GOSPODARKA SUROWCAMI MINERALNYMI

Tom 16 2000 Zeszyt 4

MAREK NIEĆ*, MAŁGORZATA KAWULAK**, EWA SALAMON**

Geoenvironmental mapping for the local landuse planning[1]

Key words

Geological mapping, environment, land use planning

Abstract

Geoenvironmental factors constrain free landuse planning. Mineral deposits, surface and underground waters, fertile soils, unstable ground and landscape features are the main components of environment that needs to be considered as a basic for sustainable developement of local communities. Their presentation on 1 : 25 000 and 1 : 10 000 maps was found the most suitable for the local landuse planing. Systematic such mapping of parish territories within the Krakow district (voivodship) is realized since 1994. Map presentation, in computerized GIS based mode, allow to check environmental constraints for mining, quarrying, settlement building, road construction, as well as natural hazards possibilities (as landslides in montainous regions). They allow to focus attention on mineral and industrial rock resources available for local and general use, not limited by protection of other components of environment and protect them if necessary for their future utilization.

1. The problem

Land use planning consists of terrain designation for different mode of utilization. It should consider the rules of sustainable development as defined in "Agenda 21" formulated at Earth Summit in Rio de Janeiro in 1993. The scope and procedures of such planning are defined in Poland by the "Act on Land use Planning" adopted in 1994 (Dz.U. nr 89, poz. 415). According to it any activity concerning the land utilization should be based on the "Local plan of land

* Prof., ** M.Sc. Eng., Institute of Mineral and Energy Resources Economy Polish Academy of Sciences, Cracow, Poland.

Reviewed by Ph.D. Eng. Elżbieta Pietrzyk-Sokulska

[1] Paper prepared for presentation at 31 IGC Rio de Janeiro 2000.

utilization" prepared and adopted by the local community ("gmina"). It should consider natural features of environment mainly those protected by law, as areas of protected landscape, monuments of nature, natural resources and their proper management and local conditions of land utilization (e.g. for building, road construction, agriculture etc.). The detailed rules of protection of particular components of environment are formulated in special Govermental Acts as for example: Act on Environment Protection and Utilization, Act on Protection of Nature, Act on Protection of Agricultural Soils, Act on Forests, Act on Wastes, Geological and Mining Law etc. Before the formulating the "Local plan of land utilization" the detailed "Study of natural conditions for land use planning" should be prepared as a basic for the further planning.

The basic features of environment that should be considered in land use planning are of spatial nature. Mapping them is the best mode of their presentation. Cartographic presentation of environment allow to define the possibilities and limitations of utilization of its particular components, as well as to predict the impact of human activity on environment especially caused by utilization of natural resources. Mineral deposits and industrial rocks need the special attention. They are the components of environment that will be destroyed if mined. They are strictly localized in space and nonrenovable, if exhausted. The mining cause deep transformation of local environment and often damage it. From the other hand, sometimes, mining can introduce new value to environment by shaping the landscape (by hills formed of recultivated tailing dumps, water ponds in abandoned open pits used for fishing or for recreational purposes), by the possibility of replacement of unfertile soils by fertile ones, by forming new habitats for plants and animals in abandoned unaccessible open pits etc.

Because several features of environment are of geological nature, geosozological — economic, detailed mapping was initiated by the present authors for communities in the former Kraków voivodship in 1994 (Nieć et al. 1995a, b).

2. The problem approach

The first attempts of geosozological mapping was presented by Tomaszewski, Rubinowski and Nowak (Tomaszewski 1988; Rubinowski, Nowak 1990; Rubinowski 1992). The maps 1 : 50 000 were proposed and the mode of such map presentation subsequently elaborated and improved (Rubinowski 1992, 1995; Kozłowski 1998; Kozłowski, Wyrwicka 1998). The such systematic mapping of the whole territory of Poland was initiated in 1992 (Instrukcja 1992), encouraged (Drągowski, Nieć 1993), and successfully realized (Sikorska-Maykowska, Strzelecki 1998). The maps present the data on environment protection, mineral deposits and mining, surface and underground water conditions and ground valorization for building (Kozłowski, Sikorska-Maykowska, Strzelecki 1998). Independently are prepared:

— sozological maps (System... 1997), that presents the environment transformations, environment transforming factors and man induced hazards to environment,

— hydrogeological maps presenting the detailed data on underground waters and their utilization (Ramowa instrukcja... 1996).

The scale of such maps, 1 : 50 000, was found too small for presentation of local phenomena and difficult for direct utilization in the local land use planing. More detailed mapping in

1 : 25 000 was proposed by Rubinowski and Nowak (1990), Irmiński (1993), Grzelak et al. (1994), Nieć et al. (1995). They present the different mode of map presentation.

The detailed map presentation proposed by the present authors (Nieć et al. 1995, 1996) was found the most suitable for the local land use planing, and after some improvements introduced as routine for mapping the parish territories within the Kraków voivodship (Myszka, Nieć 1997), and after reorganization of administrative subdivision of Poland within the Małopolska voivodship. The main attention was focused on mineral deposits and industrial rocks and their relationship to the other features of environment.

During such detailed mapping it was found that for particular areas, especially river valleys, the scale 1 : 25 000 is too small and 1 : 10 000 mapping was also introduced, which allow more detailed presentation of land utilization and industrial rocks (mainly natural aggregates) resources potential.

3. Geoenvironmental maps 1 : 25 000

3.1. General arrangement

The mappable environmental data can be subdivided into four groups:

1. Basic geology, mineral deposits and industrial rocks.
2. Hydrography and hydrogeology.
3. Environment protection.
4. Ground conditions for building.

The basic map content and mode of its presentation in general follows the same rules as applied in 1 : 50 000 mapping (Instrukcja... 1997), to faciltate the comparison of the both at the different level of their utilization. It was necessary however to modify the mode of presentation of particular phenomena, the mappable features and the map content in respect to the local conditions and needs. The final map presentation is composed of:

1. Four thematic sheets:
   a) geological map with the data on mineral deposits and industrial rocks,
   b) map of water (surface and underground) conditions,
   c) map of environment protection,
   d) map of ground conditions for building.
2. Final geoeconomic-sozological map.
3. Characteristic cross-sections.
4. Explanatory text.
5. Photographs of characteristic features.
6. List of localities of mineral and industrial rocks occurences.
7. List of water wells.
8. Maps in 1 : 10 000 (if needed).

The basic data for map presentation are the both the direct field observation and gathered from published papers, maps, accessible data files, unpublished, formerly prepared maps and reports. Although there are many previous reports on mineral occurences, water conditions etc.

they need recent field verification, especially if they are few years old, because of changing local conditions and land utilization, and sometimes because of erroneous former presentation (Nieć et al. 1995; Irmiński 1997; Myszka, Nieć 1998).

