



## SURFACE MASS MOVEMENTS IN POLAND – A REVIEW

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**Abstract.** A geodynamical hazard over Poland’s territory is mainly connected with landslide processes. The activation of those processes has been noticed during several last years, particularly in the area of the Carpathians and in some parts of the Baltic Sea coast, where they had locally a disastrous scale. The inventory of surface mass movements over Poland’s territory based on archive data, and verified and supplemented by field works, was made in the years 2002–2005. Places of landslides occurrence were reported by “Landslide inventory cards”. Following the assumptions taken, all geological disasters should be a subject of inventory. However, a much bigger scale of observed phenomena than it was anticipated, caused a necessity to concentrate the inventory at selected, most endangered areas. The territorial zonation was applied in synthetic description of results of mass movement inventory. Sets of landslides of similar genesis and developed in similar geomorphologic and geological conditions were distinguished and several zones with relatively intense mass movements processes were separated, i.e. the Baltic Sea coast, lake districts of northern Poland, the Vistula River valley, Lublin area including the Lublin Upland and Roztocze hills, the Kielce area including the Holy Cross Mountains and adjoining regions, the Carpathian Foredeep and the Sudetes with their foreland.

**Key words:** mass movements, landslides, inventory, inventory card.

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**Abstrakt.** Zagrożenia geodynamiczne występujące na terytorium Polski są związane głównie z procesami osuwiskowymi. W ostatnich kilku latach zaobserwowana została aktywizacja tych procesów, szczególnie w obszarze Karpat i na niektórych odcinkach wybrzeża Bałtyku, gdzie lokalnie przybrały rozmiary katastrofalne. W latach 2002–2005 wykonana została, poprzedzona studiami archiwalnymi inwentaryzacja powierzchniowych ruchów masowych, zweryfikowana i uzupełniona poprzez prace terenowe. Miejsca występowania osuwisk udokumentowane zostały za pomocą „Karty dokumentacyjnej osuwiska”. Inwentaryzacją objęte miały być z założenia wszystkie przejawy zagrożeń geologicznych. Znacznie większa od przewidywanej skala obserwowanych zjawisk spowodowała konieczność koncentracji na wybranych obszarach i strefach szczególnie zagrożonych. W syntetycznym opisie wyników inwentaryzacji przejawów powierzchniowych ruchów masowych zastosowano podział terytorialny. Biorąc pod uwagę zespoły osuwisk o podobnej genezie i powstałe w zbliżonych warunkach geomorfologicznych i geologicznych wydzielono strefy o względnie intensywnym rozwoju procesów osuwiskowych. Są to: wybrzeże Bałtyku, pas pojezierzy północnej Polski, dolina Wisły, obszar lubelski obejmujący Wyżynę Lubelską i Roztocze, obszar kielecczyzny obejmujący Góry Świętokrzyskie i rejon przyległe, zapadlisko przedkarpackie oraz Sudety wraz z ich przedgórzem.

**Słowa kluczowe:** ruchy masowe, osuwiska, inwentaryzacja, karta inwentaryzacyjna.

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## INTRODUCTION

A geodynamical hazard over Poland's territory is mainly connected with surface mass movements and processes stimulated by human activity including mining exploitation, building industry and transportation. The most hazardous landslide processes develop at mountain slopes, river scarps and cliff shores. Recently, the activation of mass movements has been observed in the Carpathians and some zones of the Baltic cliffs, where locally they developed on a disastrous scale. The increase of landslide processes is probably connected with intense precipitation or other natural processes, however it can also be stimulated by irrational human action (Ilcewicz-Stefaniuk *et al.*, 2004a, b).

In the years 2002–2005, after archive studies an inventory of surface mass movements was made and verified and supplemented by field works. The study covered the whole Poland's territory excluding the Carpathians, which were a subject of separate investigation. Places of landslide occurrence were reported by "Landslide inventory cards" (Rybicki, 2005). Field works concentrated on inspecting chosen areas and locating landslides or other geodynamic processes, then cataloguing the objects by measuring them, making location plans and cross-sections, taking their photographs and plotting them in maps.

It was assumed that all geological disasters would be a subject of inventory. However, a much bigger scale of the observed phenomena than it was anticipated, caused a necessity to concentrate the inventory on selected, most endangered areas (Lemberger *ed.*, 2005). In addition to landslides and other

surface mass movements catalogued in the form of 'inventory cards', many objects of smaller size or lesser hazard were observed and noted for further documentation. Detailed geodetic measurements, geoelectric resistivity tomography and shallow geological drilling were made for selected landslides, which caused the greatest danger to the environment. The purpose of those studies was to obtain input data for creating digital models of landslides as well as rough evaluation of landslides prior to routine monitoring of their development (Ilcewicz-Stefaniuk *et al.*, 2005a).

The territorial zonation was assumed in a synthetic description of mass movement inventory results. Sets of landslides of similar genesis and developed in similar geomorphologic and geological conditions were distinguished and several zones with relatively intense mass movements were separated, i.e. the Baltic Sea shore, lake districts of northern Poland, the Vistula River valley with lower courses of its tributaries, the Lublin Upland and Roztocze range of hills where the mass movements occur in loess covers, the Kielce area including the Holy Cross Mountains and adjoining regions, the Carpathian Foredeep and the Sudetes with their foreland. In making such division into zones, the authors had in mind the most important factors that, in their opinion, decided on the mass movement development (i.e. influence of the sea, presence of escarpments and ice-marginal valleys, fluvial erosion *etc.*) as well as territorial concentration of the observed effects and last but not least – the geological background.

