and also contains a small amount of quartz. The selected coal gangue dump for this study has been a 15yr of history, and highly weathered. (2) C=In page 1981, second paragraph, the authors indicate that they focus on wind-driven contamination. Have performed the authors any type of mass balance relating the export rate from the mine dump and remaining mine dump mass? What is more relevant in terms of contamination potential: The wind-driven action or the active weathering related with chemical reaction processes? R=Thank you very much for your kind comment. The mass balance relating the export rate from the mine dump and remaining mine dump mass is unknown. The dissolution transport by the atmospheric precipitation eluviations, weathering, solid particle wind-driven, and soil retention are the expected contaminant transport processes. The wind-driven contamination was one of the processes, but the active weathering related with chemical reaction processes is more relevant in terms of contamination potential. (3) C=In page 1981, last paragraph. The authors indicate that gangue samples were integrated by mixing five samples from different depths. How many samples were collected? From which depths were the samples integrated? Is there any difference when comparing the surface (i.e. weathered) of the coal dump with deeper portions? R=Thank you very much for your kind comment. There were four samples from different depths (depth=2m, 3m, 4m, 5m) of the coal gangue dump were collected, making the average of heavy metal elements concentrations at different depths as the heavy metal elements concentrations of coal gangue. The total concentrations of heavy metals (Cd, Pb, Cu, Cr and Zn) in the surface (i.e. weathered) of the coal dump were higher than deeper portions. (4) C=There is information on additional chemical constituents (for instance, electrical conductivity, Fe, Mn, Ca, etc.). This information could be useful in order to indentify sources and processes. R=Thank you very much for your kind comment. The main objectives were to understand the characteristics and extent of heavy metal (Cd, Pb, Cu,

Cr and Zn) pollution in soils impacted by coal gangue dump, to evaluate the potential ecological risk and predict the trend of soil heavy metal (Cd, Pb, Cu, Cr and Zn) pollution around a coal gangue dump. The electrical conductivity, Fe, Mn, Ca were not the main research contents in this paper, so we didn't do further research about them. If possible, we would take into consideration of the additional chemical constituents. (5) C=Inpage1982, lines25to27. Was pH the only variable tested when looking to correlation coefficients? There are more potential additional variables of interest (i.e. soil total cation exchange capacity, clay content, etc.) R=Thank you very much for your kind comment. pH was not the only variable tested when looking to correlation coefficients, Cd, Pb, Cu, Cr and Zn are also variables. The soil total cation exchange capacity, clay content, etc. were not the main research contents in this paper, so we didn't do further research about them. If possible, we would take into consideration of the additional variables. (6) C=Page 1983, first paragraph. Please, provide with a reference of the so-called NIPI, preferably the original or first one. R=Thank you very much for your kind comment. Reference: Yang Z, Lu W, Long Y, et al. Assessment of heavy metals contamination in urban topsoil from Changchun City, China. Journal of Geochemical Exploration, 108: 27-38, 2011. (7) C=In page 1983, last paragraph, the authors employ the Hakanson's(1980) PER Index in their assessment of the soil contamination potential. However, the authors do not use the same battery of contaminants (i.e. the pollutant types). However, they readjust the corresponding heavy metal indices but do not provide further information. Rationale for the readjustment as well as the actual values used is relevant and should be given. R=Thank you very much for your kind comment. Rationale for the readjustment: Making the maximum value of TRi as the lowest level limit of ERi, and the remaining level limits followed by doubles. Making the rounding digit of as the lowest level limit of RI, and the remaining level limits followed by doubles(Li et al., 2012). The adjusted grading standard of potential risk of heavy metals in soil was summarized in Table 2. (8) C= In page 1985, first paragraph. It would be advisable to provide with further information concerning the used forecasting methods, specially taking into account that the references given (Fan et al., 2005 and

