contaminated, even despite partial filtration through the layers of sediments; the conductivity of this water is from 320 to 470µS•cm^{-1}.

Short, often ephemeral watercourses in the catchment of the upper Radunia mostly display low conductivity of up to ≈ 100 µS•cm^{-1} (min 85 µS•cm^{-1} – the ephemeral watercourse opening to Lake Szewinko). With the development of the hydrographic network and a larger share of water supplied from deeper aquifers the water mineralisation increases in the watercourses of the upper Radunia; in their mouth sections the water conductivity reaches ≈ 400 µS•cm^{-1} (max 430 µS•cm^{-1} in the Struga Łączyńska). The conductivity of the lakes of the upper Radunia system is generally lower than that of the watercourses, which is due to the ability of lakes to transform matter. The conductivity values of the lake surface water range from ≈ 70 µS•cm^{-1} (Zamkowisko) to 362 µS•cm^{-1} (Bukrzyno Małe); the average for all the described lakes is 259 µS•cm^{-1}. The water of Lake Bukrzyno Małe reaches such high conductivity values due to the large share of the underground supply compared with other forms of supply.

The groundwater supply into the lakes depends on many factors, including the predisposition of the lake basin to drain aquifers, which is determined by e.g. the maximum depth. Figure 3 shows the correlation between the maximum depth of the lakes at the different levels of the system organisation and the water conductivity. The figure indicates that the correlation between these elements is insignificant, while the location in a hierarchically organised hydrographic system is important. It is also noticeable that shallow lakes (mostly from local catchments) have the greatest diversity of conductivity: from 158 µS•cm^{-1} (Szewinko) to 362 µS•cm^{-1} (Bukrzyno Małe). The lakes of this type show a distinct predominance of one type of supply (e.g. surface supply in Lake Szewinko, fluvial supply in Lake Glinno and underground supply in Lake Bukrzyno Małe), which determines the water mineralisation.

The water conductivity of the medium-depth lakes (H_{max} 5-10 m) in the headwater catchment does not show a large variation, ranging from 250 to 300 µS•cm^{-1}. Lake Lubowisko, located in the local catchment, has a lower conductivity (202 µS•cm^{-1}), which is caused by a larger role of precipitation in its supply structure. A similar situation is observed in the case of deep lakes in the elementary catchment. Lake Zamkowisko is mainly supplied via precipitation and the conductivity of its water is only 70 µS•cm^{-1}. The water of deep and very deep lakes in the headwater catchments and river basins do not show a large variation of conductivity, but its value is also dependent on the contribution of different sources of supply.

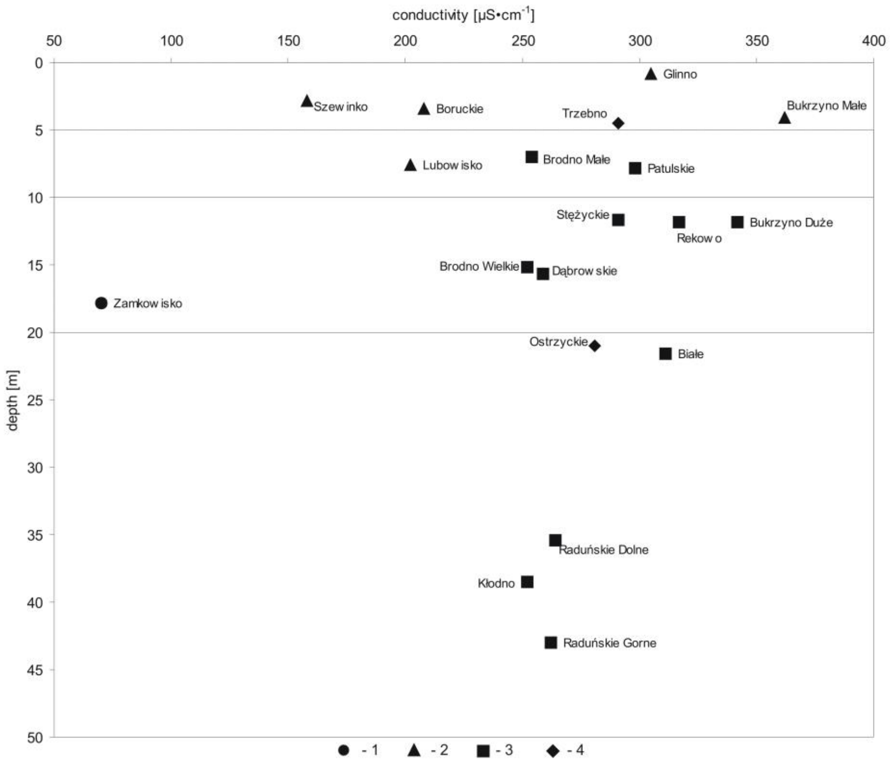

Figure 3. Correlation of water conductivity and the maximum depth of lakes
Key: 1 - lakes in the elementary catchment, 2 - lakes in the local catchment, 3 - lakes in the headwater catchment, 4 - lakes in the river basin