## INVESTIGATION METHODS

### ARCHIVE STUDIES

Archive and literature researches were made before inventory field works. All available archive data and papers on surface mass movements or – more generally – geological hazard in Poland had been studied (Ilcewicz-Stefaniuk, 2005). The studies included:

- all edited Detailed Geological Maps of Poland (scale 1:50 000) with explanations to them (excluding the Carpathians);
- geomorphologic sketches (scale 1:100 000) and topographic maps (scale 1:25 000) to locate existing landslides and identify field topography, which is favorable to landslide and surface mass movement development;
- geological-engineering sketches (scale 1:100 000) to select soils prone to landslide and other surface mass movements development;
- 'Reports of landslides in Poland' published in 1971 by the Polish Geological Institute, with maps in scale 1:500 000 and 1:200 000;
- catalogues of landslides in most contemporary administration provinces, published in 1971 by the Polish Geological Institute, destined for site planning units,

design offices, companies, and geological survey; the catalogues contain data acquired from 1968 to 1970 in the form of tables and landslide maps (scale 1:100 000).

Information on possible occurrence of natural geological hazard in areas of local administrative units was also obtained from inquiries with clerks of all stages of state administration offices. Based on the above mentioned studies, analyses and inquiries, the scale of mass movements in Poland was evaluated, a list of landslides identified till now was made, and zones and objects to further field inspection were selected.

### FIELD REVISION

Inventory field works consisted in checking the earlier chosen areas and locating landslides or other surface mass movements there and cataloguing the found objects (Lemberger *ed.*, 2005). Topographic and geodetic measurements were taken and topographic sketches and plans and cross-sections of objects were made along some representative lines. Where it was possible, the soils building the colluvium and its surrounding were macroscopically tested. Each catalogued object has an extensive photographic documentation. Inventory cards of

natural geological hazard were roughly filled-in in the field. Detailed locations of the landslides were marked in a 1:25 000 topographic map. Additionally, the location (geographic co-ordinates) of each landslide was positioned with a GPS.

#### INVENTORY (DOCUMENTATION) CARD OF A LANDSLIDE

Due to different form capacity, and motion rate of landslides, and type of sliding material etc., the inspection and documentation of landslides is difficult; therefore some standardization was needed to compare results of the studies. A form of such standardization was accepting some pattern, so-called “landslide inventory card”, which contained fundamental and detailed information on a landslide and terrain conditions

where it was formed (Rybicki, 2005). It is essential, that the form of the card and type of data writing were adjusted to the requirements of a computer database. A ‘landslide inventory card’ contains seven fundamental subject blocks including numerical or description data for each landslide, i.e.:

- landslide position,
- landslide characteristics,
- hazards and resulting damages,
- kind and range of preventive measures,
- preventive directions
- information on landslide study level,
- comments.

An inventory card incorporates an inventory number of a landslide, and boxes with the position of a landslide in a topographic map (scale 1:25 000 or 1:50 000), rough site plan of a landslide, and landslide cross-section and recent pictures.

### A REVIEW OF STUDY RESULTS

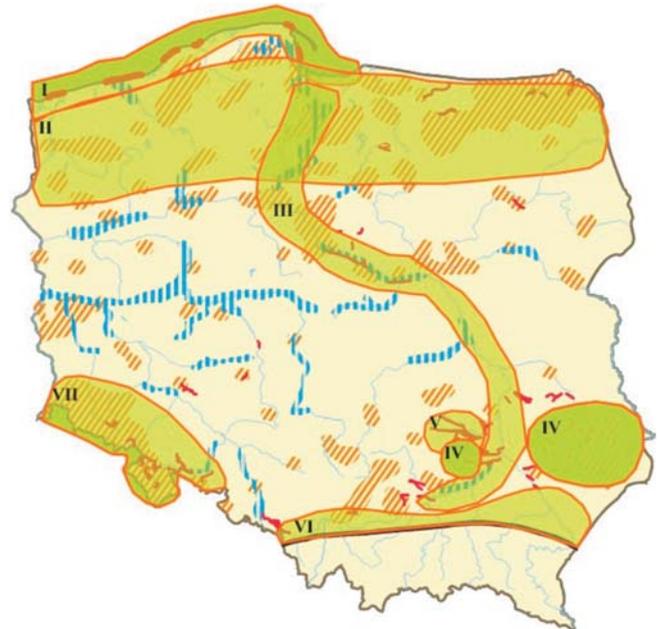
Though conceived on a large scale, the inventory works do not cover the problem of cataloguing landslides over Poland’s territory. In the authors’ opinion, the cataloguing should be continued to obtain complete information on the recent state of surface mass movement hazard. Geodynamic processes occur permanently and their effects can change hazardous conditions observed with time. Those changes can be seasonal or observed over a few or several years. Therefore it is necessary to systematically complement results of landslide studies to observe changes in the hazardous conditions.

Though incomplete, the carried-out investigations enable us to make an attempt at a synthetic analysis of surface mass movement hazard in Poland and separate regions with increased risk of landslide development. Based on similar genesis and similar geological and geomorphological conditions of landslides as well as zones of their concentration, the following regions endangered by intense landslide processes were separated (Fig. 1, Ilcewicz-Stefaniuk *et al.*, 2005d):

- the Baltic Sea coast with active landslide processes, mainly at cliffs and in narrow zones of coastal abrasion;
- moraine hills of northern Poland with numerous landslides of small size;
- the Vistula river valley and its ice-marginal valley with lower courses of the tributaries;
- valleys and ice-marginal valleys of central and western Poland;
- loess areas of the Lublin region and Roztocze range of hills;
- the Kielce region including the Holy Cross Mts. and adjoining areas;
- the Carpathian Foredeep filled with deposits with great capability of developing landslide processes;
- the Sudety Mts. and their foreland.

