The role of echosounder measurement in lidar point cloud calibration

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1.0 Introduction

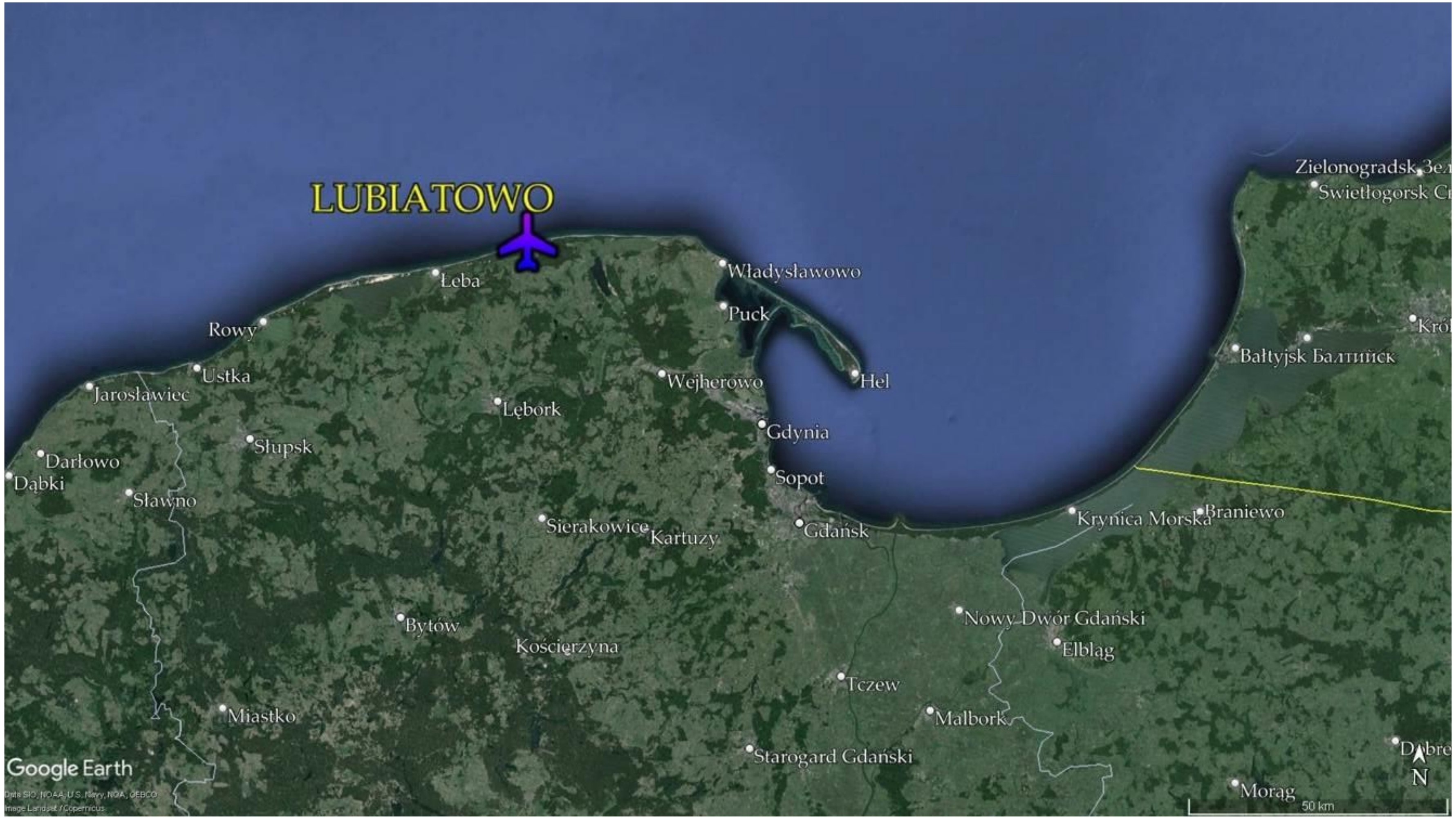
- The Lidar is a laser scanner that functions by emitting light in the green or near-infrared spectrum. It represents a sophisticated form of active remote sensing, whereby the impulse of a laser beam is transmitted from a sender, and the receiver detects the time of the return travel impulse upon its arrival at the target.

