Chapter 10

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Geomorphic and Geologic Factors in Spatial Planning Procedure Regarding Rural Areas

1. Introduction

Dramatic events witnessed in recent years – floods and landslides in developed as well as agricultural areas and material losses resulting from such phenomena clearly indicate the necessity to amend the current approach to assessment of environmental factors in spatial planning, so that it takes into consideration the threats referred to above.

An additional, disadvantageous phenomenon observed in recent years, which is important in the period of intensified development of terrains excluded from agricultural production, is the noticed high level of groundwaters (State Hydrogeological Service 2011) – the result of years of neglect with respect to irrigation system, as well as of the rise of the base level of erosion of the non-deepened main Polish rivers.

One of the important elements of analysis of spatial conditions in the economy is the assessment of geomorphic and geologic factors. Correct identification of geologic structure and of geomorphic landforms that occur in the investigated area is one of the key criteria that condition the proper drafting of ecophysiographic studies.

2. The area subject to research

The research was carried out in Cegłów commune (Pol. *gmina* – first level of local self-government in Poland), which is located in Mazovian voivodship (Pol. *województwo* – third level of local self-government in Poland), Mińsk Mazowiecki poviat (Pol. *powiat* – second level of local self-government in Poland). It is an agricultural commune that includes 19 villages (Pol. *sołectwo* – local self-government auxiliary unit that usually includes a single village), where small farms are predominant. More than thirty per cent of the commune area

is covered by cohesive state-owned forests that possess a network of well-prepared roads that are suitable for cycling tourism. The Berlin – Warsaw – Moscow railway line runs through the commune area.

The commune is fairly typical for the Mazovian region and it is affected by changes to the social structure that are caused by economic, social, as well as environmental factors (Śluzek 2010).

Cegłów commune against the background of physico-geographic mesoregions of Poland

Pursuant to the present regional division of Poland (Kondracki 2002) the commune area belongs to two macro regions: Południowopodlaska Lowland (in the western part) and Middlemazovian Lowland in the East. Two smaller units may also be singled out – mesoregions – i.e. Kałuszyńska Upland in the eastern part of the discussed area and Garwolińska Plain in its western part. The main river that, together with its tributaries, drains almost the whole commune area is Świder, except for the northern part, which belongs to the drainage of the Mienia river.

Height differences in Kałuszyńska Upland amount to between 160 and 175 metres above sea level and the upland is cut across by the valleys of the Piaseczna and Sienniczka rivers. The northern part of the commune area is drained by the Mienia river, which flows along a parallel valley that is barely distinct in morphology of the terrain.

Landform features

Postglacial forms include in particular flat morainic upland, in which uplifts of older deposits (Neogene and Palaeogene) occur, which in some places reach the surface, while elsewhere are covered with Quaternary. In the Northwest it is adjoined by push frontal moraines, which are topped by hills of, usually, accumulative moraines. The latter create recessive ranges that are clearly distinct in morphology and reflect the lobe shape of the fading continental glacier of the Warta glaciation. Most of them show marks of glacial-tectonic disturbances. They are often accompanied by lows of complicated origin (at first exaration and later ice thawing) (Fig. 1).

The said lows are in some places accompanied by dead-ice moraines (structures created in dead ice area). Tiny thaw hollows without outflow are genetically connected with irregular thawing of the glacial material.

Fluvioglacial accumulative structures include in particular fluvioglacial plains, which create two levels in the mapped area. Stagnant lake plains occur in the southern part together with genetically connected kame hills and terraces. Osar and crevasse accumulation forms were included in this group. Erosional forms comprise subglacial troughs (currently used by the Świder river and its tributaries), as well as melt water valleys.

Fluvial forms – two levels of accumulation terraces occur in the valleys of the Świder and Trytwa rivers.

Aeolian forms – dunes and blow-out hollows that accompany them in some places occur in fluvioglacial sands and peneplanes (in fields of wind-blown sand).

Denudation forms are represented by two levels of denudation plains, located in floors of terminal hollows and corresponding little denudation valleys that in some places cut across long slopes. Lacustrine plains connected with Holocene were also identified.