Such division is not, obviously, perfect, particularly from the geological point of view. The geological built-up, typical of lake districts, determines also the development of surface mass

movements at a significant part of the seashore as well as in northern Vistula river valley and its tributaries. Similarly, landslides developing at the Vistula slopes in the Sandomierz and Lublin areas are to some degree conditioned by the same character of deposits (loess). In a broader context, the geology of the Sandomierz region links that region to the Holy Cross Mts. Choosing the above given division, the authors followed the most important, in their opinion, factors that determine surface mass movement development (sea influence, presence of slopes of uplands and ice-marginal valleys, river erosion *etc.*)



**Fig. 1. Zones of intense mass movements**

I – Baltic Sea coast, II – lake districts, III – Vistula River valley, IV – loess covers of Lublin and Sandomierz regions, V – Holy Cross Mountains area, VI – Carpathians Foredeep, VII – Sudetes area

as well as territorial concentration of the observed effects and the geological background.

### THE BALTIC SEA COAST

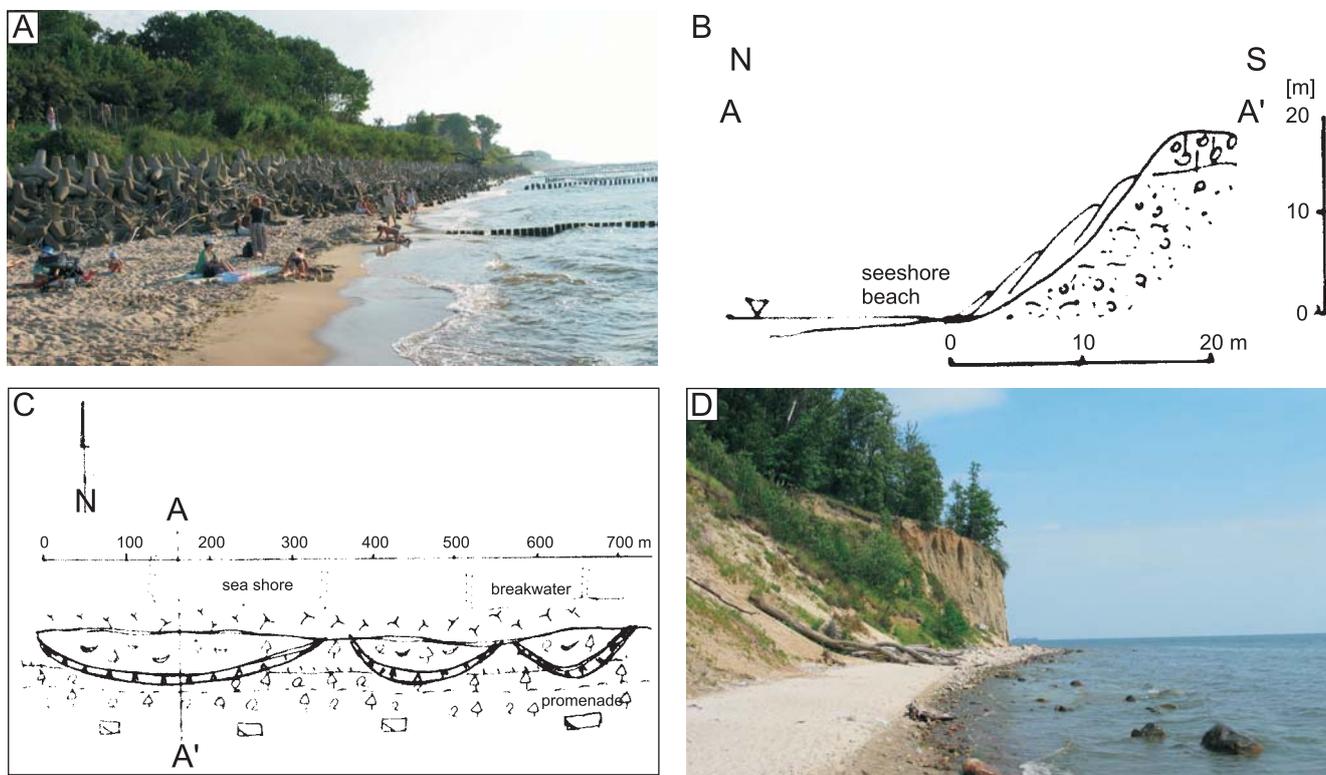
The investigations covered a belt of the Baltic Sea coast, from the Vistula river estuary on east to the Odra River estuary on west. The cataloguing of landslides was actually limited to abrasion zones of the Koszalin Seashore and cliffs of the Główny Upland (between Ustka and Rowy) at the Kępa Swarzewska, Kępa Pucka, Kępa Oksywska and Kępa Redłowska hillocks. Moreover, landslides occurring in erosional margin zones of the Kaszuby Lake District in the Gdansk region were also catalogued. A number of traces of surface mass movements were observed in the western part of the investigation area, however it was not a subject of inventory works.