2. Materials and Methods

- The research area was located in the Lubiatowo region, where a 1.5 km long coastal zone section was recorded, with a depth of 10m (figure 1).

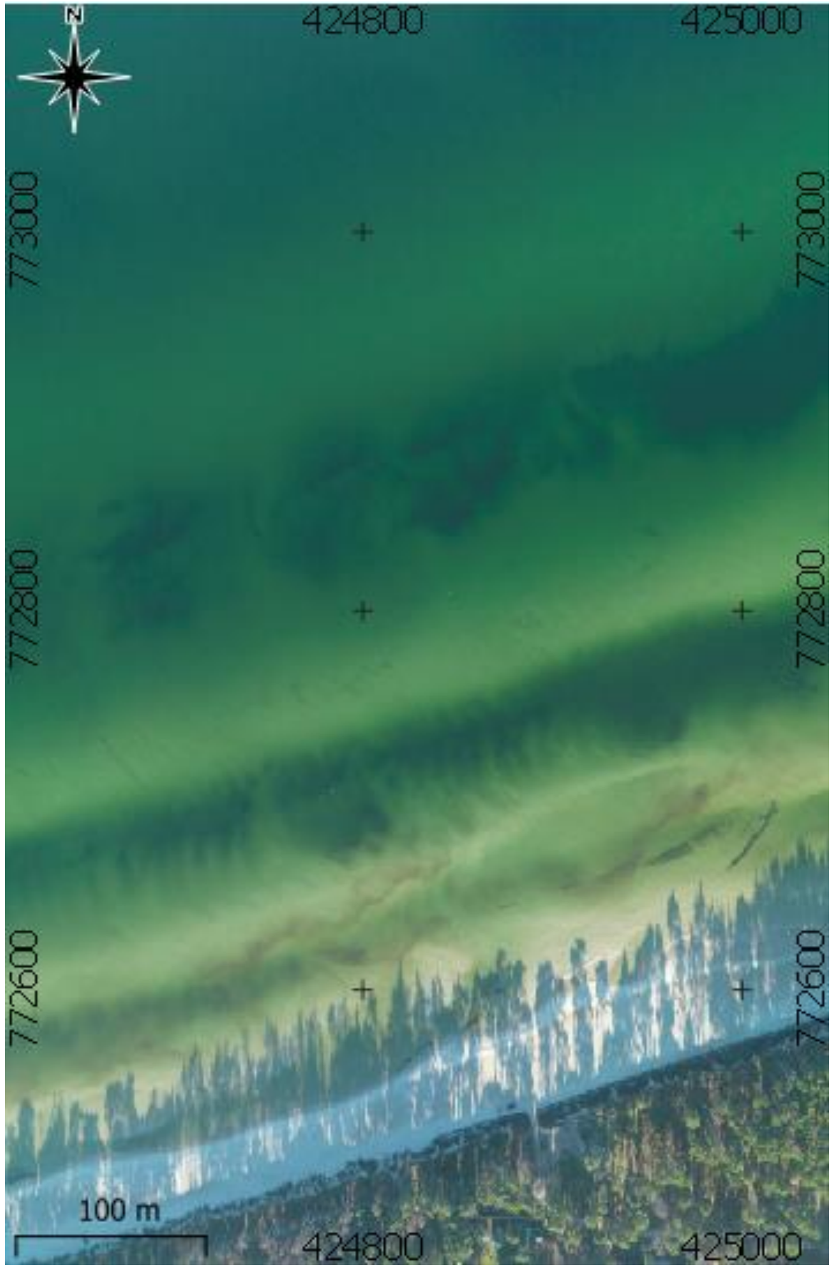
- The research was based on the lidar point clouds from 2018, which were executed by the Austrian company Airborne Hydro Mapping Gmbh for the Polish company Apeks. The Riegl scanner Vq 880 g was utilized to measure the seashore and bottom of the sea near Lubiatowo. Concurrently, the Institute of Hydro-Engineering of the Polish Academy of Sciences in Gdańsk initiated a rapid assessment of the seabed. This endeavor entailed the utilization of an echosounder and GPS technology, enabling precise geolocation and topographical analysis.