3.2. Geological map of mineral deposits and industrial rocks

The distribution of mineral deposits and industrial rocks is considered the basic feature of terrain, because their strict location, immobility, nonrenovability and socio-economic value as a source of commodities necessary for sustainable existence of society. The both known deposits and the supposed ones should be presented. The basic concept of presentation of mineral deposits and prognostic and perspective areas of their occurence was elaborated for 1 : 50 000 maps (Kozłowski, Sikorska-Maykowska, Strzelecki 1998). However it needs some modifications and improvement for detailed mapping. The distribution of industrial rocks is the most important for local communities. They are common as a rule: claystones, sands and gravels, sandstones, limestones, magmatic rocks. Their small scale (artisanal) mining is sufficient for the local purposes as e.g. for road construction or building purposes. The outcropping rocks or under the small overburden cover, 1—2 m thick as a rule, are suitable for such mining. The general geological map is sufficient for presentation of their distribution. The rock units irrelevant to mineral deposits and as industrial rocks are generalized. The ares of known outcropping industrial rock units, are exaggerated by the neighbour area where they may occur under the 1—2 m cover. The sites of previous and recent mining and quarrying are presented as well the sites where utility of rocks was confirmed (e.g. by sampling).

The "industrial quarrying" of common rocks is possible under more thick overburden sometimes up 10—20 m, if stripping ratio is less then 0,5 as a rule. The geological map analysis allow to delimit the area of possible rock occurence in such conditions. The both distribution of industrial rock suitable for:

— small scale mining,
— "industrial mining",

are separatlly presented on maps (fig. 1). In the later case, the areas of protected landscape are excluded from their presentation.

Known mineral deposits, if known (documented), and limits of their probable extention are separately presented by tracing their boundaries, as well as the boundaries of deposits exhausted by previous mining.

The map is accompanied by the list of all registered sites of mineral and industrial rocks occurences (former or recent sites of their mining and quarrying, and other sites where utility of rock is confirmed).

3.3. Map of water conditions

For the local land use and water disposal planning the most important is the knowledge on distribution of surface waters and underground reservoirs (aquifers) of potable water, their water quality and susceptibility to contamination as well as their utilizable water resources. The

basic hydrogeological data are presented on 1 : 50 000 scale hydrogeological maps (Ramowa instrukcja... 1996). Geoeconomic 1 : 50 000 maps present only the most important hydrologic and hydrogeologic features of presented area (Sikorska-Maykowska 1998). On detailed 1 : 25 000 geoenvironmental maps the limits of different underground water reservoirs are presented, considering the age and litology of waterbearing rocks. Their water quality and susceptibility to contamination is designed by set of symbols (fig. 2). The additional important informations presented on map are: surface waters and their quality, natural sources, waterwells, and potential sources of water contamination as: waste storage sites, fuel stations, cemeteries etc. The detailed data on registered water wells are separately listed. Data on water resources and quality are presented in explanatory text.

3.4. Map of environment protection

The mappable protected environment features consist of (fig. 3):

— areas of protected landscape,

— protected fertile soils,

— forests,

— protected sites of natural phenomena (monuments of nature, ecological sites, geological heritage sites),

— archeological sites,

— architectural monuments.

All of them are protected by law. Their presence should be considered in land use planing because they limit the free land utilization. Their presentation in general follows the rules adopted for 1 : 50 000 geoeconomic maps.

Landscape protection is realized in decreasing order by: national parks, landscape parks and areas of protected landscape. Within the national parks free land utilization is forbiden and within landscape parks should follow strictly defined rules.

The soil fertility categorization encounter VI categories. The I to IV category are protected and change of the mode of their utilization need to be accepted by Ministry of Agriculture (I—III category, if area greater then 0,5 ha) or Voivodship Authority (category IV if area greater than 1 ha).

Protected sites of natural phenomena, the both officialy registered and proposed are presented, especially those recognized as geological heritage. The 1 : 25 000 scale allow also precise presentation of protected archeological sites by their real area.

3.5. Map of ground conditions for building

The purpose of the map is to present the general classification of ground conditions for building. The scale of map (1 : 25 000) do not allow the detailed engineering geological evaluation of ground conditions. In general the two main ground categories are distinguished only:

— suitable for building without limitations,

— generaly unsuitable, which need detailed engineering geological evaluation, and special measures in building.

The forested areas, protected fertile soils, the areas of known (documented) deposits of industrial rocks and the areas where building is forbiden (e.g. on river banks between antiflooding walls) are excluded from such categorization. Independently on the whole area registered landslides are presented (fig. 4).

As unsuitable for building are classified: unstable grounds, soft unconsolidated soils, areas suspectible to landslides, slopes over 12% steep in soft rocks or 20% steep in hard rocks, areas of low depth to underground water (less then 2 m) etc.

More detailed subdivision and presentation of "generally unsuitable" category is advised if sufficient geological data exist (Radwanek-Bąk, Myszka 1998).

4. Detailed geoenvironmental maps in 1 : 10 000 scale

The river valleys present a special case because of accumulation of different features, contradictory to land use planning (Nieć et al. 1996). Since the remote history or even prehistoric times they are, especially in mountainous regions, suitable sites for communication routes and settlement location. They are filled with sand and gravel deposits forming the underground aquifer, used as a source for potable water for rural and urban communities. Intensive mining of sand and gravel deposits as natural aggregate, produce deep, water filled basins, changing the landscape. The sandy and gravel deposits are covered by silty clayey cover which are the base for fertile soils and fluorishing agriculture. The river valleys are also the areas suspectible for flooding, repeating periodically. The 1 : 25 000 scale is often too small for clear presentation of such varied features of river valley, accumulated on relatively small, narrow territory. For their presentation the greater scale 1 : 10 000 was found necessary, especially in those river valleys where natural aggregate resources are of special value and their mining is in strong conflict with the other modes of land utilization. Such maps present the same phenomena as 1 : 25 000 maps and the accessibility of sandy gravel deposits (natural aggregate) for mining, through presentation of their thickness and stripping ratio (fig. 5).

5. Use of geoenvironmental maps

The geoenvironmental maps are presented in computerized GIS base mode. The superposition of different thematic sheets allow to check the environmental restraints for mining, quarrying, settlement building, road construction, as well as natural hazards possibilities (e.g. landslides in mountainous regions). They allow to focus attention on mineral and industrial rock resources available for local and general use, not limited by protection of other components of environment (fig. 3) and protect them if necessary for their future utilization.