The relief of the study region is a result of the activity of a continental glacier during the Baltic glaciation in Pleistocene, as well as erosional and accumulative activity of the sea and rivers at the seashore in Holocene. The surface is formed of the Quaternary deposits including moraine clays and gravels, sand, clay and fluvioglacial silts (Kondracki, Pietkiewicz, 1967). The sub-Quaternary surface is built of Miocene and Upper Cretaceous sediments, and locally of Middle and Upper Jurassic deposits that are partly altered as a result of erosion-and-exaration processes and glacitectonics.

In the authors' opinion, the most important factors that decide on the development of surface mass movements at the Bal-

tic Sea shore include the coastal abrasion, which gives rise to active landslide processes at cliffs of the Wolin island, Trzebiatów Seashore, Koszalin Seashore and Gdansk Bay, and recently erosional edges of moraine uplands of the Warszawskie Hills in the towns of Szczecin and Police (the Lower Odra River valley) and in Gdansk city (Subotowicz, 1982; Uściłowicz *et al.*, 2004). The geological built-up and hydrogeological conditions are of minor importance and determine rather slope steepness and the character of surface mass movements. High cliffs were formed in zones of glacial tills and exposures of Tertiary deposits. Soil slides and earth falls prevail in glacial tills, while debris falls, mudflows and earth creeps develop in fluvioglacial deposits. Stagnant clays, which give rise to mud flows during heavy rainfalls, initiate the surface mass movements in some regions. Usually those processes have a complex character.

Almost all landslides are active in a two-year, rarely a few-year cycle. Their activity manifests as small earth displacement during heavy rainfalls. The most endangered zones and objects were selected based on inventory works. These included parts of the seashore near Ustronie Morskie (Fig. 2a, b, c), Unieście, Jastrzębia Góra and Chłapowo, where the landslide processes make a direct threaten to the buildings (Ilcewicz-Stefaniuk *et al.*, 2005c). Large-scale protection measures were taken there, which are supposed to stabilize the cliffs. There is a great degree of hazard to the shoreline of cliff zones of the western shores of the Gdansk Bay (Fig. 2d) and Puck Bay (Kępa Swarzewska). In Gdańsk city, even the smallest motion of landslides (including those stabilized earlier) is a great danger and causes serious damages to the infrastructure.



**Fig. 2.** Example of landslides in the Baltic Sea shore

**A** – Ustronie Morskie – landslide and example of protection against marine abrasion; **B** – Ustronie Morskie – schematic cross section; **C** – Ustronie Morskie – outline of landslide; **D** – Gdynia Orłowo cliff

The upland edge, loaded additionally with new buildings or cut by earth works in the lower part of the slopes, makes a problem to the cities of Gdansk, Gdynia and Sopot.

### MORAINE HILLS OF NORTHERN POLAND

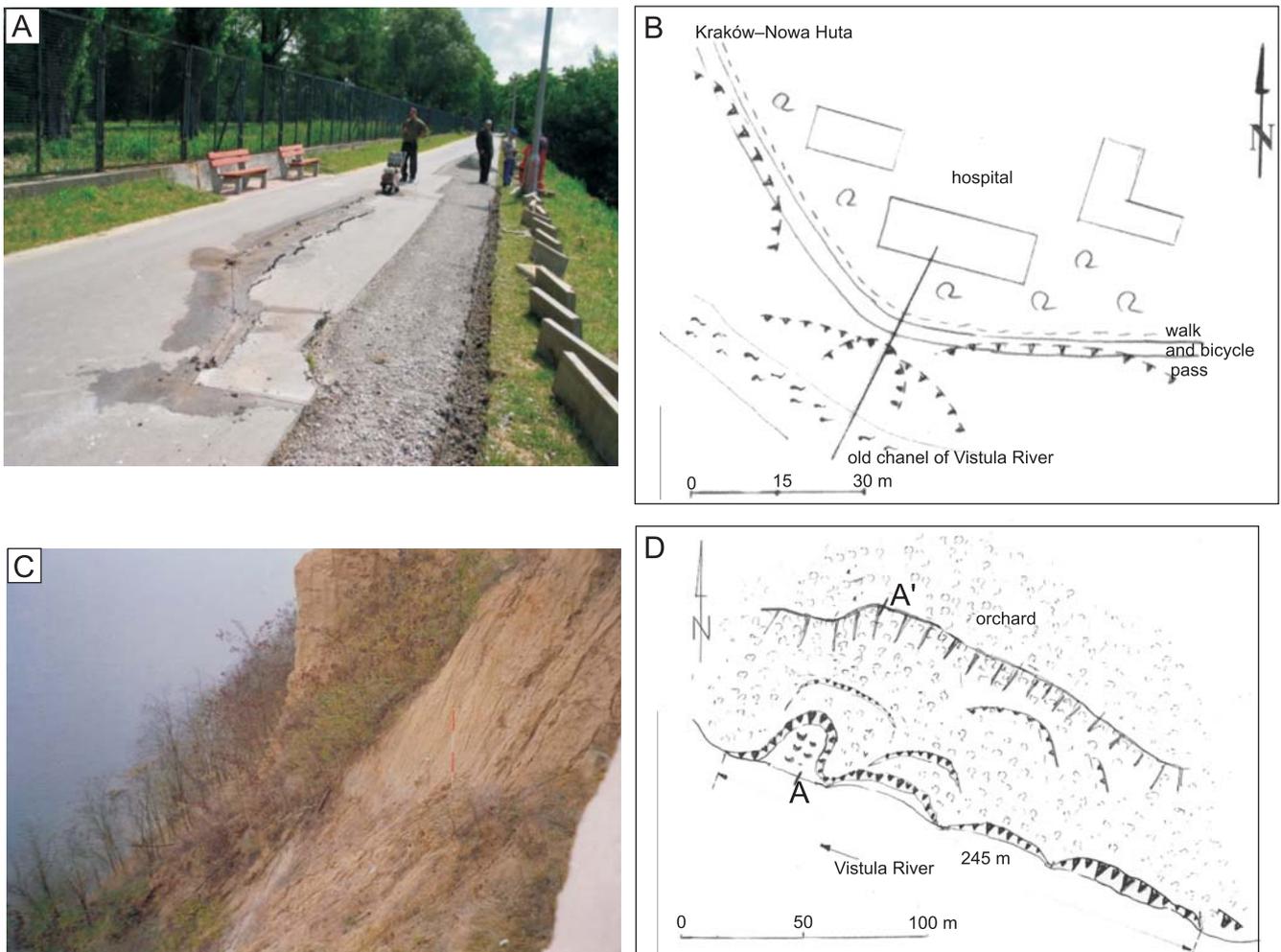
The next region covers a belt of the lake districts, which runs from the Lower Odra River through Pomerania, Warmia, Mazury and Suwalszczyzna to eastern and northeastern Poland's boundaries. A characteristic feature of that region is a diversified relief, which was formed in final stages of the Baltic glaciation of northern Poland. Varied land surface and geology of the subsurface give rise to numerous landslides of relatively small size there (Koryczan, Mżyk, 2003). The inventory works were concentrated mainly at the Mazury Lake District and Suwałki Lake District and the Lower Vistula basin. That region is recently best documented. Since results of inventory works there were a subject of a separate paper (Ilcewicz-Stefaniuk *et al.*, 2005a), in this paper we deal briefly with it. Most cata-