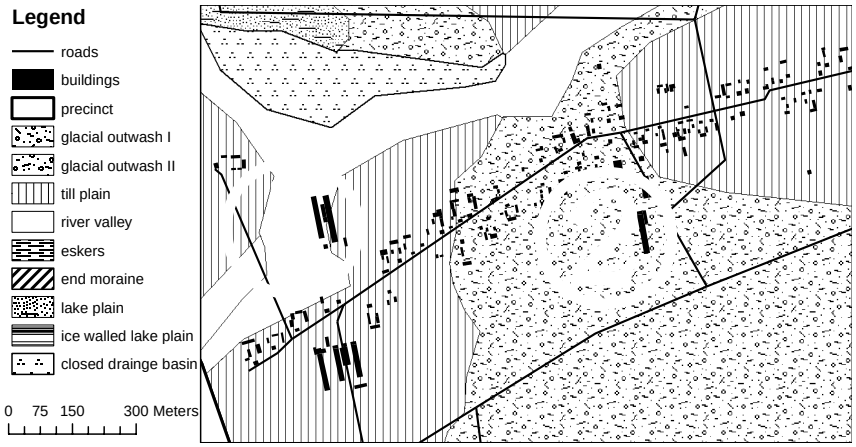

Fig. 1. Geomorphic sketch showing the existing buildings, 1 – area where the buildings are not located correctly (river valley area), 2 – area that is potentially most suitable for development

Geologic structure

The Warta glaciation

Continental glacier of this glaciation was the last to cover the investigated area and its activity decisively influenced the contemporary landscape, while the deposits it left form the subsurface layer of the terrain.

The character of the geologic processes was mainly influenced by the form of the substratum, characteristic for the presence of forms previously upheaved and of extensive hollows. The sequence begins with fluvioglacial sands and gravels (lower), which originate from transgression. They mainly occur in the vicinity of uplifted earlier deposits, where their top is the highest (185 metres above sea level), but they may also appear on the surface of the terrain, e.g. near Kuflew, where they take part in disturbances, as well as on many slopes in Kałuszyńska Upland. Varved silts, sands and clays occur in Podskwarne area and faces thereof can be found in slopes of the upland or of the valleys at the height of from 150 through 170 metres above sea level. Deposits of this era also occur in some holes located in Kałuszyńska Upland.

Boulder clays (lower) of variable thickness (from 1.00 m to 10.00 m) constitute the next layer of sedimentation of Warta deposits. Upper boulder clays cover earlier deposits with a thin (up to 6.00 m in thickness) and discontinuous layer. Not separated boulder clays were identified in the places, where there are no grounds for unambiguous determination of their age.

The sequence of the Warta glaciation deposits ends with formations that originate from deglaciation. The course of it was complicated and it was characterized by multiple face oscillations that resulted in disturbance of earlier sediments and in some places earlier deposits were either removed or covered with later ones (Bruj 2003).

Formations originating from the deglaciation phase include, in particular, silts, sands and clays, as well as sands and gravels of kames and kame terraces of fluvioglacial origin. There are also gravels and sands of dead-ice moraines, of osar and of crevasse accumulation forms. In the western part of the dead-ice depression a comparatively high hillock is located (relative height of 8 metres) of noticeably variable lithology. Its base is formed by fluvioglacial sands and gravels, while the top and slopes are formed by fine-grained and very fine-grained sands with flow tills and morainic gravels intercalations (Marks 1973). Another significant formation that originates from the deglaciation phase is sokolnicki osar, which is immediately adjacent to the investigated area. Gravels thereof have almost totally been depleted and at the bottom of gravel mines boulder clays can be found. Sands, as well as fluvioglacial sands and gravels occur in the form of lobes of various range and hypsometric position (144-180 metres above sea level), but higher than the identified lower level. Accumulation thereof was connected with local stops of the glacier front along the line of recessional frontal moraines. Their surface is cut across by little valleys created by outflowing waters and direction thereof varies in accordance with creation of subsequent marginal zones and depending on the places, where the stops were noticeably longer. Interlayering of boulder clays and sands often occurs in the places, where fluvioglacial sands encounter moraines. The material is not sorted well and thickness thereof reaches 17.00 m in areas of glacitectonic push.

Fluvioglacial sands and gravels form the lower level of fluvioglacial accumulation and often cut into the deposits of higher level. They occur in rims of terminal hollows, as well as in wide valleys of thaw waters between Kuflew and Jeruzalem.

The Eemian interglacial

Silts, gyttjas and clays, in places lacustrine sands that represent the Eemian interglacial were documented in some bore holes located in a part of the investigated area.