The geoenvironmental maps present the basic data on environment and natural conditions for land use planning. They allow to formulate opinions on sustainable development of local communities and allow proper managment of land utilization, considering the recent and future value of natural resources.

REFERENCES

Agenda 21, 1992 — Pogramme of Action for Sustainable Development. UN Dep. of Public Information. N. York.

Drągowski A., Nieć M., 1993 — Mapa geologiczno gospodarcza Polski w skali 1 : 50 000. Przegl. Geol. t. 41, nr 3, s. 212—214.

Graniczny M., 1997 — System informacji przestrzennej dla potrzeb gmin. [W:] Rola informacji geologiczno-środowiskowej w procesie koncesjonowania poszukiwań i eksploatacji kopalin. PIG o. Dolnośląski, Wrocław, s. 36—45.

Grzelak H., Janicki T., Lewandowski P., Marszczek-Graniczna T., 1994 — Metodyka sporządzania mapy geośrodowiskowej na potrzeby gminy. Przegl. Geol. t. 42, nr 11 (499), s. 919—924.

Instrukcja ramowa do opracowania mapy geologiczno-gospodarczej Polski 1 : 50 000. Przegl. Geol. R. 40, nr 1(465), s. 21—30, Warszawa 1992.

Instrukcja ramowa do opracowania mapy geologiczno-gospodarczej Polski 1 : 50 000 MOŚZNiL PIG, Warszawa 1997.

Irmiński W., 1993 — Komputerowa mapa geosozologiczna w układzie gminnym — przykład zakresu i metodyki. Przegl. Geol. t. 41, nr 12, s. 817—822.

Irmiński W., 1997 — Ocena przydatności danych do sporządzania map i atlasów geosozologicznych dla gmin. [W:] Rola informacji geologiczno środowiskowej w procesie koncesjonowania poszukiwań i eksploatacji kopalin. PIG o. Dolnośląski, Wrocław, s. 57—64.

Kozłowski S., 1997 — Przyrodnicze kryteria gospodarowania przestrzenią: kraju, województwa, gminy. KW KUL, Lublin.

Kozłowski S., 1998 — Założenia ideowe Mapy geologiczno-gospodarczej Polski w skali 1 : 50 000. Przegl. Geol. t. 46, nr 10, s. 1032—1037.

Kozłowski S., Sikorska-Maykowska M., 1998 — Treści merytoryczne Mapy geologiczno-gospodarczej Polski w skali 1 : 50 000. Przegl. Geol. t. 46, nr 10, s. 1038—1040.

Kozłowski S., Sikorska-Maykowska M., Strzelecki R., 1998 — Zasady wyznaczania obszarów perspektywicznych i prognostycznych złóż kopalin na MGGP. Przegl. Geol. t. 46, nr 10, s. 1047—1049.

Kozłowski S., Wyrwicka K., 1998 — Mapa geologiczno-gospodarcza Polski 1 : 50 000. [W:] Ochrona litosfery, PIG, Warszawa, s. 240—244.

Myszka R., Nieć M., 1998 — Zastosowanie szczegółowych map geologiczno-gospodarczych (1 : 25 000, 1 : 10 000) w planowaniu przestrzennym. Przegl. Geol. t. 46, nr 10, s. 1063—1069.

Nieć M., Kawulak M., Salamon E., 1995a — Mapa geologiczno-gospodarczo-sozologiczna gminy Gdów. CPPGSMiE PAN/ UW, Kraków.

Nieć M., Kawulak M., Salamon E., 1995b — Mapa geologiczno-gospodarczo-sozologiczna gminy Biskupice. CPPGSMiE PAN/ UW, Kraków.

Nieć M., Kawulak M., Salamon E., 1997 — Mapa geologiczno-gospodarczo-sozologiczna gminy Dobczyce. CPPGSMiE PAN/ UW, Kraków.

Nieć M., Kawulak M., Salamon E., Motyka J., Borczak S., 1997 — Mapa geologiczno-gospodarczo-sozologiczna gminy Krzeszowice. IGSMiE PAN/UW, Kraków.

Nieć M., Kawulak M., Salamon E., 1999 — Mapa geologiczno-gospodarczo-sozologiczna gminy Podegrodzie. IGSMiE PAN/ UW, Kraków.

Nieć M., Myszka R., Kawulak M., Salamon E., 1996 — Problemy gospodarki środowiskiem na obszarach występowania złóż kruszywa naturalnego w dolinach rzecznych na przykładzie rzeki Raby. [W:] Technika i technologia w ochronie środowiska. I Forum Inżynierii Ekologicznej, Lublin-Nałęczów, s. 429—436.

Radwanek-Bąk B., Myszka R., 1998 — Problematyka waloryzacji terenów dla potrzeb budownictwa na mapach geologiczno-gospodarczych. Przegl. Geol. t. 46, nr 10, s. 1056—1059.

Ramowa instrukcja sporządzania mapy hydrogeologicznej Polski w skali 1 : 50 000. MOŚZNiL, Warszawa 1996.

Rubinowski Z., 1992 — Regionalne atlasy geologiczno-surowcowe i arkuszowe mapy geologiczno-gospodarcze w ujęciu sozologicznym. Przegl. Geol. nr 1, s. 12—16.

Rubinowski Z., 1995 — Kartografia geologiczno-sozologiczna. [W:] Ochrona środowiska przyrodniczego i zasobów mineralnych. Wyd. CPPGSMiE PAN, Kraków, s. 67—72.

Rubinowski Z., Nowak M., 1990 — Szczegółowa mapa geologiczno-gospodarcza regionu świętokrzyskiego na przykładzie arkuszy Kielce 1 : 50 000 i Chęciny 1 : 25 000. [W:] Kartograficzne opracowania geologiczno-gospodarcze w ujęciu sozologicznym. Mat. CPBP 04.10, t. 20, SGGW-AR, Warszawa, s. 62—73.

Sikorska-Maykowska M., 1998 — Elementy hydrogeologii na Mapie geologiczno-gospodarczej Polski 1 : 50 000. Przegl. Geol. t. 46, nr 10, s. 1049—1050.

Sikorska-Maykowska M., 1998 — Stan i perspektywy realizacji programu Mapy geologiczno-gospodarczej Polski 1 : 50 000. Przegl. Geol. t. 46, nr 10, s. 1061—1062.

System Informacji o Terenie. Mapa sozologiczna Polski w formie analogowej i numerycznej. Wytyczne techniczne K-3.6. GUGiK, Warszawa 1997.

