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Economic assessment of landslide risk for the Waidhofen a.d. Ybbs region, Alpine Foreland, Lower Austria

Assignment No. 5 – National Civil Protection Manager

Course 24S796912: Disaster Risk Management with Geoanalytics

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June 14, 2024

National Civil Protection Management in Low Austria: ArcGIS-based approach for landslide assessment

Economic
assessment of
landslide risk for
the Waidhofen
a.d. Ybbs region,
Alpine Foreland,
Lower Austria

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Study area: Ybbs
valley

Data

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- i **Research goals:** Improving the national landslide disaster control by evaluating the expected number of people affected by landslides.
- ii **Aim:** to assess potential risk and estimate economic damage caused by landslides.
- iii **Study area:** Ybbs valley, Lower Austria
- iv **Software:** Arc GIS-based spatial analysis and estimation of the potential monetary losses caused by landslides.
- v **Technical approach:** Geospatial and economic data processing by Arc GIS using spatial and economic analysis
- vi **Methods:** Defining elements at risk located in the risk zone of 100 m near landslides, and assessment of potential consequences.
- vii **Results:** calculated possible losses caused by the destruction of immobility and transport: costs for buildings demolition, restoration, roads rebuilding, debris transport, excavation and removal.



ArcGIS

Study area: Ybbs valley, Alpine Foreland, Austria

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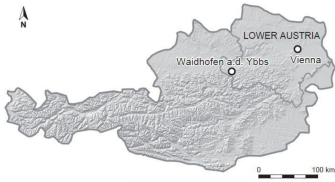
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- The region of Ybbs valley is located in mountainous Alpine Foreland, Austria.
- It covers a total area of 131.3 km².
- The environmental conditions of the the Ybbs valley are especially prone to landslides.
- Geology: deposits of gravel, sand, marl, conglomerate, calcareous sandstone, clay.
- Most of the region is used as pasture, agricultural land, and large forests.
- Climatic humid to continental. Intensive rainfalls in spring and autumn months.
- The region is attractive for tourists due to its environmental and historical value.



Data structure

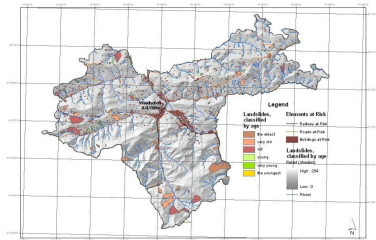
Type of factors	Thematic layers
Anthropogenic	Roads (railway, highways)
	Areas of demolishing & dismantling
	Areas of construction work
	Settlements
Topographic	Orthophotos
	DEM (1m and 3m resolution), DTM
	Vector relief map
Environmental	Watershed areas
	Water catchment areas
	Landscape protected zones
	Areas of NATURA-2000
	Geological vector map
Natural protected zones; forests; parks.	

Data characteristics

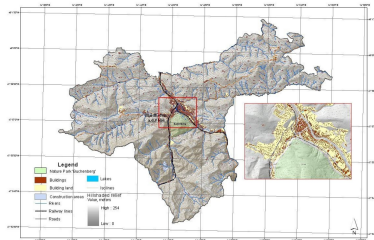
- i **Sources:** Data used in this research were obtained from the repositories of Provincial Government of Lower Austria.
- ii **Content:** Data include vector thematic layers covering the area, aerial imagery, topographic vector layers and maps.
- iii **Organization:** Data have been organized in a ArcCatalog database and sorted according to their types (Tab.1).
- iv **Compatibility:** Data have been stored in the ArcGIS project in Austrian National grid Austria Bundesmeldenetz (BMN) M34.
- v **Probability:** Data on landslide probability are gained from economic monitoring programmes.
- vi **Software:** Arc GIS-based spatial analysis and calculations for estimation of the potential monetary losses caused by landslides.

