Stability analysis of Lake Urmia bridge, northwest Iran: the effect of thermal expansion on InSAR measurements

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ABSTRACT:

In this study we investigate stability of Urmia Lake bridge (also known as Shahid Kalantari’s highway bridge) in northwest of Iran using high-resolution satellite radar imagery. The UL bridge crosses lake Urmia and together with two embankments on its eastern and western side makes Lake Urmia Causeway (LUC). The causeway connects East Azerbaijan and West Azerbaijan together reducing the driving distance between them by 135 kilometers. The bridge has a total length of about 1.7 km and consists of 4 different parts with symmetric geometrical structures including approach, transition, viaduct and arch bridge in its eastern and western parts. The bridge includes 18 caissons filled with concrete; two of them in the embankments and others in the lake. The steel deck of the bridge has three parts; the central part intended for single-track railway while two outer parts are for double lane vehicle traffic.

Preliminary analysis using Envisat, ALOS and TerraSAR-X data show that two embankments on the eastern and western side of the bridge are subject to subsidence due to consolidation caused by dissipation of excess pore pressure in embankments. Here we complement the previous study and assess stability of the bridge using high resolution X-band radar imagery acquired in spotlight mode by TerraSAR-X satellite from February 2014 to February 2015.

We show that thermal expansion of the bridge clearly appears in the interferograms causing a correlation by up to 96\% between the phase difference over the bridge and the difference in temperature of the images used for interferogram generation. Such nonlinear effect influences long-term stability analysis of the structure using standard InSAR time-series processing and therefore should be considered and modeled as an additional parameter in the chain of processing before estimating long-term velocity of the object.