Airborne Laser (LiDAR) Bathymetry for Precision Capture and Survey of River Beds and Belonging Territories

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"... The deep water is useful in many ways, but it is harmful - may to drown in it. But it can be avoided - learn to swim. "
Democritus

SUMMARY

The report examines an innovative and effective technology for a detailed study and a precision monitoring of river beds, watercourses, lakes and dams, namely air laser (LiDAR) bathymetry. It provides an opportunity to be determined at the same time as the depths of shallow systems and the topography of the floodable of them belonging territories and all this with an unbeatable level of consistency and detail. In the report is made a critical comparative analysis of data obtained by scanning a portion of Ogosta river with two different laser scanners - *RIEGL* LMS-Q680i and *RIEGL* VQ-820-G Topo-Hydrographic Airborne Laser Scanner, as well as a number of conclusions and recommendations for the use of examined technology in practice. Highlighted is the need for close collaboration and partnership between research units, business and social-management area for the full and multi-faceted use of the great potential of these modern sensors, optimizing the methods to transform data into information systems and improving the use of water resources and population protection in emergencies and disasters.

РЕЗЮМЕ

Докладът разглежда една иновативна и ефективна технология за детайлно изучаване и високоточен мониторинг на речни корита, езера и язовири, а именно въздушната лазерна (LiDAR) батиметрия. Тя осигурява възможност да се определят едновременно както дълбочините на плитководни системи, така и топографията на заливаните от тях прилежащи площи и то с ненадминато ниво на последователност и детайлност. В доклада е направен критичен сравнителен анализ на данните, получени от сканирането на част от поречието на река Огоста с два различни лазерни скенера - *RIEGL* LMS-Q680i и *RIEGL* VQ-820-G Topo-Hydrographic Airborne Laser Scanner, както и редица изводи и препоръки за използване на разгледаната технология в практиката. Изтъкната е и необходимостта от постигане на тясното сътрудничество и партньорство между научно-изследователските звена, бизнеса и социално - управленческата сфера за пълноценното и многостранно използване на големите потенциални възможности на тези съвременни сензори, оптимизиране на методите за трансформиране на данните в информационните системи и усъвършенстване на използването на водните ресурси и надеждна защита на населението при аварии и бедствия.

INTRODUCTION

From ancient times people inhabit mostly the territories around rivers, lakes and other water sources. Water is not only life determining, but in many cases it dictates and the course of human history – for example, spills and low tides of Nile river are determined to a large extent the overall life of the Egyptians. To this day, continuously develop and refine methods for measuring and studying watersheds.

The main and primary goal of science, the policy and business should be to satisfy the interests and needs of people and the environmental protection. One of the most radical and ambitious programmes adopted by the EU is a famous water framework directive (WFD). Its main objective is the improvement of the quality of aquatic ecosystems all across Europe and the reliable protection of the population in flood. We need to emphasize its fundamental and interdisciplinary nature. It puts the environment at the Centre, in the heart of the objectives of the management in Europe. For her performance, it is necessary to study the complex interactions between the hydromorphological, physical and chemical, biological, and human impacts on the environmental conditions in the various pools and objects around them. The effective and sustainable implementation of the WFD requires the development of new methods for the monitoring of the waters, as well as better reporting of biophysical and anthropogenic pressure in terms of the ecological balance of watersheds in Europe. Previous studies have suggested that many EU Member States are struggling to meet their commitments under the framework directive on water, but in practice are not in a position to respond adequately to its objectives.

To address these and of a number of other tasks in hydro engineering foundational role plays the availability of information about the topography of lakes, dams, rivers, floodplain terraces, estuaries or coastal areas. Despite the huge advances in computer technology and mathematical modelling (for example 2D and 3D-modeling) of hydraulic objects, it is important to ensure real numerical data and models. The digital elevation models of the coastal areas traditionally are created on the basis of simplified and interpolated data, obtained
on the basis of cross-sections, manually collectand during ground-based measurements of terrain or through eholot data.

