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Interactive comment on "Analysis of land cover change and its driving forces in a desert oasis landscape of southern Xinjiang, China" *by* T. Amuti and G. Luo

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Thank you for the constructive comments and kind suggestions on our submission. We have greatly improved the manuscript according the comments. Hope the revised version of the manuscript could meet the requirements as the reviewer suggested. Our responses to the specific comments are listed below, with the updated manuscript attached as a supplement for referral.

We have reworded the abstract and removed the statements that have not been approved with data in the results. We also rewrote the conclusion section and more concentrated on the results. We reconstructed the manuscript to link and mix the driv-

ing forces analysis with discussion section, and provided sources or references for all important data that were not obtained from our results.

Introduction: We have added a few statements on the driving forces in the introduction to better identify the objectives of the paper. (Please see the revised paper: page 3, lines 10-13, page 4, lines 2-5 and 13-14)

We cited and added the following reference in the references section to explain the source of the data "34.6%": “Wang, G. Q., Wang, X. Q., Wu, B., Lu, Q.: Desertification and Its Mitigation Strategy in China. Journal of Resources and Ecology, 3, 97-104, 2012.”

Goals of the study: The second objective was merged with the first. (Please see the revised paper: page 4, lines 16-17)

2.1.1 Study area: We clarified and gave only one average for each of the climate variables. (Please see the revised paper: Page 5, lines 4-7) The vegetation of the ecotone area: We added some clear definitions for land cover classes in Table 1 (Page 28 of the revised paper). We corrected the names of some initial land cover types in the revised manuscript to better explain the vegetation types that are belong to each land cover type. Therefore, the “grassland” was corrected as “grass/shrub land”. The Populus, Tamarix or Phragmites mentioned in this section are the vegetation (mixed with grasses) mostly distributed around the fringe of the oasis along the Hotan river, which was initially classified as High or medium grass/shrub land according to vegetation cover and merged into the major land cover type “oasis”. However, the vegetation in desert-oasis ecotone are characterized by low diversity, sparse cover, and dominance by perennial herbaceous grasses and semi-shrubs, such as Phragmites australis, Tamarix ramosissima, Karelinia caspia, Alhagi sparsifolia etc . (Please see the revised paper: page 5, lines 23-25) Territory of the study area: We added more information in the “Study area” section to help readers have an overall idea about the territory of study area. For example, we added landforms, heights and lowest points,

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average height of the oasis area in the middle reach, distribution shape and mode as well as the average size of agriculture etc. (Please see the revised paper: page 5, lines 8-17)

2.1.2 Data: We provided more information about the collecting sources and time resolutions or scales of the socio-economic data in data section. Also some explanation are given in data pre-processing section about plotting and analyzing those data to examine the changing trends of the natural and human variables which are considered to be relevant drivers of the changes in land cover within the study area. (Please see the revised paper: page 6, lines 18-24)

2.2.1 Data pre-processing : Good suggestion. We removed all of the explanations about standard operations on radiometric correction process, and instead kept only the related reference of it.

2.2.3 Land cover classification: The MLC requires sufficient number of representative training sets to produce satisfactory classification results. For the pixel-based classification, the number of training pixels for each class may be kept as 30 times the number of bands under consideration according to Mather (1999) while Campbell (2006) suggests using at least 100 training pixels per class. Therefore, a total of 200 training sample plots (over 3500 pixels) in which each land cover type had at least 15$\sim$30 polygons were selected. (Please see the revised paper: page 8, lines 24-27, page 9, lines 5-7) When definition of representative training areas is known, selecting training sites on the false color composite (FCC) image has the advantage of easily visually distinguishing the classes, and hence ground data collection requirements can be reduced. In this study, an interpretation key was developed and carefully evaluated with the assistance of maps, high-resolution images and vegetation/soil indexes as reference for selecting training samples. Therefore, the training samples were collected first on the FCC image of the year 2008, and then same vector layer was then overlaid upon the 1990 and 2000 datasets, and the polygons were modified wherever changes were found. (Please see the revised paper: page 8, lines 27-28, and page 9, lines

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1-8) For properly differentiating low, medium or high coverage vegetation, as well as the bare land and desert, re-classification of spectrally confused land cover classes from the initial classification was conducted. For example, the initial land cover classes that are easily identified were masked out from the multi-spectral Landsat images leaving only bare land; thresholding bare land based soil adjusted vegetation index (SAVI) to unmix the desert from bare soil in agricultural land. Secondly, all classified land cover classes above were masked from the multi-spectral Landsat images and leaving only the grass/shrub land; using thresholding based on the fractional vegetation coverage (FVC) and recoding the medium, high and low coverage grass/shrub land. Lower values represent low-density vegetation (5% –20%), while higher values represent medium (>20% and <=50%) or high coverage vegetation (>50%). The area with vegetation cover of <5% are recorded as desert. (The desert shrubs and grasses in the study area retain light green or gray green from May through October, therefore fractional vegetation cover were used to detect different density canopy vegetation.) (Please see the revised paper: page 9, lines 10-29, and page 10, lines 1- 3) The dynamic transitional zone between oasis and desert with sparse vegetation cover of 5-20%, where natural semi-shrubs mixed with desert grasses have experienced severe water shortages and poor grazing conditions, was defined as ecotone due to its high probability to alternatively change between the desert and the oasis compared to the medium coverage grass/shrub land that is relatively stable. (Please see the revised paper: page 10, lines 15-18)

The sentence in original manuscript Page 10, lines 14-15: We rebuilt this sentence in the updated manuscript (page 10, line 8-10) as: “Manual editing (refinement) was then used to modify the classification image based on the prior knowledge about the study area.”

