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Assessment of natural hazard damage potential and risk exposure using airborne laser scanning – a case study from Vorarlberg, Austria

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Owing to the rapid pace of development of sensors in airborne and spaceborne Earth Observation (EO) the amount of data available for natural hazard assessment has increased tremendously. This process, however, leads to an increase of demanded manpower to handle, manually process and evaluate the data: a requirement that cannot be fulfilled as the demand grows, especially in the field of evaluation of multitemporal data. Governmental organizations have normally very strict budget resources, therefore repeated or routinely used evaluations cannot be extended as frequently as the socio-economic development would request it. Therefore there is a great need for automated or computer-assisted data evaluation, and data integration, as well as for the knowledge transfer from research institutions to governmental offices and agencies.

The overall objective of our project is the integration of remote sensing techniques into the assessment of risks and potential losses and damages caused by natural hazards. The project covers both the aspects of risk exposure – to understand where natural hazards might occur – and of damage assessment – to estimate the potential damage and losses caused by natural hazards.

To this end the creation and continuous update of the map of buildings and other artificial objects has been started in the area of interest, the Austrian federal state of

Vorarlberg. With the help of such an inventory it is possible to account for the potential of estimated economic loss or damage at a monetary value for any predefined type of hazards.

The project is aimed at the following objectives that are mostly unresolved at the scales of our studies:

(a) From the point of view of the data integration, in number of cases there is no standardized co-registration procedures for different EO data sources and in-situ data available. This is especially problematic in alpine areas: there are co-registration difficulties in dense forests due to missing surface features. Since the relief in the area of interest is high, co-registration errors lead to a false positioning in the 3D space. A high co-registration error level is not tolerable for several model types of various hazards working in 3D, since the model result may lose its applicability in the real life.

(b) From the point of view of the development of the inventory of endangered objects the problem is that there is no automated and standardized 3D building object and infrastructure classification procedures for different data sources available.

Furthermore, in the case of some hazard types, there are some factors that *decrease* the vulnerability of man-made structures. An example for that is the existence of protection forests: they reduce the risk of snow and rock avalanches, rock falls and rock slides as they slow down, or even hamper the motion of the moving material. The effect of these forests is also accounted for in our studies.

In order to achieve these goals new approaches for improved image processing and classification of buildings and forest are being developed. In this contribution we focus on the usage of airborne laser scanning (ALS, also known as airborne LiDAR) that we use both for the position determination of man-made structures (especially buildings) that are built in the potentially hazardous area and also for the mapping and characterisation of forests focusing on protection forests. Specific analysis techniques applied to these data comprise multi-source image processing and sophisticated classification approaches. These include in a first step geometric pre-processing (e.g. data co-registration) of relevant data. Second, generic thematic processing are employed in order to detect changes, which subsequently can be used to reduce aerial flight campaigns only to those areas where changes have occurred.

In addition, three-dimensional building and infrastructure classification, functional object grouping is done in order to deliver data input for the expert system on damage and loss potential. Protection forest mapping is done in order to supply the end-users with new EO based information, which provide input data for their already existing

expert systems on risk exposure.

From the point of view of the public awareness the project provides an immediate feedback to the co-operating governmental partner organizations, the State Survey (*Landesvermessungsamt*) Vorarlberg, and the Austrian Service for Torrent and Avalanche Control (*Wildbach- und Lawinenverbauung*), Vorarlberg. The results (both as theoretical approach and in the form of spatial data) are integrated in the database of the corresponding governmental organization during and after each project evaluation phase. These data are commonly available to the public soon after the completion via the internet, or can be requested at very low cost from the governmental agency. Examples for that can be seen on the homepage of the Federal State of Vorarlberg.

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