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Geoscientific Instrumentation Methods and Data Systems Discussions

Interactive comment on "Fractal analysis of INSAR and correlation with graph-cut based image registration for coastline deformation analysis: post seismic hazard assessment of the 2011 Tohoku earthquake region" *by* P. K. Dutta and O. P. Mishra

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Q 1.The subject chosen is of great interest for society. Can remote sensing methods be applied to disaster assessment after earthquakes and do they show up as a change in observed fractal dimensions of the images? Unfortunately the questions are not addressed at a level where firm conclusions could be made. The presentation mixes arguments on using the method and developing and validating it. Therefore it is my

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judgement that the manuscript needs a major rewriting to be acceptable. As it now is I would not support publication. Interactive Comment Ans:I think I have made the necessary changes and also included sub topics regarding graph cut applications in the paper .My paper does not deal with remote sensing procedures but the development of a image registration algorithm and while registration is the matching of two images to extract some useful information using optimal transformation of fig 5 automatic extraction of deformation region has been segmented and fractal metric has been given to identify the level of deformation and the deformation region is a cluster identified on grounds of regional segmentation

Q 2:The work needs to clearly distinguish between development of method and use and validation of it. Some general background papers on the topic of natural disasters Ans:The paper is on optimal transformation of deformation field and associating a parameter of fractal dimension .We do not feel there is a need to include those references at this present point.Please check Mishra, O.P., Zhao D., Umino N. and Hasegawa A., Tomography of northeast Japan forearc and its implications for interplate seismic coupling, Geophysical Research Letters, 30 (16), 1850,doi:10.1029/2003GL017736, 2003 and Mishra, O.P., Lithospheric heterogeneities and seismotectonics of NE Japan forearc and Indian regions, D.Sc. thesis, GRC, Ehime University, Japan, 2004 That will provide a comprehensive background on the natural disaster scenario. A number of remote sensing works has been done earlier though that have used ENVISAT ASAR imagery for remote sensing applications include " Bartsch, A., Trofaier, A., Hayman, G., Sabel, D., Schlaffer, S., Clark D. & E. Blyth (2012): Detection of open water dynamics with ENVISAT ASAR in support of land surface modelling at high latitudes; Biogeosciences, 9, 703-714. doi:10.5194/bg-9-703-2012. " And " S.-E. Park, Bartsch, A., D. Sabel, W. Wagner, V. Naeimi, Y., Yamaguchi (2011): Monitoring Freeze/Thaw Cycles using ENVISAT ASAR Global Mode Remote Sensing of Environment 115, 3457–3467." which we were not very sure how to refer in our present analysis of ASAR imagery.

Q3:"Understanding global natural disasters and the role of earth observation", Guo

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(2010), could be used to set the stage. The authors do not use any "ground truth" to validate the results from the image processing in assessing damage. Similarly the image processing environment should be clearly stated, what are known before and what is our new contributions. Ans: I did not get the question very clearly.We think I have mentioned very clearly what we have included and how the method is better than other image registration scenarios.

Q 4:The language suffers from too long and complicated sentenses with unnecessary rep- etitions. Ans:I have tried to give an elaborate view of my method of study. I have tried to review my paper and keep the work as tidy as possible according to the reviewers comments.

Q 5:The abstract must express the goal of the paper, the work done and the results. Unnec- essary repetition of earthquake, Tohoku, tsunamis. Remove last part of last sentence "need ...". Ans:Made necessary changes with the abstract.Even I admit that the abstract is much better and would like the reviewers to suggest my changes.

