Multi-temporal landslide inventory for a study area in Southern Kyrgyzstan derived from multi-sensor optical satellite time series data for the time period 1986 – 2013 (http://doi.org/10.5880/GFZ.1.4.2020.002)

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1. Licence

2. Citation

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The data are supplementary material to:

Behling, R., Roessner, S., Golovko, D., & Kleinschmit, B. (2016). Derivation of long-term spatiotemporal landslide activity—A multi-sensor time series approach. Remote Sensing of Environment, 186, 88–104. https://doi.org/10.1016/j.rse.2016.07.017

3. Data Description

Multi-temporal landslide inventories are important information for the understanding of landslide dynamics and related predisposing and triggering factors, and thus a crucial prerequisite for probabilistic hazard and risk assessment. Despite the great importance of these inventories, they do not exist for many landslide prone regions in the world. In this context, the recently evolving global-scale availability of high temporal and spatial resolution optical satellite imagery (RapidEye, Sentinel-2A/B, planet) has opened up new opportunities for the creation of these multi-temporal inventories.

To derive such multi-temporal landslide inventories, a semi-automated spatiotemporal landslide mapper was developed at the Remote Sensing Section of the GFZ Potsdam being capable of deriving post-failure landslide objects (polygons) from multi-sensor optical satellite time series data (Behling et al., 2016). The developed approach represents an extension of the original methodology (Behling et al., 2014) and facilitates the integration of optical time series data acquired by different satellite systems. The goal of combining satellite data originating from variable sensor systems has been the establishment of longest possible time series for retrospective systematic assessment of multi-temporal landslide activity at highest possible temporal and spatial resolution. We applied the developed approach to a 2500 km² study area in Southern Kyrgyzstan using an optical satellite database acquired by the Landsat TM/ETM+, SPOT 1/5, IRS1-C LISSIII, ASTER, and RapidEye sensor systems covering a time period between 1986 and 2013. A multi-temporal landslide inventory from 2009-2013 derived from RapidEye satellite time series data is available as separate publications (Behling et al., 2014; Behling and Roessner, 2020).

The resulting systematic multi-temporal landslide inventory being subject of this data publication is supplementary to the article of Behling et al. (2016), which describes the extended spatiotemporal landslide mapper in detail. This multi-sensor approach prioritizes most suitable images within the available multi-sensor satellite time series using parameters, such as spatial resolution, cloud coverage, similarity of sensor characteristics and seasonality related to vegetation characteristics with the goal of establishing a robust back-bone time series for initial detection of possible landslide objects. In a second step, this initial analysis gets more refined in order to achieve the best possible approximation of the date of landslide occurrence. For a more detailed description of the methodology of the extended spatiotemporal landslide mapper, please see Behling et al. (2016).

In general, this landslide mapper detects landslide objects by analyzing temporal NDVI-based vegetation cover changes and relief-oriented parameters in a rule-based approach combining pixel- and object-based analysis. Typical landslide-related vegetation changes comprise abrupt disturbances of vegetation cover in the result of the actual failure as well as post-failure revegetation which usually happens at a slower pace compared to vegetation growth in the surrounding undisturbed areas, since the displaced landslide masses are susceptible to subsequent erosion and reactivation processes. The resulting landslide-specific temporal surface cover dynamics in form of temporal trajectories is used as input information to identify freshly occurred landslides and to separate them from other temporal variations in the surrounding vegetation cover (e.g., seasonal vegetation changes or changes due to agricultural activities) and from permanently non-vegetated areas (e.g., urban non-vegetated areas, water bodies, rock outcrops).

4. File Description

The data are provided in vector format (polygons) in form of a standard shapefile contained in the zip-file *2020-002_Behling_et-al_2016_landslide_inventory_SouthernKyrgyzstan_1986_2013.zip* and are described in more detail in the following:

- The study area is located in a highly landslide prone region in Southern Kyrgyzstan mainly in the Osh province and covers an area of 2500 km².
- Most of the landslides in Southern Kyrgyzstan occur in form of rotational and translational slides in weakly consolidated Quaternary and Tertiary sediments.
- The landslide inventory is provided in form of a standard shapefile containing a vector dataset of polygons comprising the spatial extent of each mapped landslide object.
- Each landslide polygon of the inventory is further characterized by the following attributes:
    - *Year*: The year of landslide occurrence, which is defined by the image acquisition in which the landslide was recognized for the first time (see attribute *Date_ref* for details). Note: At the beginning of the available satellite time series, temporal gaps between image acquisitions may be longer than one year; please see Fig. 1 in Behling et al. (2016) for more details.

    - *Date_o*: Image pair used to map the landslide extent, i.e., primary pair of images which are most suitable to analyze landslide-specific vegetation disturbances.
    - *Date_ref*: Secondary pair of images (image acquisitions available in between the image pair of Date_o) used to refine the date of landslide occurrence as close as possible to the actual failure date.
    - *Area*: Landslide size in square meters
- Mapped landslides have occurred during the time period of available satellite data between 1986 and 2013.
- The mapped landslides include first-time failures within the analyzed time period as well as reactivations of these already mapped landslides comprising of enlargements of the original landslides as well as detectable relocations of material within an already mapped landslide.
- The derived inventory contains 1583 landslides objects (polygons) which have occurred between 1986 and 2013. Their sizes range between 50 m² up to 2.8 km² and they cover a total area of 33.2 km². The highest overall landslide activity has been observed for the years 2003 and 2004.
- The automatically derived landslide mapping results were thoroughly validated by visual inspection of available high-resolution satellite imagery and during field investigations conducted in Southern Kyrgyzstan. False positives were manually removed from the dataset and in a few cases missing landslide objects (false negatives) were manually added to the inventory, if they were recognized as such during the validation of the automatically detected landslide objects.
- The obtained multi-temporal landslide inventory does not differentiate between landslide types. Landslides get mapped, as long as they can be associated with characteristic landslide-specific vegetation cover disturbances which are detectable within the temporal trajectories contained in the NDVI time series. The developed methodology is not sensitive to slow moving landslides, if they do not result in detectable disturbances of the vegetation cover. Moreover, there are also limitations in the detection of landslides occurring in non-vegetated areas.

5. References

Behling, R., Roessner, S., Golovko, D., & Kleinschmit, B. (2016). Derivation of long-term spatiotemporal landslide activity—A multi-sensor time series approach. Remote Sensing of Environment, 186, 88–104. https://doi.org/10.1016/j.rse.2016.07.017

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