Tomaszewski J., 1988 — Instrukcja sporządzania map geologiczno-gospodarczych z elementami ochrony środowiska przyrodniczego w skali 1 : 50 000. CPBP 04.10, Szczecin-Warszawa.

MAREK NIEĆ, MAŁGORZATA KAWULAK, EWA SALAMON

MAPY GEOLOGICZNO-GOSPODARCZE DLA POTRZEB PLANOWANIA PRZESTRZENNEGO

Słowa kluczowe

Kartowanie geologiczne, środowisko, planowanie przestrzenne

Streszczenie

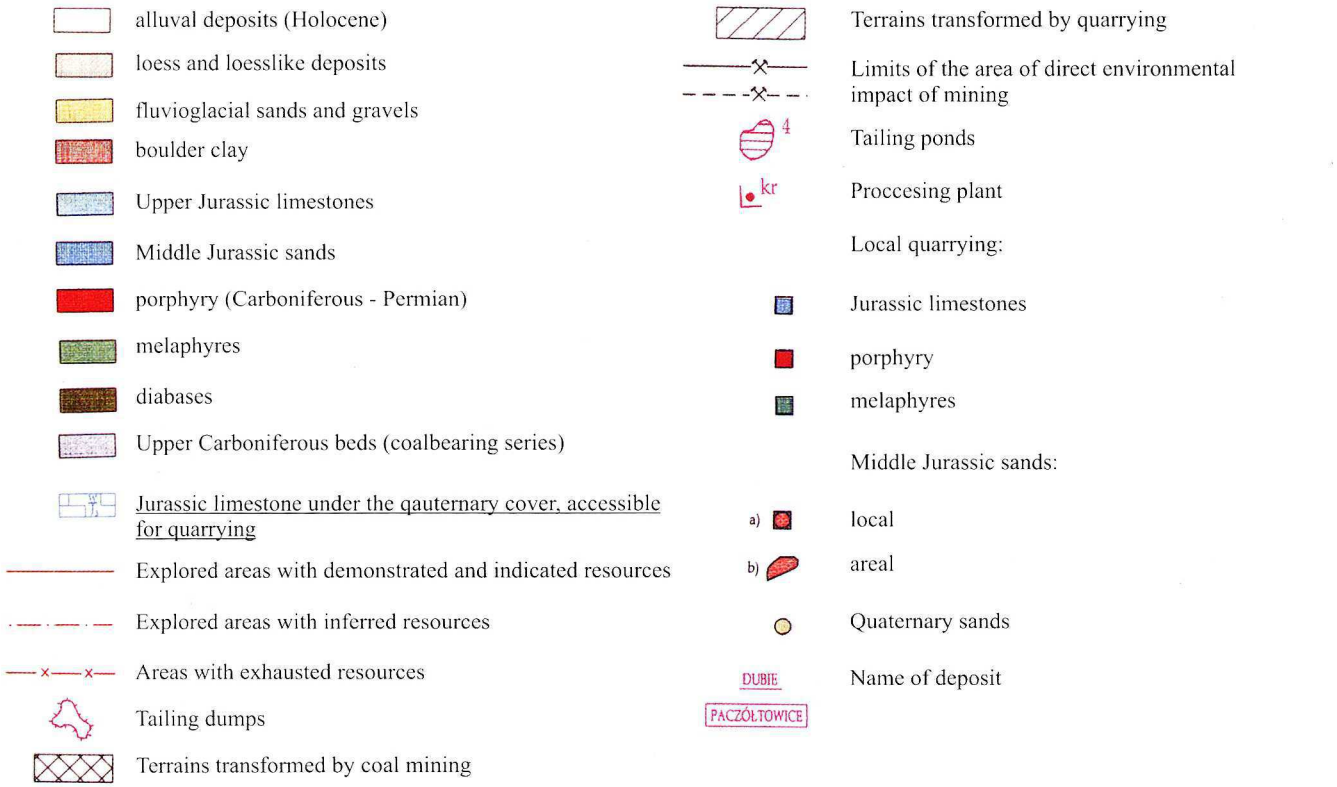
Wymagania ochrony środowiska ograniczają swobodne planowanie zagospodarowania terenu. Należy uwzględnić występowanie: złóż kopalin i wód podziemnych, żyznych (chronionych) gleb, wartości krajobrazowych oraz gruntów nieprzydatnych dla budownictwa, a zatem tych czynników, które są ważne dla planowania zrównoważonego rozwoju społeczności lokalnych. Prezentacja tych czynników na mapach jest najlepszym przekazem informacji na ich temat. Na przykładzie województwa małopolskiego stwierdzono, że najdogodniejsze na potrzeby zagospodarowania przestrzennego są mapy w skalach 1 : 25 000 i 1 : 10 000 sporządzane dla poszczególnych gmin. Systematyczne opracowywanie map geologiczno-gospodarczo-szologicznych dla poszczególnych gmin województwa krakowskiego (i obecnego małopolskiego) zapoczątkowane zostało w 1994 r. Prezentacja map w systemie GIS umożliwia łatwą ocenę możliwości eksploatacji kopalin, zabudowy terenu, budowy dróg, na tle ograniczeń wynikających z wymagań ochrony środowiska, a także ocenę możliwości występowania zagrożeń naturalnych (np. osuwisk w terenie górskim). Mapy takie pozwalają na zobrazowanie możliwości wykorzystania złóż kopalin na potrzeby lokalne i ponadlokalne oraz określenie warunków ich ochrony dla przyszłego wykorzystania.

MAP EXAMPLES

PRZYKŁADY MAP

Fig 1. Geological map of mineral and industrial rocks potential (fragment of Krzeszowice parish, original scale 1 : 25 000, Nieć et al. 1997)

Rys. 1. Mapa geologiczna z rejestracją wystapień kopalin (gmina Krzeszowice, fragment, skala oryginalna 1 : 25 000, Nieć i in. 1997)