Q 6:Introduction section needs to be rewritten clearly setting the stages. The paper is not on earthquakes but on image processing methods. Make references to other remote- sensing/disaster assessment papers. How could the validation of disaster assessment be made? In general a much more stringent approach is needed. Less adjectives and more facts. As there is a chapter on methodology, why not include all image processing and segmentation details into that chapter. Ans:I have tried to be stringent with the facts now.A proper validation was necessary which has been done now to the best of my abilities.The first paragraph details the earthquake of tohuku with studies by Mishra et al 2003 and Nagai et al 2001 signifying the type of damage in north east Japanese fore-arc region.The second paragraph details the method of analysis done in the proposed work based on ASAR images diverse set of deformation patterns acquired from INSAR images.We also include a brief overview on the suitability of the measure to calculate fractal dimensions and entropy changes.The third paragraph deals with the utilities of the studies based on similar work done in determining the

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application of remote sensing using image registration applications in environmental monitoring studies, change detection and weather forecasting.

Q 7:The methodology chapter is a key to the paper and the first part of it is too slim and confusing and needs much more work. Still the quality slightly improves in these technical sections. There should be some mentioning on handling of errors. What are the uncertainties for estimates of e.g. fractal dimension? Ans:Fractal dimensions has been introduced as a metric in the later chapters in order to identify the deformation field s associated with the image for regional segmentation analysis.

Q 8:The section 2.1 should modified by simplifying language. E.g. last sentence on p. 154 and first on 155 mix several "goals", tell several stories simulataneously. Last sentence introduces unknown concept "alpha expansion" which is also used in conclusion section without any explanation. Ans:I think we have made significant modifications We have also removed the statement that has caused a confusion “Centering that point, the displacement window obtained has been matched based on a threshold value for every pixel points with the same label share certain visual characteristics.” Which need not been there.I have included alpha expansion concept in detail satisfying the needs of the paper.

Q 9:Section 2.2 is the main methodology "what has been done". It suffers from a lack of stating "others have done" or "previously known" and "We have done". Graph cut methods can be computationally costly which should be commented. Ans: We have segregated the contents of the methodology into two sub chapters previously not explained to suit the reviewer needs. 2.3 Efficiency of graph cut with α expansions for remote sensing applications included as a sub chapter to include what we have done based on the changes made in the work of Kolmogorov and Zabih, 2005 refered by us in the paper.The chapter also explains why graph cut with α expansion is better than other methods.

Q 10:Section 3 describes the main results. Segmentation techniques make a box

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counting estimate of fractal dimension possible. The results should be more clearly stated and the picture captions properly describe what is presented. The unsertainties need to be expressed. Last sentense on p.160 claims that maximum devastation is empirically measured. How is this validated from other sources? Similarly the end of the paragraph describes an estimate that one(!) sq km has undergone maximum devastation, which is unreasonably low value. This shows the demand for "ground truth". Section 3 or the result section has been diluted into three sub chapters 3.1 Fractal Analysis of Damage;3.2 Post Seismic Hazard Assessment and histogram Analysis 3.3 Area Estimate and Segmentation.Although Fractal analysis has been done on segmented images which has been retrieved from pixel values that have suffered pixel displacements.We have reconstructed the images in fig 7 based on the deviations to identify the deformation map.The ground truth is that .997 sq km has been identified from 1031 pixels where we have taken a pixel to be 30 m unit scale which have undergone maximum displacement based on the label associated with them.Other regions in the group 10-20,20-30 30-40 have undergone varied changes and the number of pixels has been identified.Fractal dimension is a metric associated with the deformation field concurrent segmentation and registration as mutually supporting processes for region based cluster mapping.So After segmentation we give a metric for the deformation and also analyze the change in entropy.The variation of fractal dimension and entropy are considered likely precursor of catastrophic failure as suggested by Lu et al 2005 referred in the paper. Section 4, conclusions similarly are weak unsupported statements needing a validation from other sources. Fractal dimensions should be available from other sources as well and can be estimated from any picture directly, as a reference. Graph cut is conspicuously established and its utility in disaster response with fractal distribution estimation has been tried to be established by us in the conclusion.The utility of the fractal distribution metric lies in the fact that we allocate a metric based on regional segmentation analysis.So once the deformation fields are recovered the metric can be associated and utilized in future disaster warning resources.

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