Undivided Quaternary

It comprises deposits, the accumulation of which could have begun in the deglaciation period of the Warta glaciation and lasted, intermittently, through the Eemian interglacial and the Vistula glaciation until Holocene. This pertains in particular to deposits that fill in all the topographic inequalities. Silts and sands, in places undivided gyttjas and lake-marl were identified by many mechanical probes in topographic lows – such as terminal hollows and thaw hollows without outflow. In Kuflew area finely laminated sands and silty sands are 2.90 m thick and cover a 4.5 metres wide series of silts with organic material and peat in floor,

located on boulder clays. Accumulation of deposits originating from slope wash – sands and silts of higher coverage level – began, presumably, in the Vistula glaciation period, lake accumulation also took place (aggradation of lakes with material originating from slope wash).

Accumulation of alluvial sands of meadow terraces (2-3 metres above river level) in the Świder and Trytwa valleys took also place in the same period (Bruj 2005).

Erosion period that preceded the accumulation of sands and silts of lower coverage level presumably took place at Vistula level in the period immediately before development of glaciation (Rotnicki 1998). This level, just like the higher one, is of complicated genesis, apart from sands and silts of various thickness (0.50 – 15.00 m) that originate from slope wash it is formed by Eemian and Holocene lake deposits and in some places also by alluvial sands.

A characteristic feature is the presence of peats or peaty-sandy outwash that cover deposits of diverse origin with almost continuous layer of variable thickness (from 0.50 m to over 2.00 m). Sands, silts and deluvial clays occur on gentle, denuded slopes of the upland or at the foot thereof, usually in a layer that is up to 0.50 m thick. Weathering (eluvial) sands lie on boulder clays and are up to 1.00 m thick.

Aeolian sand covers and aeolian sands in dunes of largest surface area occur near Roztanki in the southern part of the mapped area, as well as in the centre and in the East, where they cover the surface of the lower fluvioglacial level together with the higher coverage level. Thickness thereof often exceeds 2.00 m and 10.00 m in dunes. They consist of matt, light yellow grains of fine-grained and medium-grained sands and sometimes include single little gravel grains.

Holocene

The complex of the youngest Quaternary deposits in the investigated area comprises silts and lacustrine sands that occur in the eastern part of the area.

Outwash, silts and sands of thaw hollows without outflow, as well as humic sands, silts and outwash of valley floors and of hollows of intermittent flow are most often a little more than 0.50 m thick. Peats, peaty and sandy outwash cover large areas of Węgrowskie topographic low and fill in thaw hollows without outflow in uplands.

3. Analysis of geologic factors of spatial planning documents

Geomorphic and geologic analysis of Cegłów commune area in the „Study of conditions and directions of land use for Cegłów commune" dated 2010, due to the general character of the whole said document, takes up one and a half pages (while the study consists of 93 pages) and includes solely a very brief and general description of geologic structure and of geomorphic forms that occur in the said area.

However, the type and physical properties of rocks that form the substratum determine, to a considerable degree, the type and manner of potential development

of a given area, as well as the types of soils that are created thereon. The necessity of such investigation results from the fact that, for example, too high a level of groundwaters may limit development of a given area, while too low a level may indicate areas threatened by soil degradation. Certain specific geomorphic forms, such as landslides, completely preclude any development.

The authors hereof recommend a different approach to the discussed issue – apart from a general description of geologic structures and formations that occur in the analysed area, they suggest performing precise and responsible assessment of spatial development possibilities based on data verified during a reconnaissance. For that purpose it is necessary to identify the geologic structure, geomorphic formations, as well as hydrogeological conditions in the investigated area.

The authors assume that complete analysis of geologic conditions should include:

- general identification of terrain geologic structure,
- analysis of the existing geomorphic formations,
- assessment of surface mass movement threats (landslides),
- hydrogeological threats – specifically the occurrence of areas of high level of groundwaters, or identification of contingent terrains of lower water level (cones of depression), the result of e.g. drainage of excavations,
- other threats – e.g. occurrence of effervescing clays in the subsoil,
- protection of mineral deposits,
- protection of underground waters,
- management of post-mining excavations and contingent reclamation thereof.

For the purposes of such study the following data sources are suggested:

- topographic maps at a scale of 1:10,000 and, in justified instances, master maps (at a scale of 1:5,000),
- detailed geologic map at a scale of 1:50,000 of the investigated area,
- geomorphic sketch at a scale of 1:50,000,
- hydrologic map at a scale of 1:50,000,
- reconnaissance.