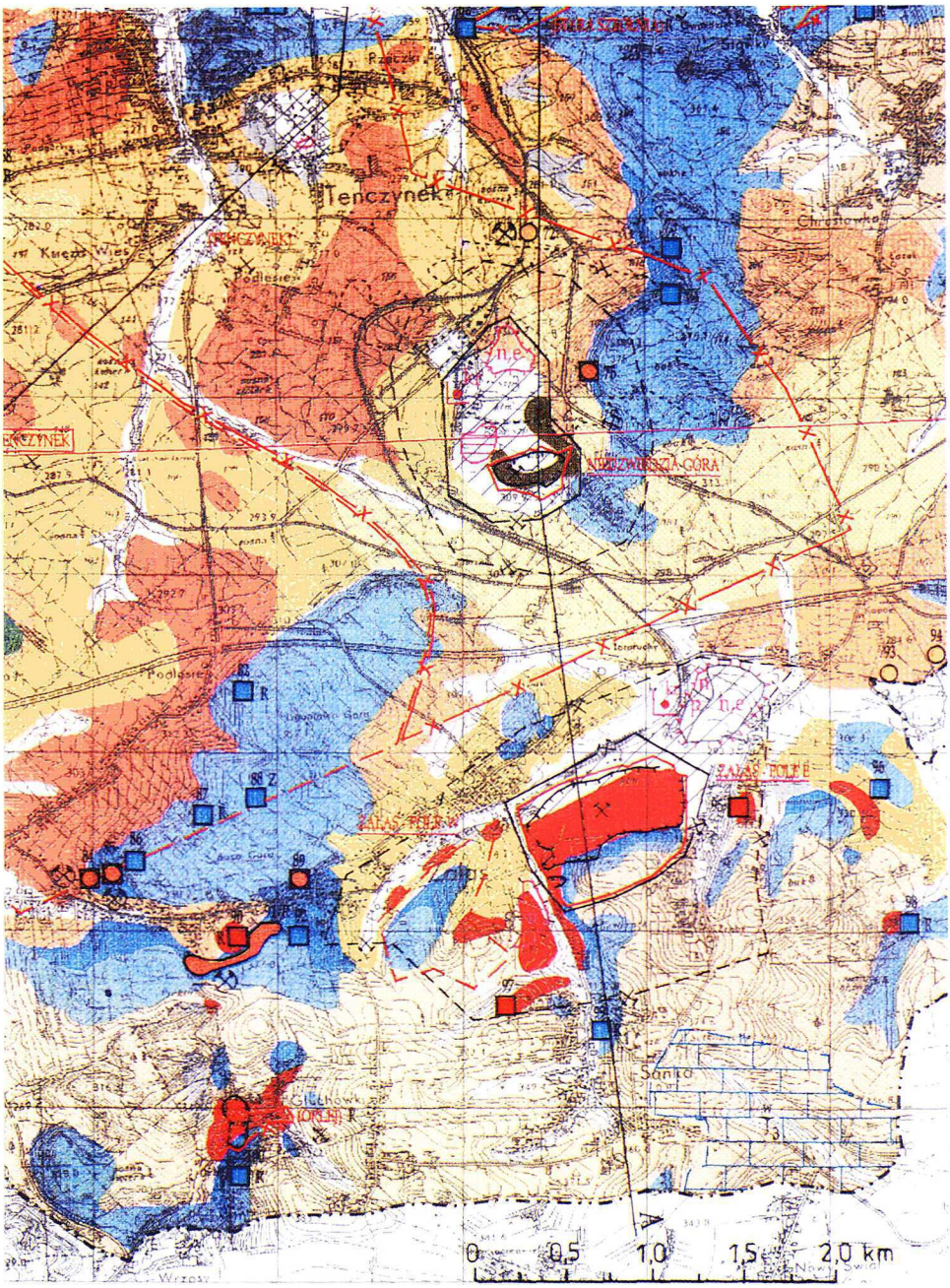
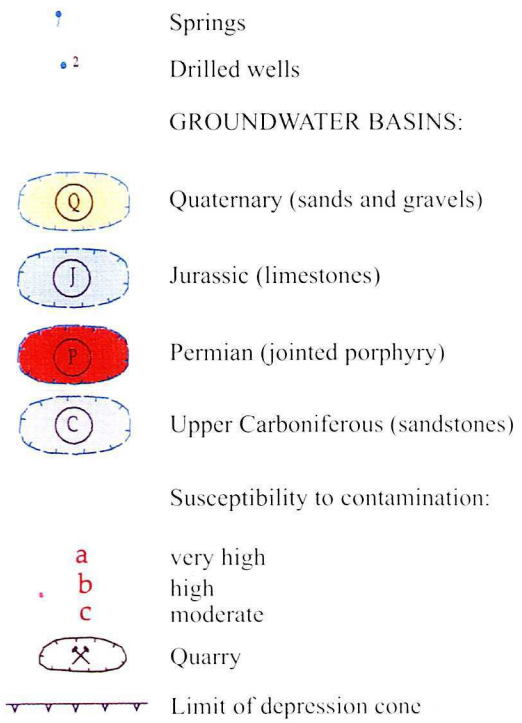

Tenczynek
Podlesie
Sanka
0 0,5 1,0 1,5 2,0 km

Fig. 2. Hydrogeological map
(fragment of Krzeszowice parish, original scale 1 : 25 000, Nieć et al. 1997)

Rys. 2. Mapa warunków wodnych
(gmina Krzeszowice, fragment, skala oryginalna 1 : 25 000, Nieć i in. 1997)