logued landslides developed in slopes of river valleys and streams. Those are earth landslides formed in Quaternary deposits: moraine clays, sands, gravels, as a result of lateral river erosion and infiltration of rainwater and water outflow and water seepage at slopes.

### THE VISTULA RIVER VALLEY AND ITS TRIBUTARIES

Steep escarpments of the Vistula valley and its ice-marginal valley make good conditions to development of surface mass movements there. The river dynamics, particularly during rapid floods, is an additional factor that promotes landslide processes. Hence, the main cause of landslide processes in that region is the lateral erosion of the Vistula and its tributaries.

Based on concentration of active landslides in the Vistula river valley, five landslide regions were separated along the river course (Ilcewicz-Stefaniuk *et al.*, 2005b, 2006): western part of the Nadiwślańska Lowland, loess upland near



**Fig. 3. Example of the landslides in Vistula River valley**

**A** – Kraków–Nowa Huta – the section of way destroyed by landslide, left escarpment (photo: D. Ilcewicz-Stefaniuk); **B** – Nowa Huta – outline of landslide; **C** – Tulibowo area – example of landslide in escarpment of ice-marginal valley; **D** – Tulibowo – outline of landslide

Sandomierz, Warsaw City escarpment, the Włocławek artificial lake region, and Kujawy and Lower Vistula region.

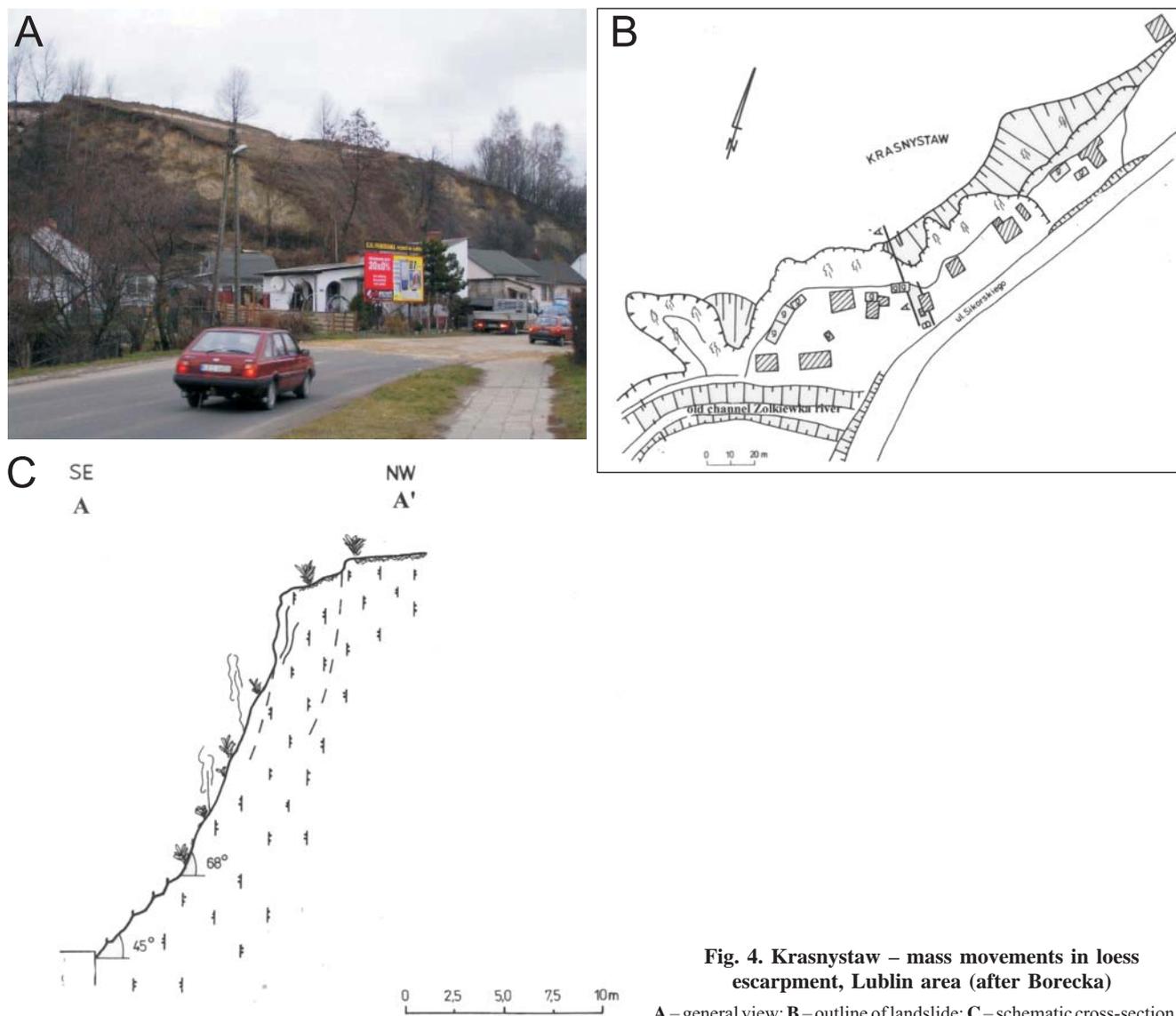
Landslides of the Nadwiślańska Lowland develop in the southern edge of the Małopolska Upland, which the Vistula river, strongly meandering and pushed aside by fluvial fans of the Carpathians rivers, undercuts there (Fig. 3A, B; Ilcewicz-Stefaniuk *et al.*, 2005b). There prevail in the Sandomierz region rockfalls and soil creeps that develop in the loess upland, which is cut by erosional valleys and steep gorges (Borecka, Kaczmarczyk, 2005). The Sandomierz region is densely populated and intensely developed, hence even poor mass movements with small activity make a big hazard to dwelling houses and farm buildings and infrastructure, especially roads.

