Geomatics Canada
Scientific Presentation 7

GROUND DEFORMATION AT THE AQUISTORE CO_2 STORAGE SITE IN SASKATCHEWAN (CANADA) MEASURED BY RADARSAT-2 DINSAR

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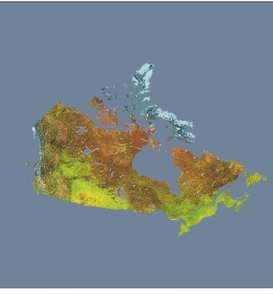
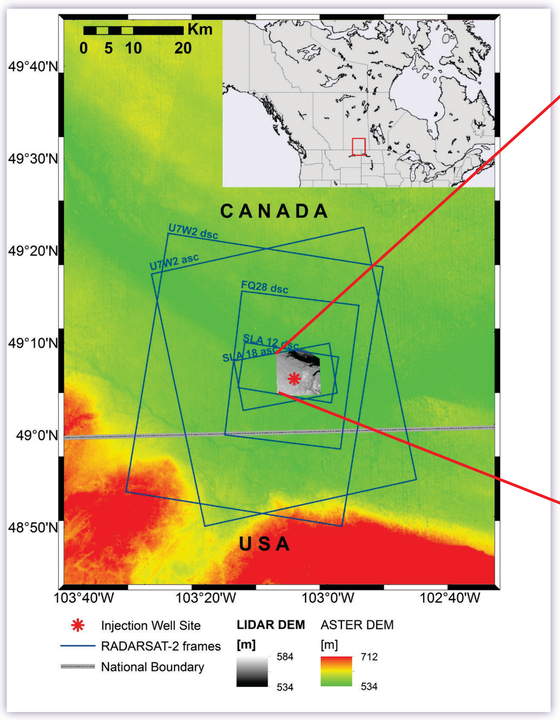
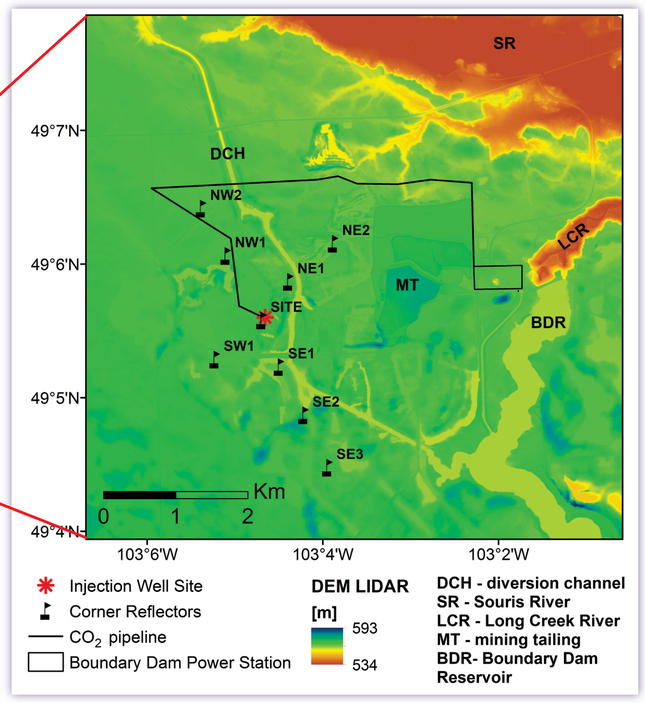


INTRODUCTION: The research objectives of the Aquistore CO_2 storage project are to design adapt, and test non-seismic monitoring methods for measurement, and verification of CO_2 storage and to integrate data to determine subsurface fluid distributions, pressure changes, and associated surface deformation. Aquistore site is located southeast of Estevan township on the south flank of the Souris River in southeastern Saskatchewan, Canada. Large pit mining operation has been carrying out there and reclaimed to a depth of ~20–25 m. The targeted CO_2 injection zones are within the Winnipeg and Deadwood formations located at >3000 m depth. We performed MSBAS DInSAR analysis to recognize the ground stability condition of the Aquistore injection site for the two years from June 2012 to July 2014, prior to CO_2 injection. Calculated MSBAS DInSAR deformation maps will be used as background information to detect the ground stability conditions of the site during the CO_2 injection and the storage. MSBAS DInSAR deforemation maps will be used as an independent data source for validation of in-situ monitoring.