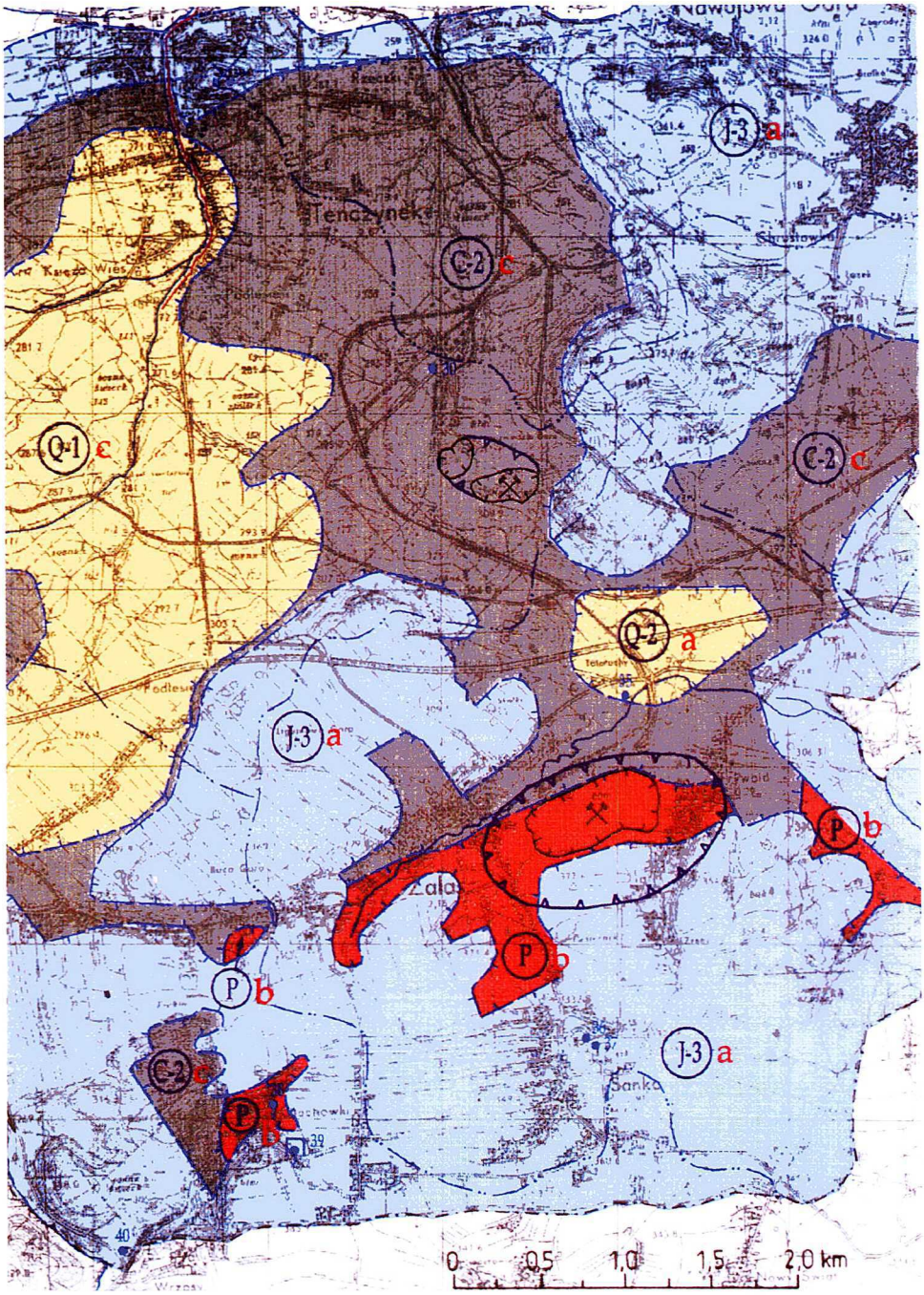
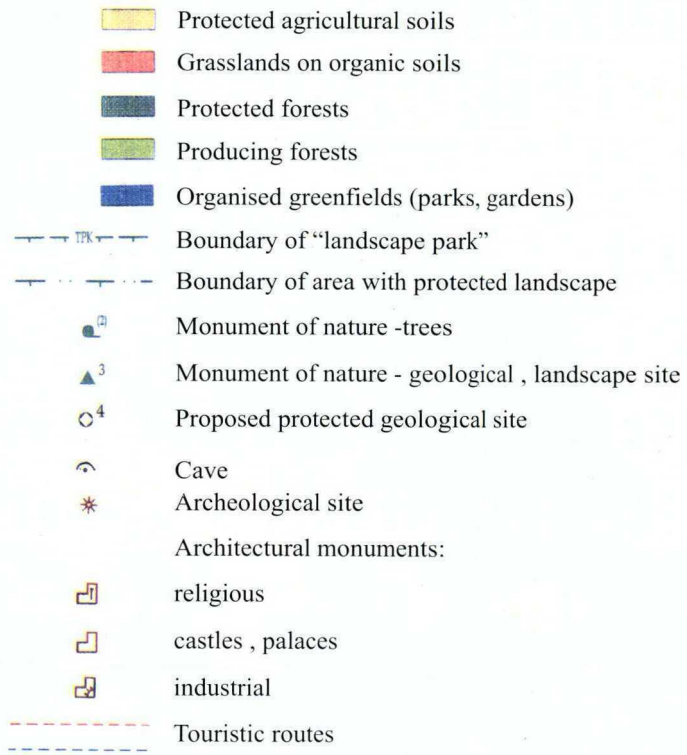
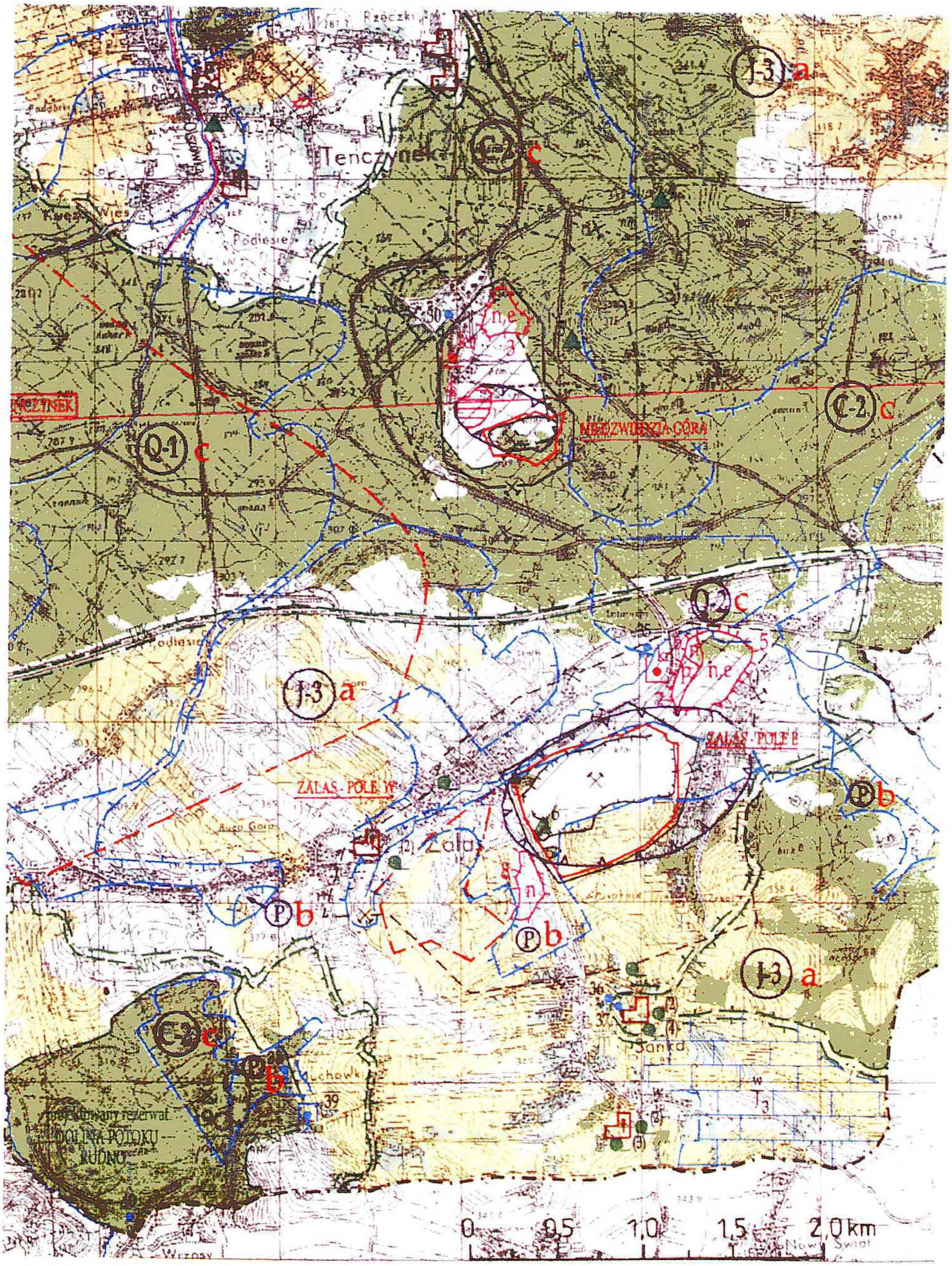