Yan et al., 2007) are described in the bibliography as being in Chinese. R=Thank you very much for your kind comment. We had provided further information concerning the used forecasting methods, specially taking into account the view of Fan and Yan (Fan et al., 2005 and Yan et al., 2007). (9) C=In page 1986, scenarios (1) and (2). The description of the two forecasting scenarios is not sufficiently clear and a wide range of variation is possible between the "null environmental protection actions" –i.e. scenario (1)- and "full promotion of environmental protection actions" –i.e. scenario (2)-. It is reasonable to expect that the results expected for both situations will deviate significantly what would render forecasting controversial. R=Thank you very much for your kind comment. The two scenarios were not absolute, but relative. We can determine scenario (1) or scenario (2) should be used based on investigation. (10) C=In page 1987, second paragraph. How many reference samples were taken? What are their corresponding statistics (mean, median, CV, standard deviation, etc.) R=Thank you very much for your kind comment. There were eight reference "background" samples (depth=0.15m, 0.4m, 0.8m, 1.2m, 1.6m, 2.0m, 2.5m, 3.0m). The main research object in this paper is topsoil (depth=0.4m), so I chose the sample values in depth of 0.4m as background values. There were four samples from different depths (depth=2m, 3m, 4m, 5m) of the coal gangue dump were collected. The mean, median, CV, standard deviation of heavy metals was showed in the paper. (11) C=In page 1987, lines 20 to 22. Classification of pH ranges would require some refinement. I would suggest "slightly acidic" rather than "acidic" if pH is around 5, "mildly acidic" (if between 5 and 6.5) and mildly alkaline (if between 7.5 and 8.5). R=Thank you very much for your kind comment. We had corrected as suggested. (12) C=In page 1990, line 13. Reference Carmona et al (2013) lacks from the reference list. R=Thank you very much for your kind comment. We had been checked and deleted this reference. (13) C=In page 1990, first and second paragraph. There is no trial of explanation in order to interpret the observed sample groupings. R=Thank you very much for your kind comment. We had interpreted the observed sample groupings as suggested. (14) C=Reference listed but not called in the text: Uceda et al. (2013) R=Thank you very much for your

kind comment. We had been checked and inserted into the page 1990, line 13. (15) C=Table 1 could be eliminated and information transferred to Figure 1. R=Thank you very much for your kind comment. Table 1 was eliminated as suggested. (16) C=Table 3. Concentration of target metals in the gangue and reference soil is, with respect some of them, not so different (e.g. Cu and Pb). It would be advisable to include the variability around these mean values in order to make sure that the difference in composition is significant. R=Thank you very much for your kind comment. We had corrected as suggested. (17) C=Table 4. Some of the heavy elements analyzed in the samples have mean concentrations higher than the "background" sample (e.g. Cu, Zn, Pb). Are the authors sure that the "background" values are representative? If so, can be concluded that contamination is severe, even in the case of Cd? What about the variability of the "background" values? R=Thank you very much for your kind comment. We determine the background values based on field surveys and interviews, so we are sure that the "background" values are representative. Compared with the background value of soil in the study area, the soil around coal gangue dump was the most seriously enriched with heavy metal Cd. There were eight reference "background" samples (depth=0.15m, 0.4m, 0.8m, 1.2m, 1.6m, 2.0m, 2.5m, 3.0m). The main research object in this paper is topsoil, so we chose the sample values in depth of 0.4m as background values, and we did not have to consider the variability of the "background" values. (18) C= General comments about tables: There are, perhaps, too much tables. It would be desirable to merge, when possible, some of them. R=Thank you very much for your kind comment. Table 4 and Table 7 were merged into Table 3 and Table 5, respectively. (19) C=Figures 2, 3, 4 and 6. The amount and distribution of the available data do not support the type of plot presented by the authors. Isovalue lines appear to be skewed due to the spatial dispersion and scarcity of data. It is suggested to replace these map plots by x-y plots, being the x-variable distance with respect the coal dump. R=Thank you very much for your kind comment. Figures were redrawn as suggested.

Many thanks for your kind comments. All the technical corrections suggested will be integrated into the ïňĄnal manuscript version. Best Regards, Xue Jiang, on behalf of

all co-authors.

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