Solifluction and landslip of Quaternary deposits down the top of Pliocene clays, where they rest above the average Vistula river level and slope towards the river, are observed in the Warsaw city escarpment region (Koryczan, Mżyk, 2003). The Włocławek artificial lake region, and especially its right bank, is part of the biggest landslide zone of the Polish Lowland, which extends between the towns of Włocławek and Płock

(Fig. 3C, D). Numerous landslides develop there in the top of easily soaking Pliocene clays (Banach, 1977). In the Kujawy and Lower Vistula region, landslides are observed in high slopes of the Vistula ice-marginal valley and in ravines that cut the valley's edges (Banach, 1977). Their causes include lateral erosion of the Vistula river, seepage of underground water and improper draining of thaw-water and rainwater from cultivated fields of the upland (Ilcewicz-Stefaniuk *et al.*, 2005a). The study of landslide processes in the Vistula river valley is a subject of a separate paper (Ilcewicz-Stefaniuk, Stefaniuk, 2006).

## THE LUBLIN REGION

Major parts of the Lublin Upland and the Roztocze range of hills are covered by a thick layer of Quaternary loesses, which are cut by a network of deep ravines and gorges with steep, sometimes almost vertical walls. The thickness of the loess cover is about 10–20 m there. Surface mass movements developed there mostly as rockfalls (Fig. 4A, B, C) and soil