2.2.4 Accuracy assessment: In accuracy assessment, we conducted the accuracy assessment with 291, 245 and 166 test sample plots, respectively for each of the land cover maps, in which 166 plots are the same for each image, and selected additional

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test samples for older images (1990 and 2000) due to the slight differences of spectral reflectance (reflected by DN) for the year 1990, whereas 2000 and 2008 were more or less similar by comparison. These additional test samples generally increase precision of assessment but do not improve accuracy. (Please see the revised paper: page 10, lines 27-29; page 11, lines 1-3). The assessment results obtained from two different classification methods were given in Table 2 (page 29). Because of the difficulty of collecting simultaneous "ground truthing" data for historical images, the recent available high-resolution image can be used for the comparison in further validation of the classification accuracy (Zhou et al., 2008). In this study, only the Quickbird image was synchronous with the 2008 ETM data, however, Landsat image of 2000 was recorded one month later compared to the reference image (IKONOS) of 2000. Due to the differences between the acquisition times of the reference data and Landsat images for 1990 and 2000, the Quickbird image of the year 2008 was used as the basis of the other two historical images for comparison and proper interpretation. By this means, obvious changes in land cover could be reliably detected by image interpretation. More information used for production of the maps in 1990 were included in dataset section. (Please see the revised paper: page 11, lines 3-13)

3.1 Land cover classification: Very good suggestion. We improved the manuscript by adding statements on comparing both classifications in results and providing the additional data (shown in a updated Table 2) that we obtained from our original results, which can explain the comparison of two different classification processes, and superiority of the method integrated with various indexes compared to conventional method.

The sentence in original manuscript Page 12, lines 20-23: We rebuilt this sentence in the new version of the manuscript as: "It can be found that more than half of the study area was covered by sandy desert in proportion to other land cover types." (Please see the revised paper: page 13, lines 9-11) We reordered the tables according to the results as context information.

3.2 Land cover change: We have moved the statement "..transformed to desert mainly

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due to being desertified by wind erosion, water deficiency and overgrazing." to driving forces analysis part in deep discussion section, and provided the following references to support it. (Please see the revised paper: page 18, lines 10-15) "Li, Z., Li, X., Wang, Y., Ma, A., Wang, J.: Land-use change analysis in Yulin prefecture, northwestern China using remote sensing and GIS, International Journal of Remote Sensing, 25, 56591-5703, 2004b. Luo, G. P., Zhou, C. H., Chen, X., Li, Y.: A methodology of characterizing status and trend of land changes in oasis: A case study of Sangong River watershed, Xinjiang, China. Journal of Environmental Management, 88, 775-783, 2008. Hao, H., Ren, Z.: Land use/land cover change (LUCC) and eco-environmental response to LUCC in farming-pastoral zone, China, Agricultural Sciences in China, 8, 91-97, 2009. Yu, R., Liu, T., Xu, Yi., Zhu, C., Qu, Z., Liu, X., Li, C.: Analysis of salinisation of dynamics by remote sensing in Hetao Irrigation District of North China, Agricultural Water Management, 97, 1952-1960, 2010."

The number "44.9%" original manuscript: This was calculated from the data in the Table 5, e.g. : the changed area of ecotone to oasis during 2000-2008 (52438 ha) was divided by the total area of ecotone in 2000 (116 634 ha). The table 5 was updated with the percent of the changed and unchanged area in specific land cover type.

3.3 land cover change patterns: We have not the types of forest or grassland after merging initially classified land cover types. Therefore, we replaced these types with "oasis" as it was final land cover type in this study.

4 discussion: Thank you for this suggestion. It is very useful and helpful in the process of reorganizing the structure of the manuscript. We removed the explanations about radiometric rectification since they are not analyzed in the results as you suggested. We kept the explanations on the changes and trends of driving factors with corresponding data in the results section as it is a part of the goals in this study, but moved the analysis on the relationship of driving factors and land cover changes based on those data into the discussion section, as well as cited some other studies for scientific support.

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5 Driving forces: In the revised manuscript, we provided a brief information about the driving forces in the introduction, and then provided the sources of all related data used in the paper. At last, we analyzed the changes and trends of these data in the results to discuss the impacts of these factors on the land cover changes in the discussion section.

Tables: Table 1: We specified the boundaries of these thresholds in the method of classification section: Lower values represent low-density vegetation of >5% and <=20% of coverage, while higher values represent medium (>20% and <=50%) or high coverage vegetation (>50%). The area with vegetation cover of <5% are recorded as desert. (Please see the revised paper: page 9, line 29 and page 10, lines 1-3)

Table 4: It would be clear with explaining that they represent the unchanged area. We added explanations of these numbers as footnotes under the change matrix Tables (Table 4 and 5). We also included these numbers in Figure 3.

Figures: Figure 3: We included the total areas of changed and unchanged, as well as the data of changed area in each category in Figure 3. For Figures 6-8, we included the data sources in the dataset of materials and methods section.

Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/6/C1050/2014/sed-6-C1050-2014-supplement.pdf

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