J-3 a
Tenczynek
C-2 c
Q-1 c
C-2 c
Q-2 a
J-3 a
P b
P b
P b
J-3 a
Sanka
C-2 c
P b
0 0,5 1,0 1,5 2,0 km

Fig. 3. Map of environment protection with superimposed data on mineral deposits and underground water reservoirs (see fig. 1 and 2)
(fragment of Krzeszowice parish, original scale 1 : 25 000, Nieć et al. 1997)

Rys. 3. Mapa ochrony środowiska z przedstawionymi danymi o złożach i warunkach wodnych (zob. rys. 1 i 2) (gmina Krzeszowice, fragment, skala oryginalna 1 : 25 000, Nieć i in. 1997)

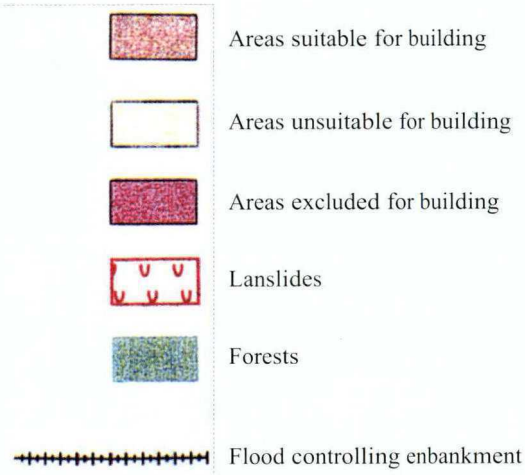




Rzeczki
Tenczynek
J-3 a
C-2 c
Podlesie
Q-1 c
NIEDZWIEDZIA GÓRA
Q-2 c
ZALAS - POLE W
ZALAS - POLE E
P b
Zalas
Sanka
projektowany rezerwat
DOLINA POTOKU
RUDNO
0 0,5 1,0 1,5 2,0 km

Fig. 4. Map of ground conditions for building
(fragment of Podegrodzie parish, original scale 1 : 25 000, Nieć et al. 1999)

Rys. 4. Mapa warunków podłoża budowlanego
(gmina Podegrodzie, fragment, skala oryginalna 1 : 25 000, Nieć i in. 1999)