2. Registration of a section of the Baltic Sea with a beach near the Lubiatowo (Poland) region show Figure 1



2. View of the bottom of the sea near Lubiatowo show figure 2

- Furthermore, the system demonstrated its capacity for aerial imaging, as illustrated in Figure 2. This imagery revealed the absence of suitable objects for use in the calibration process at the sea depths.



3. Results and Disscusion

- In Figure 3, eight lidar point strips were performed parallel to the coastal zone, with one line perpendicular to them and integrated.

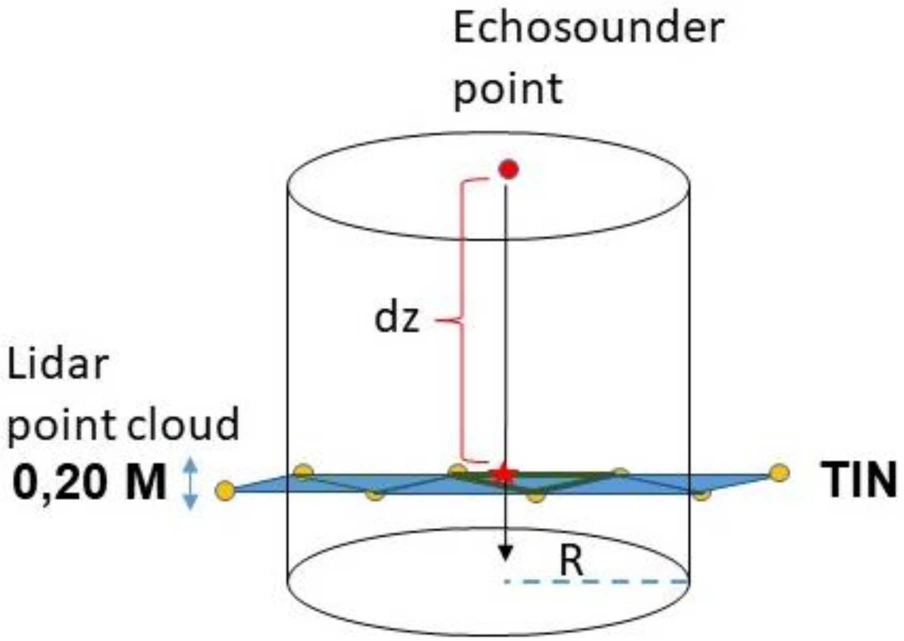
- The echosounder profile is performed perpendicular to the lidar point cloud, commencing at a depth of 1m. Figure 3 illustrates its localization. The measurement was conducted immediately following the completion of lidar point cloud registration. An investigation was conducted into the relationship between lidar point cloud depth and echosounder profile at the location indicated in Figure 3, with the objective of ascertaining their disparities.

- The utilization of Microstation Power Draft in conjunction with Terrascan, Geokonwerter, and Microsoft Office Excel software facilitates the generation of the echosounder profile rule within the context of lidar point cloud calibration.

