Biogeosciences Discuss., 10, C9423–C9431, 2014
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Biogeosciences Discussions
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Interactive comment on "Application of remote sensing and GIS for detection of long-term mangrove shoreline changes in Ca Mau, Vietnam" *by* V. Tran Thi et al.

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Received and published: 8 April 2014

We would like to thank the anonymous reviewers for their positive and valuable comments which we used to improve our manuscript. Please kindly find our detailed responses to reviewers' remarks below.

Responses to remarks of Reviewer 1:

1. What's the mangrove cover in Vietnam? What's the mangrove cover in Ca Mau? It is important to know the percentage of mangrove cover (country x study area).

Answer: By 2012, the Ca Mau province had about 69,000 ha of mangroves accounting

for approximately 50% of the whole country (139,046 ha). This has been updated in the revised manuscripts.

2. p. 20049 (l. 20) How you measured or identified the loss of mangrove ecosystem services? Is it only about area loss or not? Which aspects were used to identify it?

Answer: We have not measured or identified the loss of mangrove ecosystem services. In this case, the authors cited opinions of the MAB Vietnam (2008) that mostly based on socio-economic studies on the aspects of shoreline protection, windbreaks, carbon sequestration, nursery area, biodiversity, migratory species, etc. .To avoid misunderstanding, we have rephrased the sentence and cleared the citation in the revised manuscript.

3. MINOR COMMENTS Reference 'Filho et al. (2006)' have to be replaced by 'Souza Filho et al. (2006)', p. 20048 (line 24) and p. 20049 (line 8). Filho = Junior = son. It is necessary to use the main last name also.

Answer: It has been changed in the revised manuscript.

4. Reference 'Mangroves for the Future (2012)' have to be replaced by 'IUCN (2012)', p.20050 (l. 2; 7-8), p 20059 (l. 21), p. 20061 (l. 15), 20065; (l. 23). 'Mangroves for the Future' is probably a program/project, whereas IUCN produced the document.

Answer: It has been changed in the revised manuscript.

5. P. 20051 (l. 4) Which natural and anthropogenic factors? It will be good to expose some of the natural and anthropogenic factors. Just to give some ideas.

Answer: Natural and anthropogenic factors could be currents (southwards long-shore drift), waves, deforestation (anthropogenic driven mainly by war strategies and conversion of land into aquaculture), reduction of sediment supply from the Mekong mouths by rapidly increasing the number of dams on the Mekong system, etc.

6. P. 20054 (l. 16) How many respondents were interviewed? What's the population

BGD
10, C9423–C9431, 2014

(inhabitants) of Ca Mau? What's the population (inhabitants) of Vietnam?

Answer: According to the General Statistics Office, the population of Vietnam in 2012 was about 88,772,900 people, of which there was 1,217,100 people in Ca Mau. In this study, 54 respondents were interviewed.

Responses to remarks of Reviewer 2:

The authors would like to express our appreciation to the reviewer for his/her positive comments.

- This study is interesting in a local, regional and global scale. Their goals are fully the achievable with the tools and programs for aerophotogrammetry (Landsat, DSAS version 4.2), the statistics performed as well as the applied time series. The results are explained through the analysis of the origin of sediments and the causes of the erosion.

- The number of transects (1129) and the distances between them are suitable, as well as the periods to assess geomorphological changes, and the calculations and layout of the coastal baseline for reference.

- The inventory and study of the current social reality were built based on surveys of aged people, experienced in the region who knew firsthand the changes studied.

- The authors acknowledge as an added value of their research that the specific history of the study area makes it difficult to compare their mangrove ecosystems with others elsewhere. It is undisputed that each site has its own characteristics, and that of Vietnam stand out. However, this claim is not without exaggeration and, since the conclusions are not very far from those of Alatorre et al. (2011), Berlanga-Robles & Ruiz-Luna (2011), Chen et al. (2013), Giri et al. (2011), Heumann (2011), Kovacs et al. (2011), Kuenzer et al. (2011), Nascimento et al. (2013), Péron et al. (2013), among others, the contrast could increase the added value of the results.

- The destruction of mangroves by misguided social problems (e. g. "over-capacity

BGD
10, C9423–C9431, 2014

in aquaculture and capture fisheries") certainly need to be addressed, but attempts to manage mangrove ecosystems that are frustrated by policy, legislative and regulatory complexity, confusion, contradiction and conflict are common to many developing countries. The commentary on the Vietnamese institutions that manage mangroves is interesting and should be read and studied by all their bureaucrats.