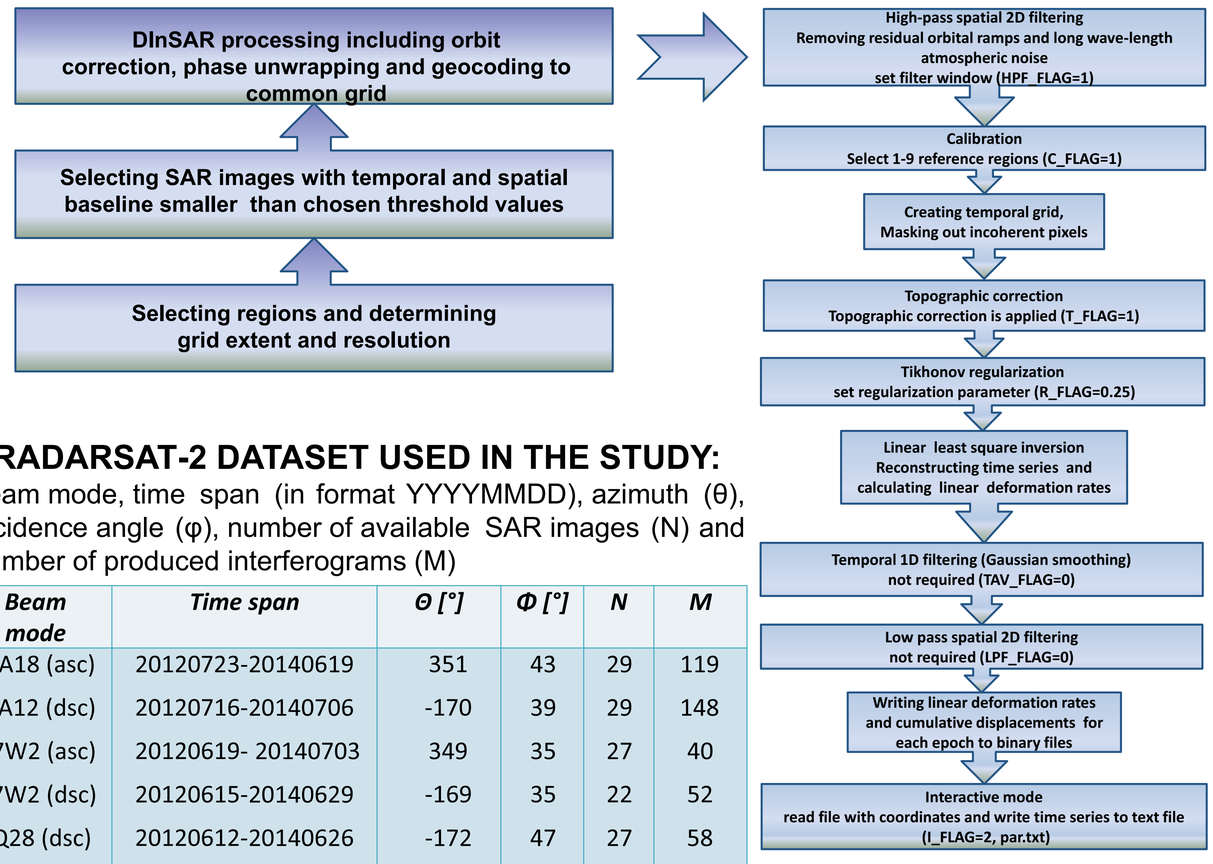


LOCATION: Aquistore project study area, southeastern Saskatchewan, Canada



Detailed injection study site. The background is LIDAR DEM with horizontal accuracy of 45 cm and fundamental vertical accuracy on flat hard surfaces of 30 cm.

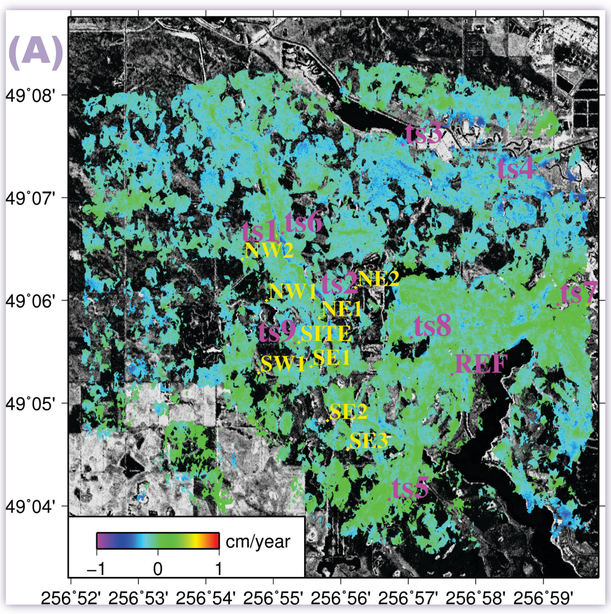
PROCESSING: Flowchart diagram of MSBAS DInSAR processing algorithm used in the study