Due to the lack of spatial information with high resolution for water masses on rivers, of shallow areas such as meadows, estuaries, river shores or dunes, the modelling and study of these structures is in the general case labor intensive, and sometimes even impossible for task execution. Frequent lately riparian and coastal flooding in populated areas undoubtedly give rise to an urgent and pressing need of improving methodsfor documentation of the watersheds.

In recent years, increasingly clearly stands out and having the need to qualitatively, quickly and economically feasible study of the dynamics of the water level, the structure and zone variations of lakes, dams, rivers and riparian zones (as well as the degradation of the rivers, the streams or reservoirs, and a number of other coastal sequestration processes). Society needs and requires a reliable, timely and detailed information about the size of the water quantities and for probability and the risk of dangerous flooding. Only upon this

premise could take adequate measures for the prevention and mitigation of the consequences of floods.

This is important to learning not only the water quantities, but also the actual form of the watersheds, sediments, overwhelms, or man-made structural changes of watersheds. Furthermore, it is essential and any additional information such as the availability of data for the ground surface and roughness. The innovative technology of airborne laser bathymetry has an ambitious aims to decide and it is of high technical and professional level of all these problems. Globally, the latest trend in this regard is the use of digital models with perfect quality and high resolution derived from topographic aerial laser data. Over the past few years, the spatial laser (LiDAR) scanning quickly developed and refined and is increasingly widely used mainly in the following three main areas — terrestrial, mobile and airborne. Extraction of high-quality spatial data with their main characteristics as XYZ coordinates, and
16-bit high resolution information about the intensity of the objects represents a uniform basis
for all three of the above directions.
After the scientific development of any new technology is necessary to comprehensive practical verification and performance evaluation and study of the accuracy and reliability of the final results and data. These report is dedicated to airborne laser bathymetry, as made a critical comparative analysis of data obtained by scanning a portion of Ogosta river with two different laser scanners - RIEGL LMS-Q680i and RIEGL VQ-820-G Topo-Hydrographic Airborne Laser Scanner.
Practical main objective is to address a bit more detail differences between referreds two types of airborne scanners from one and the same manufacturer based on the wavelength of the laser pulses. But before this we stop for a bit of the entire (RIEGL LMS-Q680i) and realtime (RIEGL VQ-820-G Topo-Hydrographic Airborne Laser Scanner) waveform analysis – a technology that provide high density, quality and precision of the received data. For guaranteed receipt the reflected signal from a small in size objects must have met the conditions, illustrated in Fig. 1.

