Table of Contents

List of Figures

List of Appendices

No table of figures entries found.

1. Introduction

The enclosed report as completed by Altamira Information presents detail on the satellite selection, data acquisition and data processing completed as part of the Stage 1 program as well as detailing deliverables. The report goes onto summarise the baseline results for all four proponents areas, and provides examples of areas experiencing natural and anthropogenic ground deformation independent of CSG activities.

This Appendix summarises the Altamira Information 'Stage 1' Baseline study report as submitted to the industry proponents at the conclusion of the Stage 1 program, and applies some context to the findings presented.

2. Stage 1 Study Program

The main objective of this project was to establish a baseline of ground motion over the area of interest for comparison with ongoing surface deformation monitoring during approved CSG developments.

High resolution ground surface radar satellite imagery was collected using a synthetic aperture radar (SAR). During data acquisition the satellite continuously transmitted microwaves to the Earth's surface and recorded the characteristics of the waves reflected back to the satellite (amplitude and phase). The change in amplitude and phase between two images is then measured (representing the satellites distance from the Earth's surface at different moments in time). The difference between two measurements within a time series indicates a possible spatial deformation at surface (x, y and z).

2.1 Study Area

The study area comprised tenements from all four industry proponents, and is presented in Figure 1 in the report. The study area covered some 55,000 km^2, and included land utilised for a number of different land uses. Land use and land cover impacts the ability of the satellite processing technology to record accurate ground motion measurements, and impacts motion recorded, so an overview of land cover is also presented.

2.2 Satellite Selection and Data Acquisition

Only a limited number of satellites had SAR data available to enable this historical review to be completed. Typically radar satellites are mission specific, and only collect data over specific areas as per the mission requirements and programming. The Advanced Land Observation Satellite (ALOS) selected for this program was operated by the Japanese Space Agency (JAXA) utilising a phased array L Band sensor.

The ALOS mission had a background acquisition mode, which meant the satellite collected data over the area of interest (AOI) independent of any mission programming. This together with the uniform data archive, the good coverage and the high data resolution and coherence provided by the L-band ALOS satellite, provided a more robust data set given the scope of works.

A total of seven historic ascending data tracks were selected which covered the study area, with these tracks comprising a total of 698 ALOS SAR images. The period of study was December 2006 to February 2011, with the data tracks yielding more than 30 million measurement points, representing a mean point density of 600 points/km^2.

2.3 SAR Data Processing

Once acquired the SAR data was then processed through the application of Persistent Scatter Interferometry (PSI) techniques to natural radar reflectors. Altamira Information's proprietary Stable Point Network (SPN) is an algorithm belonging to the PSI family of software, and is used to extract precise displacement and position information of radar stable points by identifying high quality reflectance points in the radar imagery.

Once identified model fitting methodologies were applied to these high quality points to derive the precise height and displacement measurements.

Satellite tracks were then merged with unique reference points in the central track established and used for calibration purposes. Where track areas overlap a mask was applied to ensure information was not duplicated.

Finally vector files containing the details of the ground motion through time for each measurement point (Time Series), including the location, absolute accumulative displacement (with respect to a spatial and temporal reference), the mean annual displacement rate and the main InSAR processing quality parameters were generated.

2.4 Data Delivery

The delivered products were produced separately for each proponent for their respective area of interest, without including data from other proponents' areas. Due to the size of the study area and the degree of processing required the program was divided in smaller areas and delivered in batches at different times. Each product batch included vector data, geocoded TIFF images and GIS maps.

The vector data was delivered in an ESRI GIS Shape file format (.shp). Due to the large number of data points the Shape file was divided into more than one vector file for computational efficiency, following a quadrants division layout structure.

The geocoded TIFF image files were delivered as digital images containing the mean annual rate of ground motion retrieved from the SPN analysis. This file provides a rapid means of understanding the location and magnitude of any recorded motion. The mean annual rate was presented as a colour scale, with a mean annual displacement scale displayed in increments of 8 mm/yr. This was determined based on statistical analysis of data outputs. Finally these images were converted and delivered as maps for each area.

2.5 This Report

Following the delivery of each of the industry proponents final data sets in July 2012 it became apparent that any ground motion assessment works would be limited by tenement boundaries, as each proponent had only been provided data for their AOI. In order to more accurately define baseline conditions on a regional scale the proponents agreed that Altamira Information should provide a summary report and assessment that included all four proponents AOI and utilising the entire dataset.

The baseline study findings summarised below and presented in the baseline report as received from Altamira Information (**Appendix A**) is applicable to the entire study area and is not specific to the QCLNG project area.