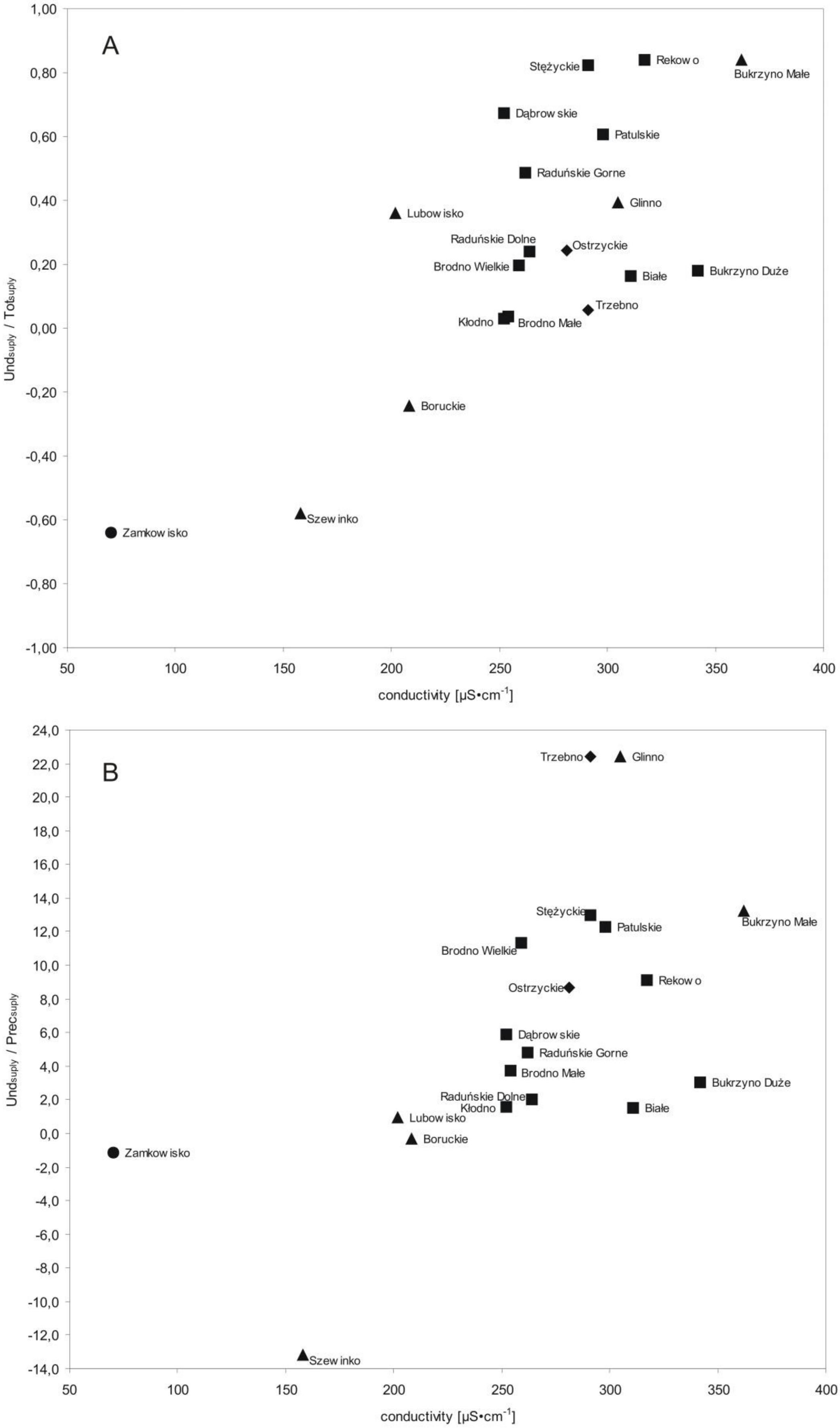

Figure 4. Correlation of water conductivity and the underground supply relative to the total water supply to the lakes (A) and the ratio of the underground supply to the precipitation supply (B)

The proportions between the various components of supply, namely the volume of the underground, surface and precipitation supply, affect the chemical composition of the water, which is reflected via its conductivity. The correlations of conductivity and the underground and total supply quotient (Und_{suply} / Tot_{suply}) as well as the ratio of the underground and precipitation supply (Und_{suply} / $Prec_{suply}$), represented in Figures 4 A and 4 B, show the dependency of mineralisation on the source of the water supply in lakes.

The biggest participation of the resultant underground supply in the total supply to the lakes (Und_{suply} /$Tot_{suply} \approx 0.8$) is recorded in Lakes Stężyckie, Rekowo and Bukrzyno Małe. Such a large supply with the underground water of higher mineralisation increases water conductivity in these lakes. The reservoirs in which the underground drainage is found (Und_{suply} / Tot_{suply} <0) show the lowest water mineralisation. These are mostly lakes in the elementary catchments (Zamkowisko) or some shallow lakes in the local catchments (Szewinko). The exception is Lake Boruckie, which, despite the advantage of the precipitation supply and underground runoff, shows an average conductivity of 208 $\mu S \bullet cm^{-1}$. This condition is caused by severe anthropopressure exerted on this water body.

