

Assessing the Impact of the Turkish Earthquake on Cultural Heritage

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Assessing the impact of the February 6th earthquake, which occurred in South-eastern Turkey near the Turkey-Syria border, on cultural heritage sites is crucial to ascertain the cultural and historical cost of the disaster. These twin quakes, which had a magnitude of 7.8 and an after-shock magnitude of 6.7, resulted in widespread damages with the official death toll figure rising to 55,000+ and over 107,000 injured across the eleven cities most affected. The zone of occurrence of this earthquake is a hotbed for seismic activity because of the complicated network of plate boundaries underlying the area. This zone is under-laid by three major plate boundaries namely the Anatolian plate, the Arabian plate and the African plate. It is characterized by series of lateral strike-slip fault movement which ultimately results in series of frequent earthquakes of varying magnitude.

The aim of this study is to detect damaged cultural heritage sites in the earthquake zone in Turkey, by using SAR (Synthetic-Aperture Radar) images. The affected cities are home to some of Turkey's most iconic heritage sites. In this study, TerraSAR-X high-resolution X-band data and open access Sentinel-1 data was used. At some locations we also used Google Earth images as a reference images.

To detect damages on cultural heritage sites, two methods were adopted. First, since TerraSAR-X have high resolution spotlight mode, we tried to 'visually recognize' damages on historical buildings by comparing SAR images with terrestrial and UAV photos from the area taken by locals, archaeologists, and reporters. Second, we processed open access Sentinel-1 data of different dates, before and after the earthquake using 'coherence change detection' to detect the changes in specific structures in the city. The research will focus to a large extent the cultural and historical cost of the impact of earthquake and also highlight the further impacts of after-shock on damaged cultural heritage sites through time series analysis of images. We realized that some damaged buildings continued to collapse several days later as a result of subsequent aftershocks which shows the need to initiate mitigative measures as fast as possible to save what is left of the important monuments.

土耳其地震对文化遗产的影响评估

对 2 月 6 日发生在土耳其东南部靠近土耳其-叙利亚边境的地震对文化遗产影响的评估，对于确定这场灾难的文化代价和历史代价至关重要。这两次地震震级分别为 7.8 级和 6.7 级，造成了大范围的破坏，官方公布的死亡人数达到 55000 多人，受影响最严重的 11 个城市总计有 107000 多人受伤。由于该地区复杂的板块边界网络，本次地震发生的区域成为了地震活动的温床。该地区被三个主要板块边界覆盖，即安纳托利亚板块、阿拉伯板块和非洲板块，板块活动的特点是一系列横向的冲击-滑动断层运动，最终导致一系列不同程度的频繁地震。

这项研究的目的是通过使用 SAR（合成孔径雷达）图像来检测土耳其震区文化遗址的受损情况。受影响的城市是土耳其一些最具代表性遗产的所在地。在这项研究中，我们使用了 TerraSAR-X 卫星高分辨率 X 波段数据和开放的 Sentinel-1 数据。在一些地方，我们还使用了谷歌地球的图像作为参考图像。

为了检测文化遗址的损害情况，我们采用了两种方法。首先，由于 TerraSAR-X 具有高分辨率聚束模式，我们试图通过比较 SAR 图像和当地居民、考古学家和记者拍摄的该地区的地表和无人机照片来 "视觉识别" 历史建筑的损坏情况。其次，我们利用 "相干性变化检测" 处理了地震前后不同日期的 Sentinel-1 数据，以检测城市中一些特定结构的由于地震发生的变化。该研究将在很大程度上关注地震导致的文化和历史成本，并通过图像的时间序列处理分析震后受损文化遗产地受到的进一步影响。我们意识到，由于随后的余震，一些受损的建筑在几天后会发生继续的倒塌，这表明有必要尽快启动缓解措施，以挽救重要古迹的剩余部分。