3. Stage 1 Baseline Study Findings

3.1 Discussion

Results were presented as average annual deformation maps along with time series data for the period of study. These maps enable any large scale ground movement patterns that might be present over the processed area to be identified. It was summarised that in this study, no significant large-scale ground deformations have been detected. However, several areas with local patterns of deformation were found that were related to natural or anthropogenic factors. Movement that was detected generally occurred over irrigation pools and ponds, rural roads, fields and riverbanks. Altamira Information indicates that the region generally appears to be stable.

An average annual displacement map covering the study area is presented in **Figure 3-1**.

A histogram of the Stage 1 data shows that 97% of the total data set demonstrate stability (movement below limits of the study accuracy). Only 0.3% of the points have a magnitude of ground motion higher than 15 mm/year and these points are distributed throughout the area of interest and do not follow any significant large-scale spatial trend.

Altamira Information go on to note that this ground motion baseline assessment has been conducted over a period where the CSG extraction phase for each of the four proponents has yet to begin in full. As such any ground motion recorded is unlikely to be related to CSG extraction activities. However, there are several existing operational CSG fields in the study area where no significant ground surface motion has been detected by this study.

Altamira Information also noted that natural or anthropogenic factors may also impact the quality and the final density of the measurements. It is also noted that one important condition which should be met to ensure the accuracy of the motion measurements is ensuring the ground surface remains invariant over time. Given the land use in the area, the ongoing development works (including CSG) and natural processes like erosion and sedimentation that act on the ground surface, such a condition is unlikely to be met.

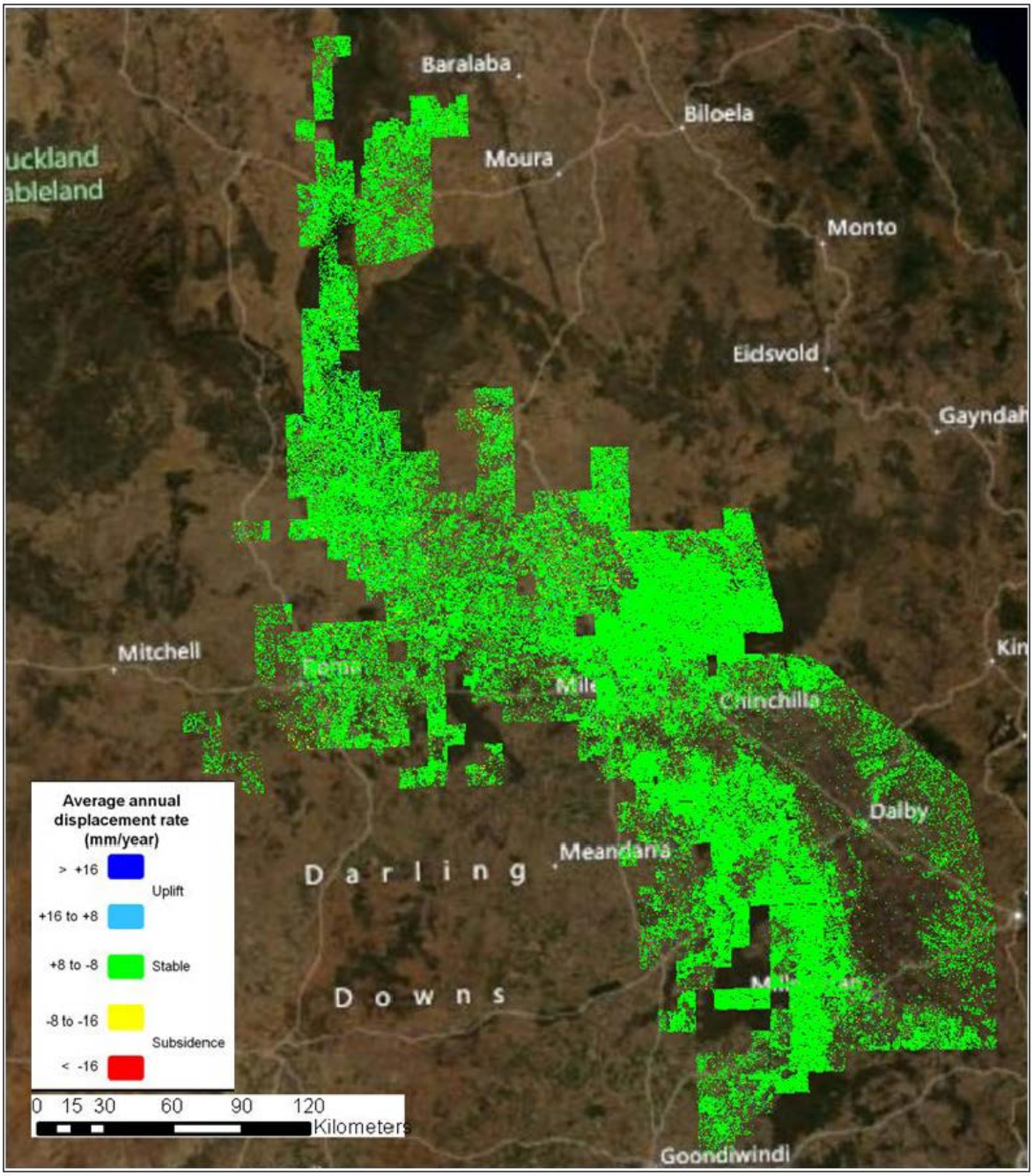
3.2 Conclusions

In summary the results of this study do not show any large scale pattern of ground motion, with the majority of the study area exhibiting stable conditions (less than 8 mm of ground motion per year of the study).