**Fig. 4. Krasnystaw – mass movements in loess escarpment, Lublin area (after Borecka)**

A – general view; B – outline of landslide; C – schematic cross-section

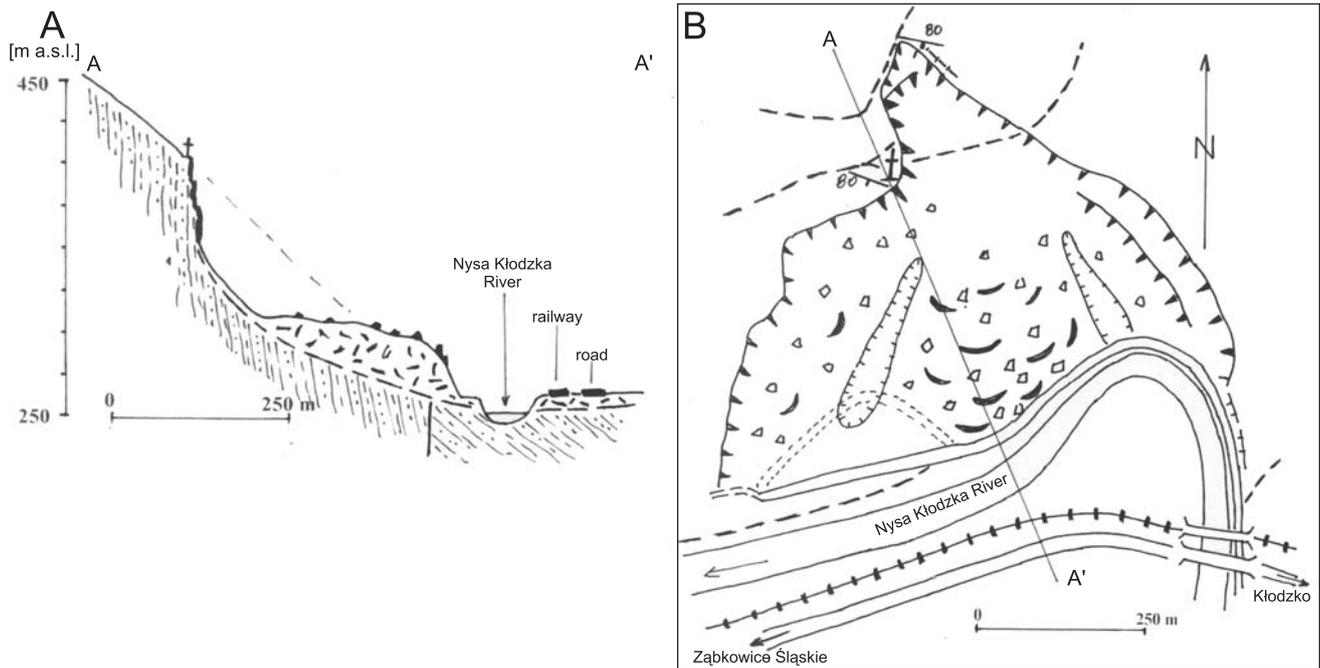


Fig. 5. The Sudetes area – Bardo, landslide rock fall in the Nysa Kłodzka valley (after A. Joniec)

A – schematic cross-section; B – outline of landslide

creeps, mudflows, subsidence and suffosion (Borecka, Kaczmarczyk, 2005). The activation of those processes is usually observed during thaws or long and heavy rainfalls.

#### THE HOLY CROSS MTS. AREA

The inventory works were carried out in the eastern part of the Holy Cross Mts and neighbouring areas. In addition to landslides and other surface mass movements, a number of objects with smaller size or lesser hazard degree were observed there (Ilcewicz-Stefaniuk *et al.*, 2004A, B). Due to the geology of the region, landslides of the Holy Cross Mts. are rather small and usually have a rock-waste character. In most cases they occur as soil creeps that significantly affect the safety of old or newly built buildings (Lasak *et al.*, 2005). That process is dangerous enough because its harmful effects (e.g. cracks, displacement of foundation) can be observed only at existing constructions. Damages caused by solifaction can be seen mainly in areas where the buildings were built without earlier geotechnical studies. After analyzing the causes of the above-mentioned hazard, it was noted that in many cases landslide processes had been activated or induced by man. However, some landslides developed in a natural way, as a result of rainwater infiltration or frequent downpours.

#### THE CARPATHIAN FOREDEEP

Landslides identified at the Carpathian Foredeep developed in zones where loess overlies gravel and fluvial or glacial sands resting at Miocene clays. Active landslides prevail there. Their origin is connected with significant wetness of sandy-gravel deposits and riverbeds incising into Miocene clays. Erosional undercut and water load caused equilibrium disturbance at slopes and development of landslides as a result of gravitational motion. Well preserved landslide headwalls and other landslide elements point to their young age (Ilcewicz-Stefaniuk *et al.*, 2005d, 2006; Lemberger *et al.*, 2005).

#### THE SUDETY MTS.

The Sudety Mts. region is characteristic of diversified and complex geology. It is built up of rocks with different lithology and immense time span. The amount of surface mass movements, which endanger the man, is rather small (Joniec, Waśkowska-Oliwa, 2005). In areas built up of flat-lying formations of younger Palaeozoic and Mesozoic that are structurally poorly liable to gravitational displacement, the mass movements are mainly connected with rock-waste covers (Fig. 5A, B). Strong tectonization, folding and cracking of Pa-

leozoic and Mesozoic rocks decides on their liability to mass movements. Development of landslides in forms built of Mio-

cene and Quaternary clayey sediments depends on their saturation with water.

## CONCLUSIONS

Based on identified indications of geodynamical processes, eight major regions with high risk of surface mass movements (mainly landslides) were separated: the Baltic Sea coast in zones of intense coastal abrasion; moraine hills of northern Poland; the valley and ice-marginal valley of the Vistula river with lower valleys of its tributaries; valleys and ice-marginal valleys of rivers of central and western Poland; loess regions of the Lublin Upland and Roztocze hills; the Holy Cross Mts.; the Carpathian Foredeep; the Sudety Mts. and their foreland.

In the authors' opinion, the inventory methods developed in the presented studies are suitable for the type and range of investigations. The proposed "landslide inventory card" contains sufficient information on an investigated object (e.g. geological, morphological and hydrogeological data *etc.*), therefore it should be a basis for further inventory works following a uniform pattern. However it seems advisable to extend inventory card information and include synthetic data, that is archive information or recent data on physical-and-mechanical properties of soil, and results of geotechnical and geophysical investigations.

The biggest and most dangerous forms of landslides are observed in near-riverbed escarpments and banks of rivers and streams, and cliff coasts. Such landslides are a result of lateral erosion of slopes of geologically young river valleys, and coastal abrasion. Under such conditions, the destruction of

river slopes and cliff scarps is a continuous process, which is very difficult and expensive to stop.

Landslides and other surface mass movements develop mainly in Quaternary deposits, i.e. loose or poorly cemented sand, dust (loess), and clay and loam, which are liable to sea abrasion and infiltration of underground and rain water. High and steep banks of rivers and streams and cliff coasts are often built of deposits of such kind. All those factors favor surface mass movement development.

Surface mass movements are dynamic in cliff coasts of the Baltic Sea. The specific geology of that region meets intense abrasive action of sea waves there. Hydrogeological conditions and human action are additional factors that accelerate the development of those processes.