The performed reconnaissance unambiguously proved that the scale of the existing detailed geologic maps and geomorphic sketches (1:50,000) is often not sufficient for the purposes of spatial planning documents, e.g. area marked in a geomorphic sketch as outwash plain is in fact, in a part adjacent to a river valley, a relatively highly inclined escarpment, which is dozen or so metres high (Fig. 1).

Inventorying of the terrain could, therefore, prevent incorrect localization of developed areas, in particular in flood plains, in areas of high level of groundwaters or of impervious bottom, in closed basins without outlets, in areas of former marginal lakes (Phot. 1), or in terrains of poor ground bearing capacity.

The performed inventorying revealed many irregularities. Buildings were found in a river valley, as well as in other areas characterized by unsuitable properties for development, e.g. in ice walled lake plains (Phot. 2).

Phot. 1. Local flooding

Phot. 2. Ice walled lake plain

Many large overbank floodplain sandy landforms were also identified in the Piaseczna river valley, which unambiguously indicates the necessity to completely exclude that valley from any development.

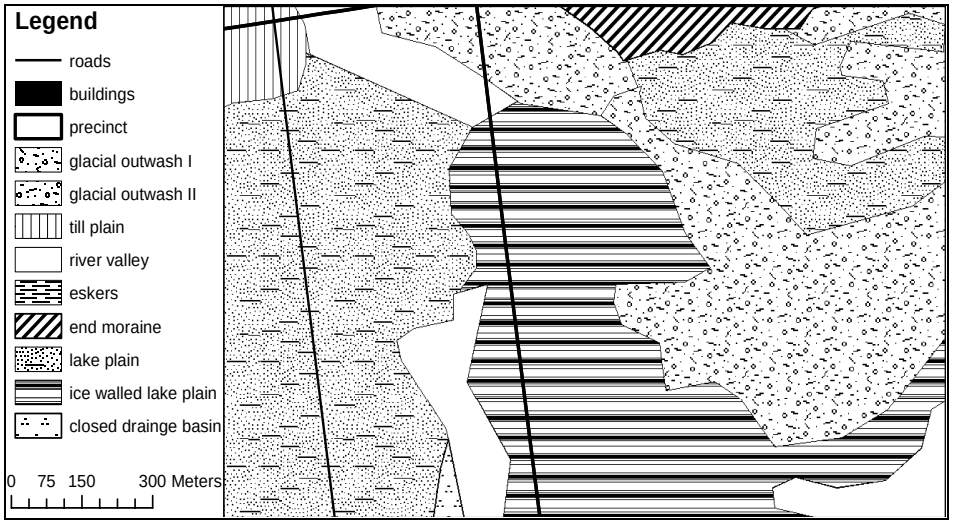

Fig. 2. Ice walled lake plain in a geomorphic sketch

Illegal sand, gravel and loam open mines were also revealed, some of them in areas that are recorded in land register as arable lands (e.g. near Skupie village) or even in protected archaeological sites. This clearly indicates the necessity of frequent inspections and of proper inventorying of the terrains in question.

4. Conclusions

1. The results of the research clearly indicate the necessity of analysing geologic conditions and of assessment of the existing geomorphic landforms during the spatial planning process.
2. With respect to geologic structure the investigated area is a typical example of a terrain of postglacial origin, with geologic landforms that are characteristic for such terrains.
3. As regards geomorphology, postglacial formations also prevail, such as flat morainic upland, frontal accumulative moraines, as well as two levels of fluvioglacial plains.
4. The most frequent lithological forms in the investigated area are loams, sands, clays and silts.
5. Differentiation of geologic and geomorphic conditions is reflected in differentiation of the level of suitability of relevant terrains for development.

6. Surface configuration and geologic structure of the area result in the fact that there are no threats connected with mass surface movements (landslides).
7. There are no mineral deposits of industrial importance in the investigated area and, consequently, there is no need to exclude any terrains located above such potential deposits from development.
8. Contingent reclamation of post-exploitation areas could be effected in sokolnicki osar, which is adjacent to the investigated area.
9. Location of some buildings in flat morainic upland that is formed mainly by boulder clays may result in flooding of the buildings by stagnant melt waters.
10. The areas certainly unsuitable for development include thaw hollows without outflow and river valleys, due to their poor ground bearing capacity, as well as disadvantageous water conditions.
11. Much more suitable for development are sandy outwash plains, due to good ground bearing capacity, as well as low level of groundwaters; however, even in such areas local floodings may occur, especially in flat areas or in topographic lows.
12. The investigation revealed illegal open mines that are not registered and some of them are located in archaeological sites.

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