The InSAR analysis has shown areas of natural/anthropogenic ground deformation in space and time and independent of CSG extraction activities. These areas are heterogeneously distributed within the study area, and examples include fields and rural tracks. Additionally, several uplift patterns are observed along selected riverbanks, possibly related with the heavy rains that occurred during 2010 and 2011.

The completion of this project has resulted in the development of a regional baseline dataset for ground motion prior to large-scale CSG extraction operations commencing across the Surat and Bowen Basins. The establishment of the regional ground motion baseline allows for comparisons with future ground motion monitoring data to assess the effects of CSG production on ground motion.

Figure 3-1 Average Annual Displacement Rate Map



4. Stage 1 Findings - QGC Tenement Areas

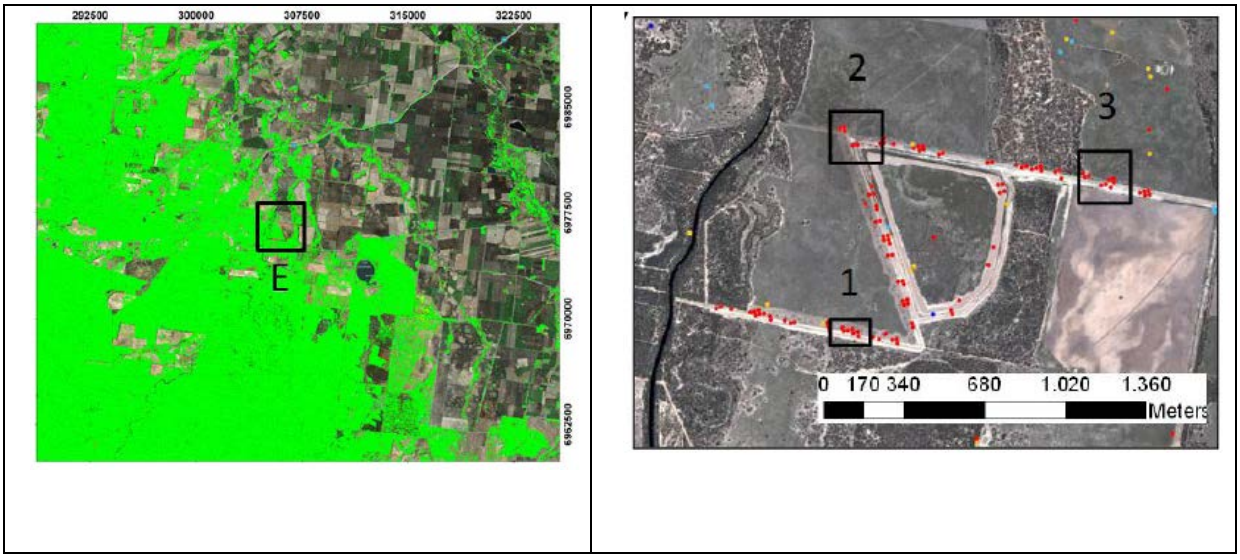
Of the six example areas identified by Altamira Information as having ground motion included in the appendices attached to the baseline report, only one area occurred within the QCLNG tenement area, namely 'Area E'. All areas provide a case study in the influence of natural processes and anthropogenic activities on ground motion data packages. While Altamira information provided an initial discussion this discussion was provided with limited local knowledge of terrain and land use. To provide more background and context to these findings this area is discussed further below.

4.1 Area E

The area identified as 'Area E' in Appendix A of the Altamira Information report is located in the southern portion of the Broadwater field as part of the SDA. It should be noted that there was no CSG abstraction activity occurring at the time the Stage 1 ground motion baseline program was completed.

As can be seen in the accumulated displacement map **Figure 4-1**) displacement occurred along lineaments that can be clearly associated with access tracks in and around an earth structure.

Figure 4-1 Area E – Broadwater



The time series data for these data streams are also presented in the Altamira report. These time series results were summarised as presenting a similar time evolution of displacement along the linear features in the area. Altamira go on to state that this could indicate that the motion detected forms part of the same deformation system. In this case the system is most likely compression of the access track as vehicles travel back and forth around the structure. This is a clear demonstration of an anthropogenic activity (construction) impacting ground motion independent of CSG extraction activities.