- The title is clear, it helps to determine the importance of the manuscript as a relevant tool for the research and management of coastal resources in other latitudes. The abstract clearly shows the importance of research, methods and the used tools, as well as the most telling results of the erosion and accretion processes along the Ca Mau coast, Vietnam. It is a scientific and relevant document that combines efforts to collect; process and analyze digital and field information for reading the littoral changes for an extended period.

- The authors determined the changes in the Ca Mau coast over time, caused by coastal erosion and accretion, which may be important to make decisions for conservation and recovery of coastal ecosystems. Clearly all calculations made of the variables considered are relevant for reading the coastal dynamic and for the implications of anthropic interventions and natural phenomena during the evaluation period and for the future.

- The multitemporal analysis of natural and anthropogenic changes affecting the mangrove forests and the management of digital information are appropriate, although atmospheric corrections of images could reduce noise. Although not clear enough in the text, one can presume that the authors considered very well how to manage the procedures and test the different resolutions and the availability of one or more images for several parts of the coastline (Table 3).

- P. 20052 (l 12-14). This methodology seems to be good for not overestimate vegetation cover.

- P. 20059. (l 6-7). The explanation of the results (in terms of erosion in some places

BGD
10, C9423–C9431, 2014

and sedimentation in others) is clear and satisfactory.

Besides, we would like to discuss further on the remarks:

1. Because of the large variations found in the geomorphology, it could be convenient to deepen on how these results could be useful for the management of the Vietnamese coastal resources. For the treatment of these large variations as management tools one could think in treating each littoral segment separately.

Answer: In this study, the segments were divided by coastal characteristics (erosion and accretion) and availability of remotely sensed data. The results show the mangrove shoreline is changing dynamically with erosion and accretion dominating along the East Sea and Gulf of Thailand respectively. Therefore, the main groups of geomorphological variations were considered as erosion (East Sea) and accretion (Gulf of Thailand). Along the East Sea coastline, adaptation measures that combines "soft" and "hard" solutions focusing on wave reduction, facilitating accretion and mangrove reforestation (page 20060, line 11-23) were discussed. Besides, management tool for accretion segments along the Gulf of Thailand were also mentioned in the discussion, page 20059, line 13-28. In the revised manuscript, the authors have rearranged this related discussion on management in section "Implication for mangrove management and conservation".

2. The authors list techniques that are variations of the linear and nonlinear modeling. For instance, although it may be truth that Otsu (1979) methods remains one of the most cited for thresholding, several better can be found and the authors might have tested some of them. However, admittedly, the results would not change substantially.

Answer: At a very early stage of this study, we started with manual technique to determine mangrove shorelines. Then digital and automated techniques have been updated. The clustering threshold technique of Otsu (1979) was used to improve the accuracy of mangrove shoreline detection. This is the technique we always use in binary image treatment. But for shoreline detection we learnt from Kuleli (2010) for

BGD
10, C9423–C9431, 2014

the first time. The result is better than the manual technique. We have not tested other thresholding methods. We do believe however that the results would not change substantially as the reviewer stated.

3. The same authors have published a paper with a slightly modified title (Tran Thi, V., Phan Nguyen, H., Dahdouh-Guebas, F., & Koedam, N. (2012). Application of remote sensing and GIS for detection and prediction of long-term seaward mangrove changes in Ca Mau, Vietnam. VLIZ Special Publication, 57, 180) and the research group has at least another paper on the very same topic (Tran Thi, V., Minh, T. L., Van Dam, T., Dahdouh-Guebas, F., & Koedam, N. (2012). Evolution of mangrove area in a war and land use change affected region of Vietnam (Ca Mau) over a 60 year period. VLIZ Special Publication, 55, 84).

Answer: Obviously, these two publications has been published respectively as posters at the international conference "Meeting on Mangrove ecology, functioning and Management - MMM3" (Galle, Sri Lanka, 2-6 July 2012) and the VLIZ Young Scientists' Day (Brugge, Belgium, 24 Feb. 2012). Then their abstracts have been published in the proceedings of MMM3 conference and the book of abstracts VLIZ Young Scientists' Day. For the full paper, the authors are very sure that this manuscript is the first occasion to present the detailed results of the study. Hereby, we would like to inform that the full paper of the second publication entitled "Changes in mangrove vegetation area and character in a war and land use change affected region of Vietnam (Ca Mau Peninsula) over six decades" is being under review of another scientific journal. These are parts of our research on impacts of sea level rise on mangroves in Ca Mau peninsula.

4. As for the references, although it is true that the number is often limited by every journal, the authors may consider as noted above for revisiting and incorporating some of the following papers:

Alatorre, L. C., Sánchez-Andrés, R., Cirujano, S., Beguería, S., & Sánchez-Carrillo, S. (2011). Identification of mangrove areas by remote sensing: The roc curve tech-

nique applied to the northwestern mexico coastal zone using landsat imagery. Remote Sensing, 3(8), 1568-1583.