3. The localization of a partial lidar point cloud for analyses show figure 3

3. Scheme for determining the lidar height adequate for echosounding show figure 4

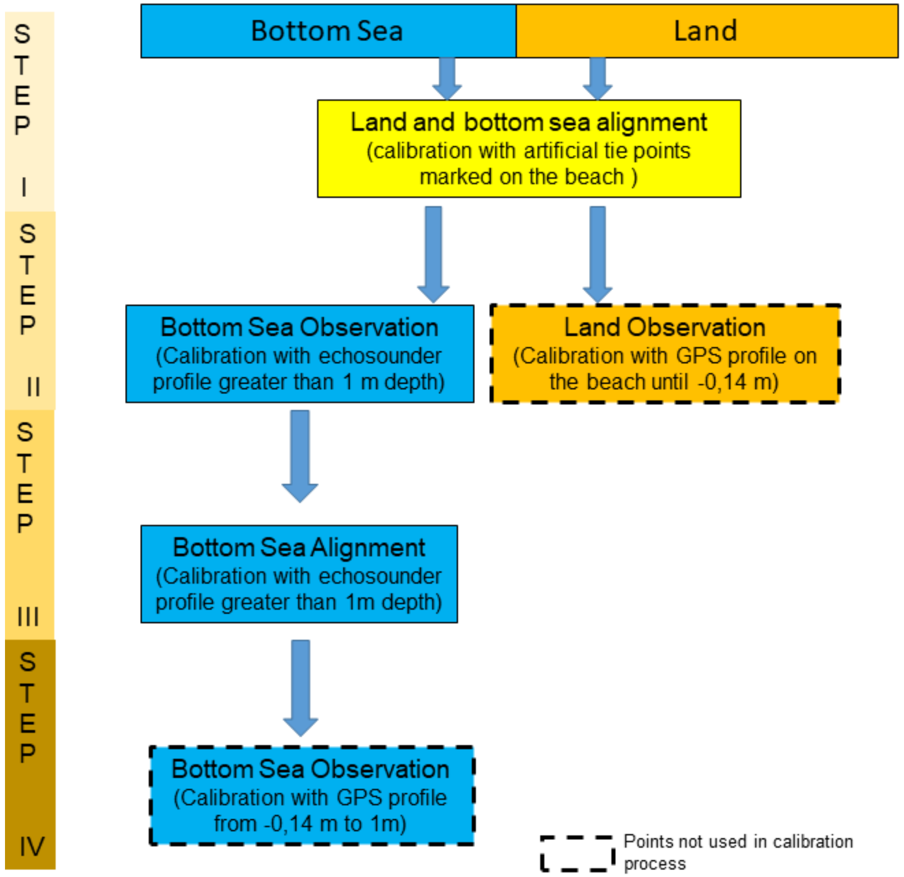
- As illustrated in Figure 4, the calculation of distance from a given point to the plane surface is achieved through a systematic series of steps. Within the specified radius R(2m), the echosounder and lidar points are identified, and the closest point is determined. Once installed, the plane triangle is managed through the implementation of least squares estimation. The distance from the echosounder point to the plane-fitted surface is denoted as Dz (Geocue Development Team, 2017).



3. The modification steps of the lidar point cloud show figure 5

- Final step of the experiment, the observation of a portion of the sea floor revealed a usefulness coefficient of 0.76, ranging from 0.14 meters (sea level) to 1 meter in depth. The lidar point cloud area was examined using a GPS profile and a range of 0.14 to 1 meter. Consequently, only the vertical deviation, equivalent to the standard deviation (0.02 meters), was detected.