In the other lakes of the upper Radunia the participation of the underground supply ranges from 3-4% (Kłodno, Brodno Małe) to over 60% (Patulskie, Dąbrowskie). With the varying influence of surface and precipitation supply this causes the differentiation of the water mineralisation. Moreover, the ratio of the water from the underground resources to the precipitation supply variability explains the conductivity of the water in this group of lakes (Fig. 4 B). In most of the lakes of the upper Radunia the impact of these supply sources on the mineralisation of water is visible. The lakes whose water conductivity depends mainly on the surface supply (Bukrzyno Duże, Białe, Brodno Wielkie, Trzebno, Glinno) are the most deviating from the scheme. Lakes Szewinko, Zamkowisko and Boruckie have a negative indicator and the more the underground runoff exceeds the precipitation volume, the smaller the value.

3. CONCLUSIONS

An important role in shaping the properties of water, including conductivity, is the location of the lakes in the hierarchically organised hydrographic system as well as the supply structure of the lakes in conjunction with the morphometric characteristics of the lake basins. These correlations allow us to conclude the following:

- In terms of the supply conditions and water mineralisation, a greater role is played by the location in a hierarchically organised hydrographic system than the maximum depth of the lakes.
- The total mineralisation of the lake water is correlated with the ratio of the underground supply and the overall supply (Und_{suply} / Tot_{suply}) and the ratio of the underground supply and precipitation supply (Und_{suply} / $Prec_{suply}$). The variability of the characteristics of the Und_{suply} / Tot_{suply} in the lakes of the upper Radunia ranges from the negative values (underground discharge) in Lakes Zamkowisko, Szewinko and Boruckie, and below 0.1 (Kłodno, Brodno Małe, Trzebno) to over 0.8 (Bukrzyno Małe, Rekowo, Stężyckie). The values of the other correlation (Und_{suply} / $Prec_{suply}$) also take negative values in the lakes with the underground drainage. In the remaining lakes range from 1 (Lubowisko) to more than 10 in Lakes Brodno Wielkie, Patulskie, Stężyckie, Bukrzyno Małe, Glinno and Trzebno.
- Shallow lakes (H_{max} <5 m), located mostly in local catchments, show the greatest diversity of water conductivity: from 158 $\mu S \bullet cm^{-1}$ (Szewinko) to 362 $\mu S \bullet cm^{-1}$ (Bukrzyno Małe). The lakes of this type show a distinct predominance of one type of supply (e.g. surface supply in the case of Lake Szewinko, fluvial supply in Lake Glinno and underground supply in Lake Bukrzyno Małe), which determines water mineralisation. Lake Bukrzyno Duże has a very large participation of the underground supply in the total supply of water to the lake (Und_{suply} / $Tot_{suply} \approx 0.8$), while in Lake Szewinko there was no groundwater supply (Und_{suply} / Tot_{suply} <0).
- The water conductivity of the medium-depth lakes (H_{max} 5-10 m) at the level of the local catchment is ≈ 200 $\mu S \bullet cm^{-1}$ (Lubowisko), which reflects the greater importance of precipitation in the supply structure (underground supply to precipitation supply Und_{suply} / $Prec_{suply}$ = 1). The water conductivity of the medium-depth lakes at the level of the headwater catchment range from 250 $\mu S \bullet cm^{-1}$ (Brodno Małe) to 300 $\mu S \bullet cm^{-1}$ (Patulskie), which reflects an increase in the importance of surface supply in the case of Lake Brodno Małe and the underground supply in Lake Patulskie (Und_{suply} / Tot_{suply} = 0.61).
- The water conductivity of the deep lakes (H_{max} 10-20 m) located at the level of the headwater catchments ranges from 260 $\mu S \bullet cm^{-1}$ (Brodno Wielkie) to 340 $\mu S \bullet cm^{-1}$ (Bukrzyno Duże). The mineralisation of these lakes is mainly due to water supplied from the lake above, while the importance of the underground supply is evident in the case of Lakes Rekowo and Stężyckie where Und_{suply} / $Tot_{suply} \approx 0.8$. Lake Zamkowisko, at

the level of the elementary catchment and supplied predominantly via precipitation, despite its considerable depth, shows no underground supply (Und_{suply} / Tot_{suply} <0), resulting its water conductivity of ≈ 70 $\mu S \cdot cm^{-1}$.

- The very deep lakes (H_{max}> 20 m) at the level of the headwater catchments and river basins do not show a large variation of conductivity, which ranges from 250 $\mu S \cdot cm^{-1}$ (Kłodno) to 310 $\mu S \cdot cm^{-1}$ (Białe). In the lakes at this level of the territorial hydrographic system the importance of surface supply increases at the expense of the underground supply (Und_{suply} / Tot_{suply} ranges from 0.03 to 0.16).
- Lake Boruckie, despite the advantage of the precipitation supply and underground runoff, shows an average conductivity of 208 $\mu S \cdot cm^{-1}$. This condition is caused by a severe anthropopressure exerted on this water body.

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