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## REFERENCES

- BANACH M., 1977 — Rozwój osuwisk na prawym zboczu doliny Wisły między Dobrzyniem a Włocławkiem. *Pr. Geogr. IGIiZ PAN*, **124**.
- BORECKA A., KACZMARCZYK R., 2005 — Powierzchniowe ruchy masowe w utworach lessowych Lubelszczyzny i w rejonie Sandomierza. *In: Mat. Seminarium „Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju”*, Kraków, 23.11.2005 (ed. M. Stefaniuk): 35–36. AGH.
- ILCEWICZ-STEFANIUK D., 2005 — Powierzchniowe ruchy masowe w utworach lessowych Lubelszczyzny i w rejonie Sandomierza. *In: Mat. Seminarium „Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju”*, Kraków, 23.11.2005 (ed. M. Stefaniuk): 15. AGH.
- ILCEWICZ-STEFANIUK D., LEMBERGER M., MAGIERA J., RYBICKI S., SŁOMKA T., STEFANIUK M., 2004a — Cataloguing natural geological hazards over Poland's territory; Proceedings of the conference "Risks caused by the geodynamic phenomena in Europe", May 20–22, 2004, Wysowa, Poland. *Pol. Geol. Inst. Sp. Papers*, **20**: 53–60.
- ILCEWICZ-STEFANIUK D., LEMBERGER M., MAGIERA J., RYBICKI S., SŁOMKA T., STEFANIUK M., 2004b — Landslide hazard in Poland: review and database. *In: ITALIA 2004: 32nd International Geological Congress: Florence, Italy, August 20–28, 2004 abstracts. Pt. 1 / Poster: 146-23*.
- ILCEWICZ-STEFANIUK D., CZERWIŃSKI T., KORYCZAN A., TARGOSZ P., STEFANIUK M., 2005a — Landslides survey in the northeastern Poland. Proceedings of the conference "Mass movement hazard in various environments", October 20–21, 2005, Kraków, Poland. *Pol. Geol. Inst. Sp. Papers*, **20**: 67–73.
- ILCEWICZ-STEFANIUK D., KACZMARCZYK R., KORYCZAN A., STEFANIUK M., 2005b — Powierzchniowe ruchy masowe w dolinie Wisły. *In: Mat. Seminarium „Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju”*; Kraków, 23.11.2005 (ed. M. Stefaniuk): 33–34. AGH.
- ILCEWICZ-STEFANIUK D., LEŚNIAK T., STEFANIUK M., 2005c — Zagrożenia geodynamiczne w wybranych rejonach wybrzeża Bałtyku. *In: Mat. Seminarium „Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju”*; Kraków, 23.11.2005 (ed. M. Stefaniuk): 31–32. AGH.

- ILCEWICZ-STEFANIUK D., KORYCZAN A., RYBICKI S., SŁOMKA T., STEFANIUK M., 2005d — Inwentaryzacja powierzchniowych ruchów masowych w Polsce – przegląd. *In: Mat. Seminarium „Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju”*; Kraków, 23.11.2005 (ed. M. Stefaniuk): 16–17. AGH.
- ILCEWICZ-STEFANIUK D., STEFANIUK M., 2006 — Investigations of mass movements hazard in the Vistula river valley. *In: The abiotic environment – evaluation of changes and hazards – case studies*, 16–17 October 2006, Warszawa, Poland: abstracts and field trip guide-book: 30–31. Pol. Geol. Inst.
- JONIEC A., WAŚKOWSKA-OLIWA A., 2005 — Wybrane przejawy powierzchniowych ruchów masowych w obszarze sudeckim. *In: Mat. Seminarium „Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju”*; Kraków, 23.11.2005 (ed. M. Stefaniuk): 39–40. AGH.
- KONDRACKI J., PIETKIEWICZ S., 1967 — Czwartorzęd północno-wschodniej Polski. *In: Czwartorzęd Polski* (red. Galon R., Dylik J.). Państw. Wyd. Nauk.
- KORYCZAN A., MŻYK S., 2003 — Sprawozdanie z inwentaryzacji osuwisk lub innych przejawów powierzchniowych ruchów masowych na obszarze Mazowsza, Pojezierza Mazurskiego i Pojezierza Wschodniopomorskiego. PBG Archives. Warszawa.
- LASAK J., ILCEWICZ-STEFANIUK D., KNAPCZYK R., STEFANIUK M., 2005 — Wybrane przykłady powierzchniowych ruchów masowych obszaru świętokrzyskiego. *In: Mat. Seminarium „Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju”*; Kraków, 23.11.2005 (ed. M. Stefaniuk): 41–42. AGH.
- LEMBERGER M. (red.), 2005 — Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju. Sprawozdanie końcowe. PGI Archives. Warszawa.
- RYBICKI S., 2005 — Metodyczne założenia rejestracji i inwentaryzacji przejawów powierzchniowych ruchów masowych. *In: Mat. Seminarium „Rejestracja i inwentaryzacja naturalnych zagrożeń geologicznych (ze szczególnym uwzględnieniem osuwisk oraz innych zjawisk geodynamicznych) na terenie całego kraju”*; Kraków, 23.11.2005 (ed. M. Stefaniuk): 7–8. AGH.
- SUBOTOWICZ W., 1982 — Litodynamika brzegów klifowych wybrzeża Polski. Ossolineum. Wrocław.
- UŚCINOWICZ SZ., ZACHOWICZ J., GRANICZNY M., DOBRACKI R., 2004 — Geological structure of the Southern Baltic coast and related hazards. *Pol. Geol. Inst. Sp. Papers*, **15**: 61–68.