3. Steps modyfication represents figure 5



3. The modification of the lidar point cloud based on the echosounder profile

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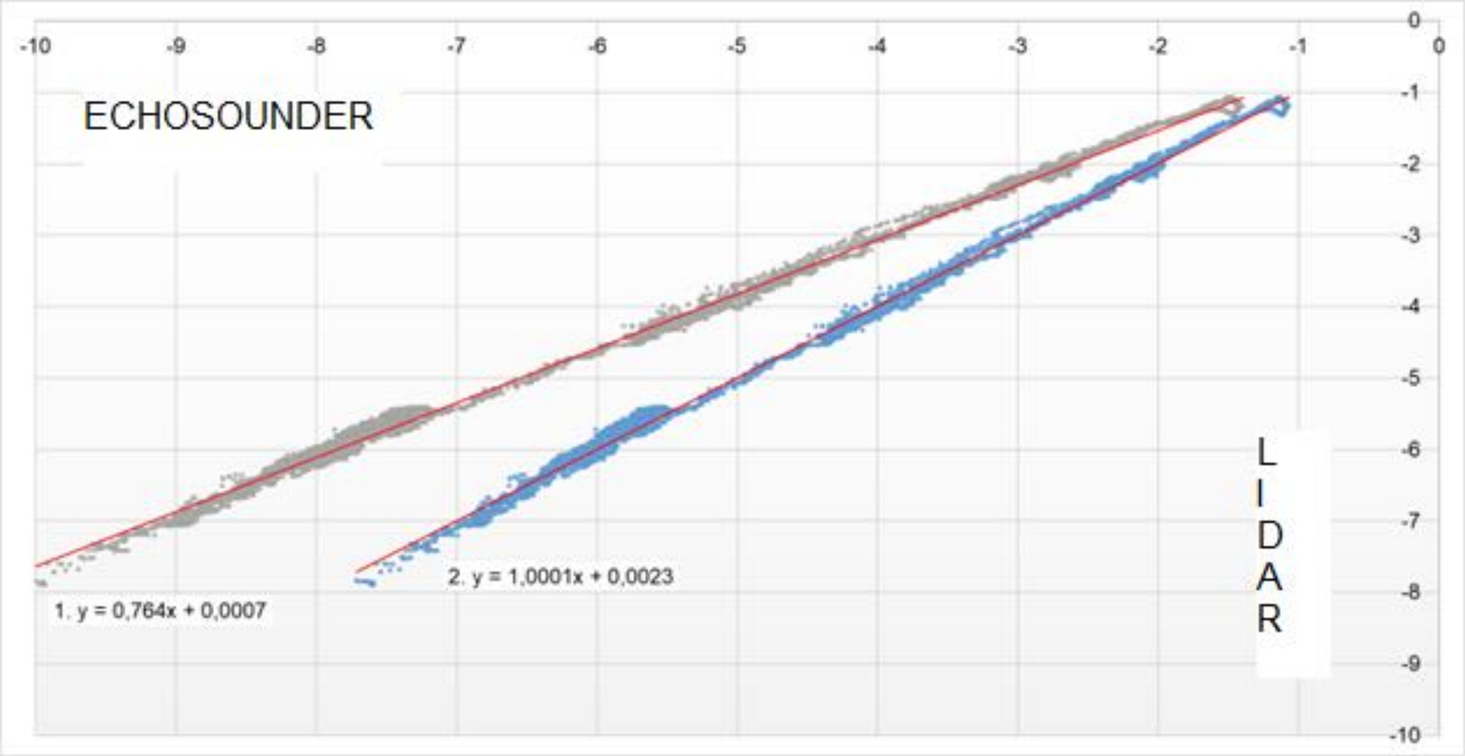
- In Figure 6, the echosounder profile plays a pivotal role in the calibration of the lidar point cloud. The graph demonstrates a shifted lidar point cloud, derived from the localization of the echosounder profile. The coefficient of 0.76 was derived from the relationship between the two data sets, and its application resulted in a change in the lidar point cloud's depth. The differences between the data can be primarily explained by the functions $y=0.76x$ to $y=1$. In the case of calm Baltic Sea water, the coefficient 0.76 can be used for refraction correction.

3. The modification of the lidar point cloud based on the echosounder profile show figure 6



4. Conclusion

- The echosounder profile enhances the accuracy of the lidar point cloud coefficient (0.76), facilitating the implementation of refraction correction in the stable Baltic Sea.

- It is imperative to execute the echosounder profile concurrently with the registration lidar point cloud to ensure the efficacy of the calibration process. This approach enables the calculation of corrections and deviations.

- The methodology involves the assessment of the trend in changes in depth between lidar and echosounder profile measurements.