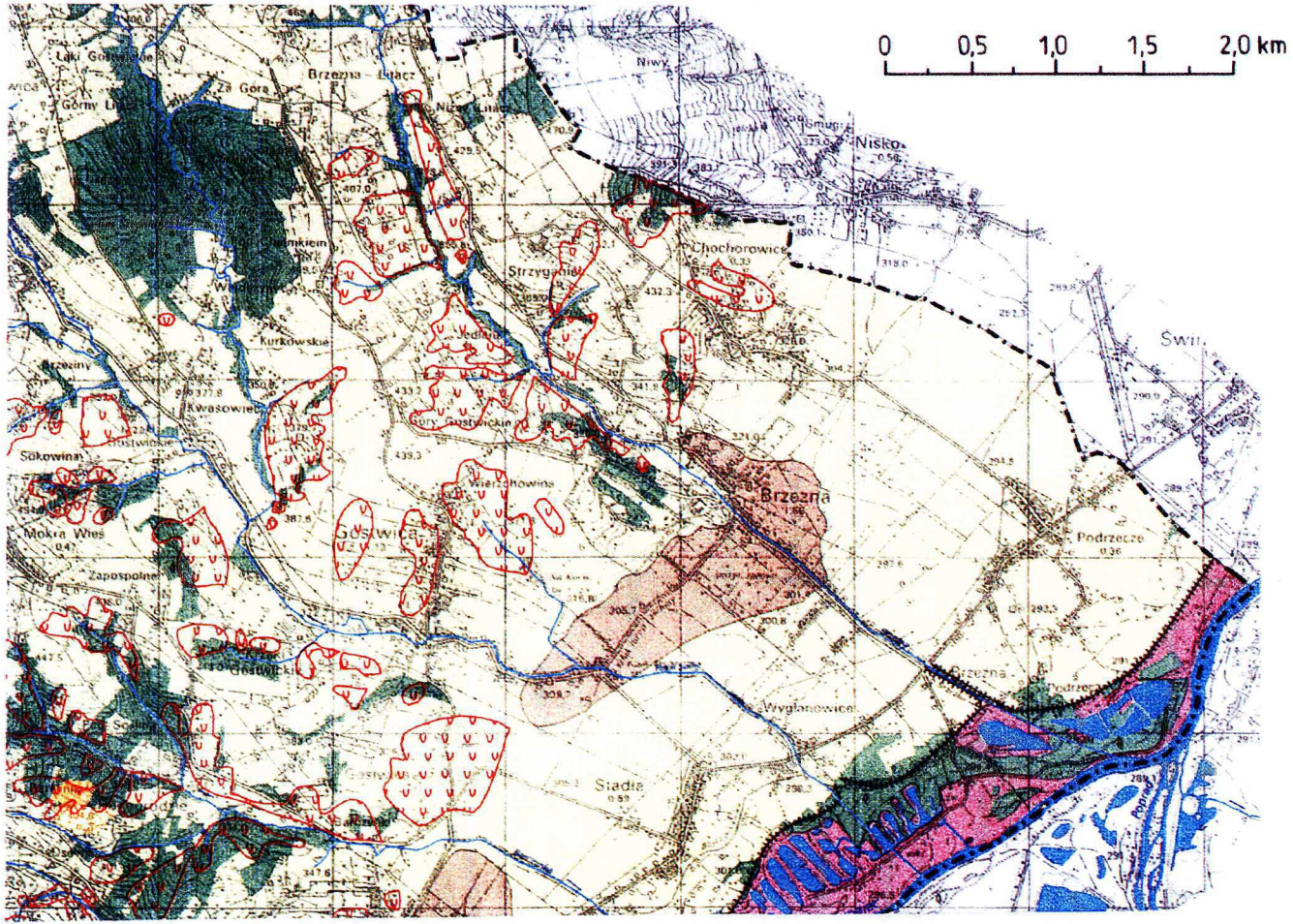
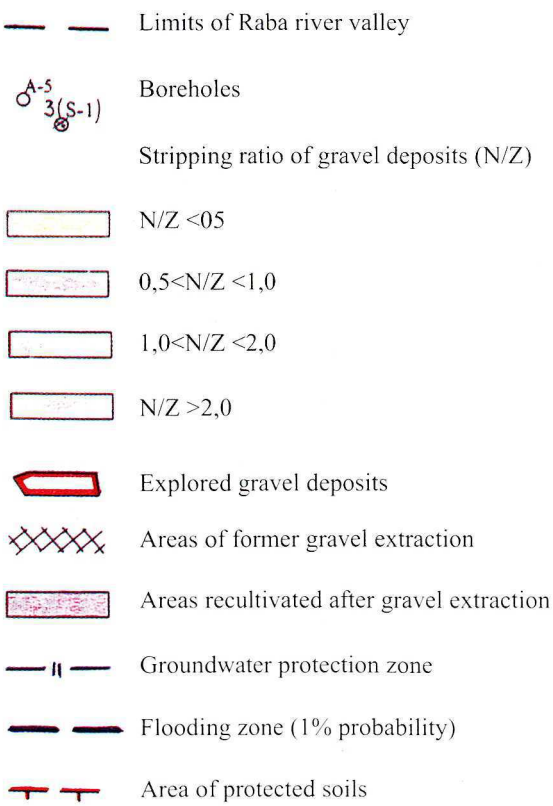
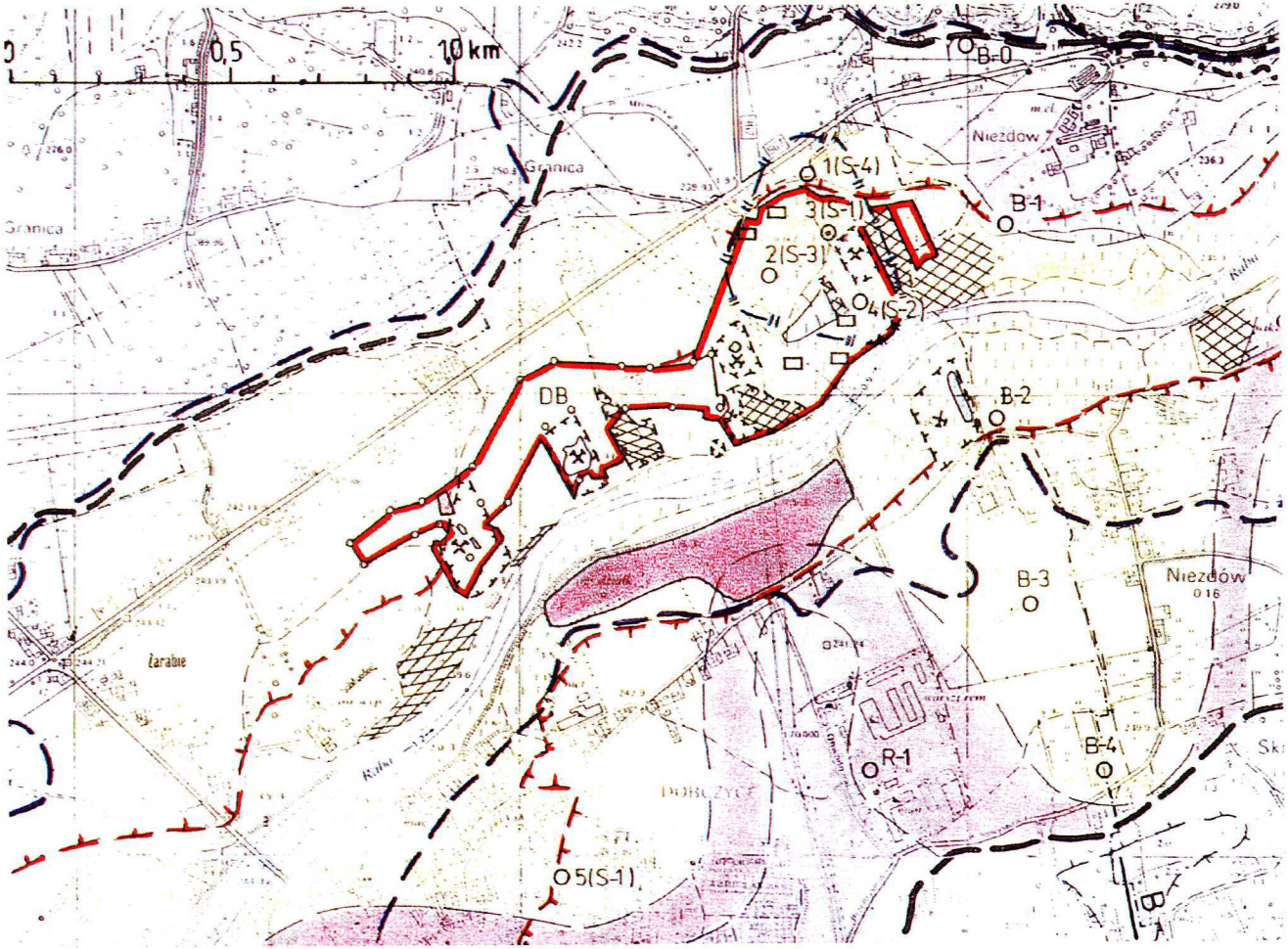

0 0,5 1,0 1,5 2,0 km
Brzezna
Nisko
Chochorowice
Strzygowice
Kwasowiec
Sokowina
Mokra Wieś
Zapospolne
Wierzchowina
Podrzecze
Wyglanowice
Siadła

Fig. 5. Map of availability of natural aggregate resources
(Raba river valley, Dobczyce parish, original scale 1 : 10 000, Nieć et al. 1997)

Rys. 5. Mapa występowania kruszywa naturalnego w dolinie Raby
(gmina Dobczyce, skala oryginalna 1 : 10 000, Nieć i in. 1997)




0
0,5
1,0 km
B-0
Niezdow
1(S-4)
3(S-1)
B-1
2(S-3)
4(S-2)
Granica
Granica
DB
B-2
B-3
Niezdów
Żarabie
R-1
B-4
5(S-1)