RADARSAT-2 DATASET USED IN THE STUDY:

beam mode, time span (in format YYYYMMDD), azimuth (θ), incidence angle (φ), number of available SAR images (N) and number of produced interferograms (M)

Beam mode	*Time span*	*Θ [°]*	*Φ [°]*	*N*	*M*
SLA18 (asc)	20120723-20140619	351	43	29	119
SLA12 (dsc)	20120716-20140706	-170	39	29	148
U7W2 (asc)	20120619- 20140703	349	35	27	40
U7W2 (dsc)	20120615-20140629	-169	35	22	52
FQ28 (dsc)	20120612-20140626	-172	47	27	58
Total	20120612-20140706			134	417



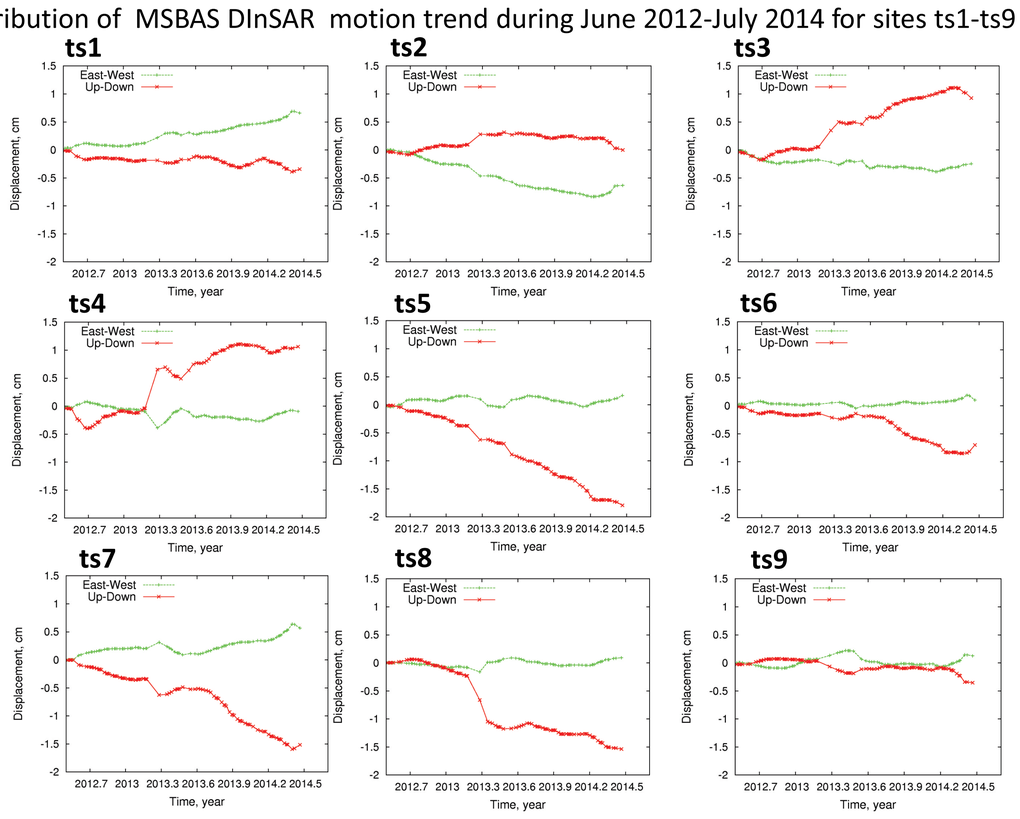
CONCLUSIONS

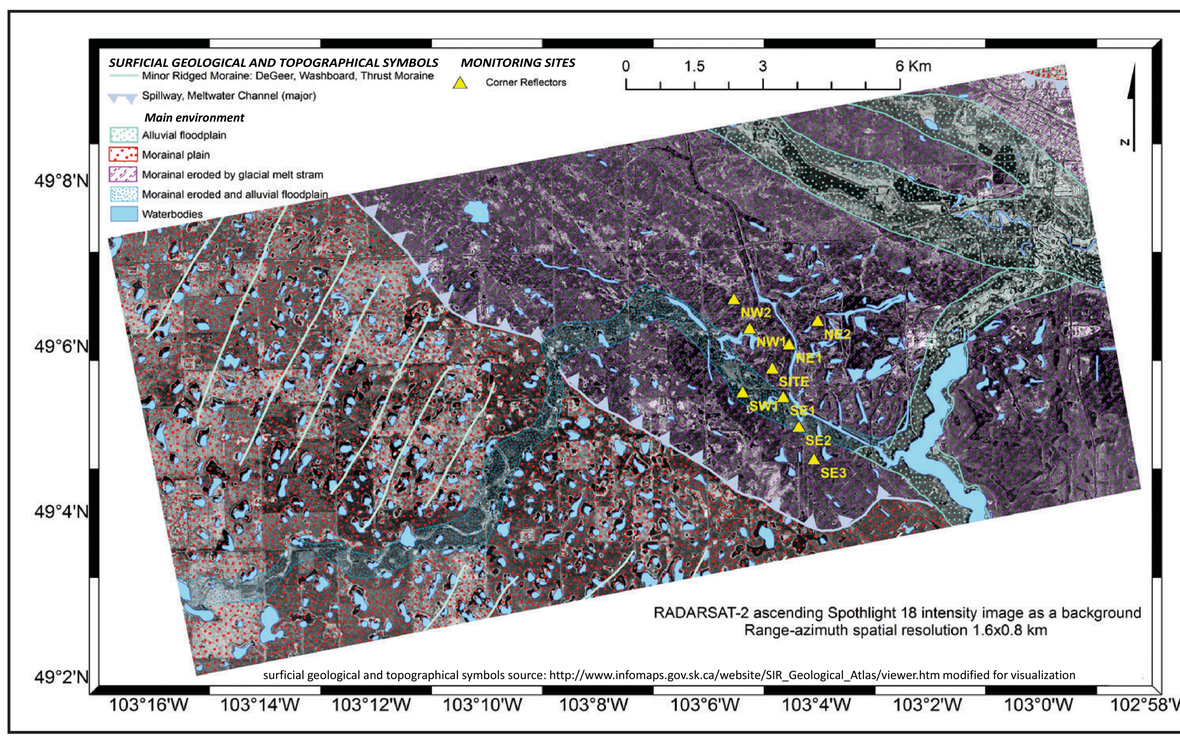
MSBAS DInSAR deformation maps of the Aquistore site were calculated from over four hundred interferograms using five different beam modes of RADARSAT-2 satellite. MSBAS DInSAR results revealed ground deformation up to 1 cm/year during June 2012-July 2014. Horizontal motions of east-west direction were noticed along the Boundary-Rafferty diversion channel (ts1 and ts2). Uplift was observed particularly around Souris river valley (ts3 and ts4) and subsiding motions were identified along the diversion channel (ts5, ts6) as well as in the former mining area (ts7, ts8). The Aquistore injection well site vicinity is stable, however, some seasonal changes were observed (ts9). Surface ground motions observed by MSBAS DInSAR technique are not related to CO_2 injection but caused by natural and anthropogenic processes, such as snow melting surface moisture fluctuations, ground and surface water level changes and post-mining activity.

RESULTS: (A) Horizontal and (B) vertical MSBAS DInSAR linear deformation rate maps for June 2012–July 2014, reference point is marked by magenta dot and labeled REF, time series for selected sites are marked by magenta and labeled ts1–ts9, Aquistore injection well is labeled SITE, GPS monitoring stations and corner reflectors are as follows NE1, NE2, SE1–SE3, SITE, SW1, NW1, NW2. RADARSAT-2 Spotlight intensity image is used as background.
Standard deviation for East-West motion is 0.14 cm/year and for Up-Down motion is 0.22 cm/year.

TIME SERIES OF GROUND DEFORMATION FOR SELECTED SITES

Distribution of MSBAS DInSAR motion trend during June 2012-July 2014 for sites ts1-ts9





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