Methods

Landslides classified by age in Ybbs valley, Lower Austria



Elements at risk: buildings, roads, railway lines. Enlarged: city centre



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- i **Location:** The geographic location of landslides within the Ybbs valley was used for defining risk zones.
- ii **Risk zone:** 100-meter buffer area surrounding all landslides downwards, as a landslide with volume of 1 km³ may reach 100 meters while moving.
- iii **Definition of the elements at risk:** objects located in the 100 meter distance downwards the landslides

- i **Estimation of the economic losses:** for Ybbs valley, real estate prices for common goods (immobility, roads) were used for estimation of possible losses in the zone of risk.
- ii **Calculations:** Economic losses were computed approximately (€) based on the average real estate prices for various aspects of renovation, reconstruction and rebuilding of the destroyed objects.

Results

Estimation of possible monetary losses for transport.

Type of investment	Construction cost	Length (m)	Total losses (€)
Railway tracks, (€/m) restoration (*)	4,200	20,953	A = 88,005,204
Road rebuilding, €/m (**)	4,131	13,541 (length in Ybbs valley)	B = 55,948,749
Debris excavation (a)	17		
Debris removal (b)	25		
Transportation & storage (c)	26		
Roads restoration, (a)+(b)+(c), €/m ² (***)	68.0		
Total possible direct damages (A+B+C) = 144,881,544			C = 927,590

(*) Source: Zischg et al., 2005 (**) Source: Giacometti, 2005. (***) Source: Sterlacchini et al., 2007

i Spatial analysis: The length and number of the elements at risk within the distance of 100 m near landslides totals to 20.9 km of railway lines, 13.5 km of roads and 641 buildings.

ii Calculation the economic losses (real estate): computed from 5 different types of costs: 1) demolition, 2) transport and disposal debris, 3) restoration of inner walls, 4) furniture restoration and 5) house construction.

Real estate destruction losses, Ybbs valley, as for average market value.

Types of investment	Construction cost, €/year, one house	Total costs, all houses (*)
Demolition cost (concrete masonry), €/m³ (a)	87	-
Average volume to demolish, m ³ (b)	189,32	-
Mechanical excavation costs, €/m ³ (c)	25.5	-
Total (€) to demolish walls, concrete masonry = (a*b)+(c*b)	21,298	13,652,338
Transport and disposal debris, €/m² (**)	26	3,608,462
Inner walls restoration costs (€/m²)	7	-
Average surface of inner walls (m ²)	607	-
Average charge to restore inner walls (€)	4,252	2,725,852
Average price to restore furniture, €/m² (x)	600	-
Average house base area, m ² , (y)	317	-
Total average charge (€) to restore furniture (x*y)	190,500	122,110,500
Average house base area, m ² , (y)	317	-
Average cost to build a house (€/m³)	1,100	-
Total average charge to build a house, €	349,250	223,869,250
Total complete average charge (demolition + restoration), €	216,051	138,488,691

(*) Number of houses at risk in Ybbs valley = 641
 (***) Total area of buildings at risk, m² = 138

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Conclusions and key deliverables

- ▶ **Focus** The research focuses on the monetary estimation of the possible losses caused by landslide risks.
- ▶ **Approach** Estimation of the economic damages is performed using existing simplified methodologies.
- ▶ **Estimation of the economic losses:** for Ybbs valley, real estate and market prices for common goods (immobility, roads) were used for estimation of possible losses of the elements at risk in the risk zone.
 - ▶ The average volume of demolish damaged buildings indicated the dimensions of the losses of ca. 13.65 M €.
 - ▶ The estimated price for the debris removal is approx. 3.6 M €, in case buildings are totally affected and covered.
 - ▶ The restoration of the inner walls is based on average prices for building restoration and approximate surface of the walls: 2.73 M €.
 - ▶ Using approximate prices of the furniture costs in a typical house the costs for furniture renovation is € 190,500.
 - ▶ Cost for house construction is computed using real estate prices and average house area in m² which sums up to € 349,250.
 - ▶ The losses for transport include costs to rebuild a road, a railway, and a restoration of the roads.
 - ▶ A total of almost 140 M € would have to be invested for the renovation of the Ybbs valley in case of a landslides disaster
- ▶ **Economic losses:** were calculated *approximately* (€) based on the average real estate prices for various aspects of renovation, reconstruction and rebuilding of the destroyed objects.
- ▶ **Vulnerability:** estimation included basic census and approximate social data.
- ▶ **Software:** Arc GIS presents excellent geospatial tool for risk assessment

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