Berlanga-Robles, C. A., & Ruiz-Luna, A. (2011). Integrating remote sensing techniques, geographical information systems (GIS), and stochastic models for monitoring land use and land cover (LULC) changes in the northern coastal region of Nayarit, Mexico. GIScience & Remote Sensing, 48(2), 245-263.

Chen, C. F., Son, N. T., Chang, N. B., Chen, C. R., Chang, L. Y., Valdez, M., ... & Aceituno, J. L. (2013). Multi-Decadal Mangrove Forest Change Detection and Prediction in Honduras,Central America, with Landsat Imagery and a Markov Chain Model. Remote Sensing, 5(12), 6408-6426.

Giri, C., Long, J., & Tieszen, L. (2011). Mapping and monitoring Louisiana's mangroves in the aftermath of the 2010 Gulf of Mexico oil spill. Journal of Coastal Research, 27(6), 1059-1064.

Ha, T. T. P., & van Dijk, H. (2013). Fishery livelihoods and (non-)compliance with fishery regulations: A case study in Ca Mau Province, Mekong Delta, Viet Nam. Marine Policy, 38, 417-427.

Ha, T. T. P., van Dijk, H., & Visser, L. (2014). Impacts of changes in mangrove forest management practices on forest accessibility and livelihood: A case study in mangrove-shrimp farming system in Ca Mau Province, Mekong Delta, Vietnam. Land Use Policy, 36, 89-101.

Ha, T. T. P., van Dijk, H., Bosma, R., & Sinh, L. X. (2013). Livelihood capabilities and pathways of shrimp farmers in the Mekong Delta, Vietnam. Aquaculture Economics & Management, 17(1), 1-30.

Ha, T. T. T., Bush, S. R., Mol, A. P., & van Dijk, H. (2012). Organic coasts? Regulatory challenges of certifying integrated shrimp–mangrove production systems in Vietnam. Journal of Rural Studies, 28(4), 631-639.

Ha, T. T. T., van Dijk, H., & Bush, S. R. (2012). Mangrove conservation or shrimp farmer's livelihood? The devolution of forest management and benefit sharing in the Mekong Delta, Vietnam. Ocean & Coastal Management, 69, 185-193.

Heumann, B. W. (2011). Satellite remote sensing of mangrove forests: Recent advances and future opportunities. Progress in Physical Geography, 35(1), 87-108.

Kovacs, J. M., Liu, Y., Zhang, C., Flores-Verdugo, F., & de Santiago, F. F. (2011). A field based statistical approach for validating a remotely sensed mangrove forest classification scheme. Wetlands Ecology and Management,19(5), 409-421.

Kuenzer, C., Bluemel, A., Gebhardt, S., Quoc, T. V., & Dech, S. (2011). Remote sensing of mangrove ecosystems: A review. Remote Sensing, 3(5), 878-928.

Nascimento Jr, W. R., Souza-Filho, P. W. M., Proisy, C., Lucas, R. M., & Rosenqvist, A. (2013). Mapping changes in the largest continuous Amazonian mangrove belt using object-based classification of multisensor satellite imagery. Estuarine, Coastal and Shelf Science, 117, 83-93.

Péron, C., Chatelet, A., Gensac, E., & Gardel, A. (2013). Mud bank migration from remote sensing and bathymetric data: The example of the Kourou River Estuary, French Guiana, South America. Journal of Coastal Research, 65, 558-563.

Answer: The authors are grateful for the reviewer's advice. We have visited the papers. All of them are very helpful for us in remote sensing and GIS studies on mangroves in general, and mangroves management in Ca Mau in particularly. Some of them have been incorporated into the revised manuscript.

5. P 20052 (l 5). The authors use ArcGis 9.3, but today a 10.2 version is available which might be easier to use, offer better analysis capabilities and allow finer comparison with other groups results.

Answer: Thanks to the version of ArcGIS 10.2, better analysis capabilities are offered by integrating the Image Analysis tool. This means we can perform NDVI here instead

of using ENVI or any other image analysis software. However, it should be noted that all the analysis of the study had been done in 2011. We used the familiar image analysis software, ENVI 4.7, for image analysis and ArcGIS 9.3 (DSAS extension) for mangrove shoreline rate calculating. Recently, ArcGIS 10.2 was used for mapping. In the scope of this study, we do believe that the updated version of ArcGIS does not cause substantial changes in the results. In order to avoid misunderstanding, in the revised manuscript, we have excluded the version of software used.

Interactive comment on Biogeosciences Discuss., 10, 20047, 2013.