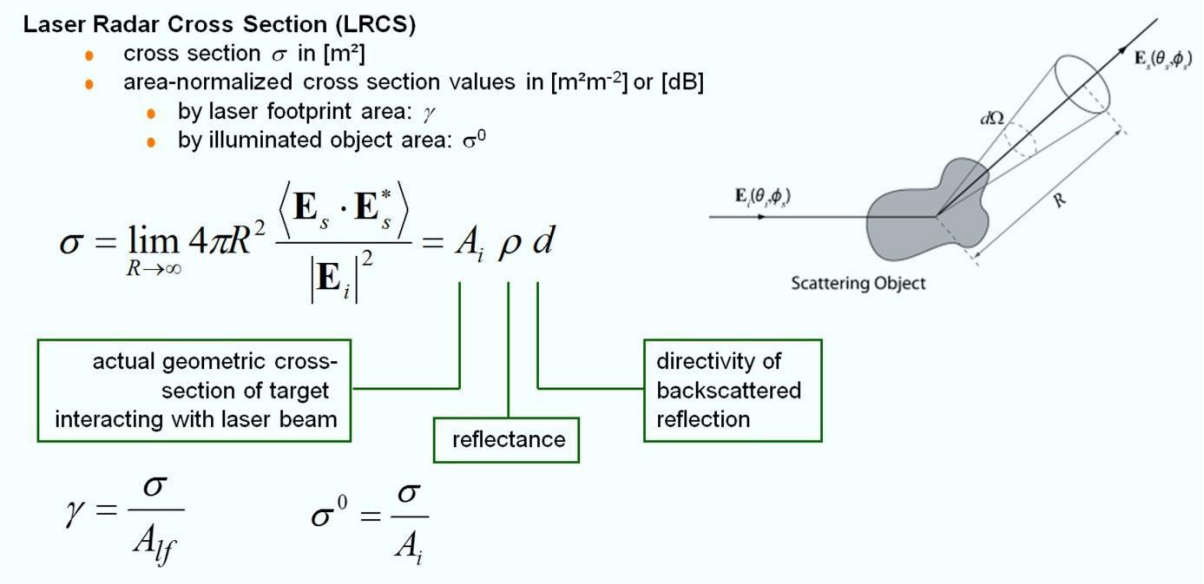


Fig.1 Radiometric calibration of the reflected signal

Fig. 2 Block diagram of RIEGL LiDAR instrument

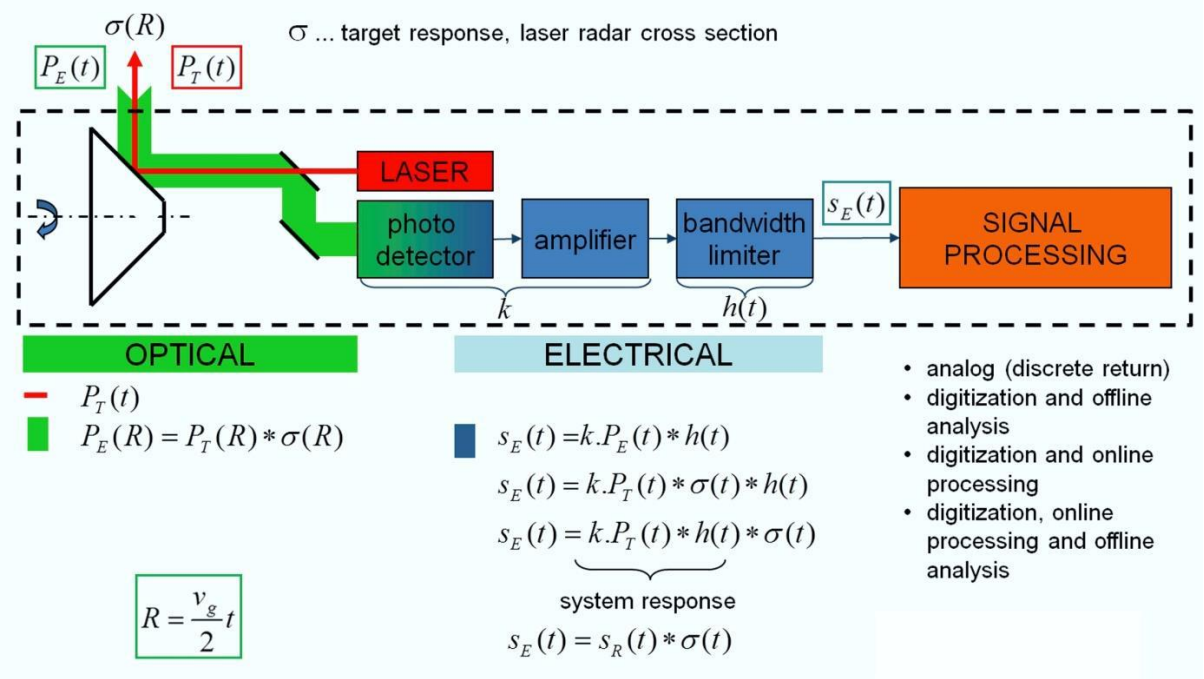


Fig. 3 A single reflected signal in comparison with one, but with a full-wave analysis

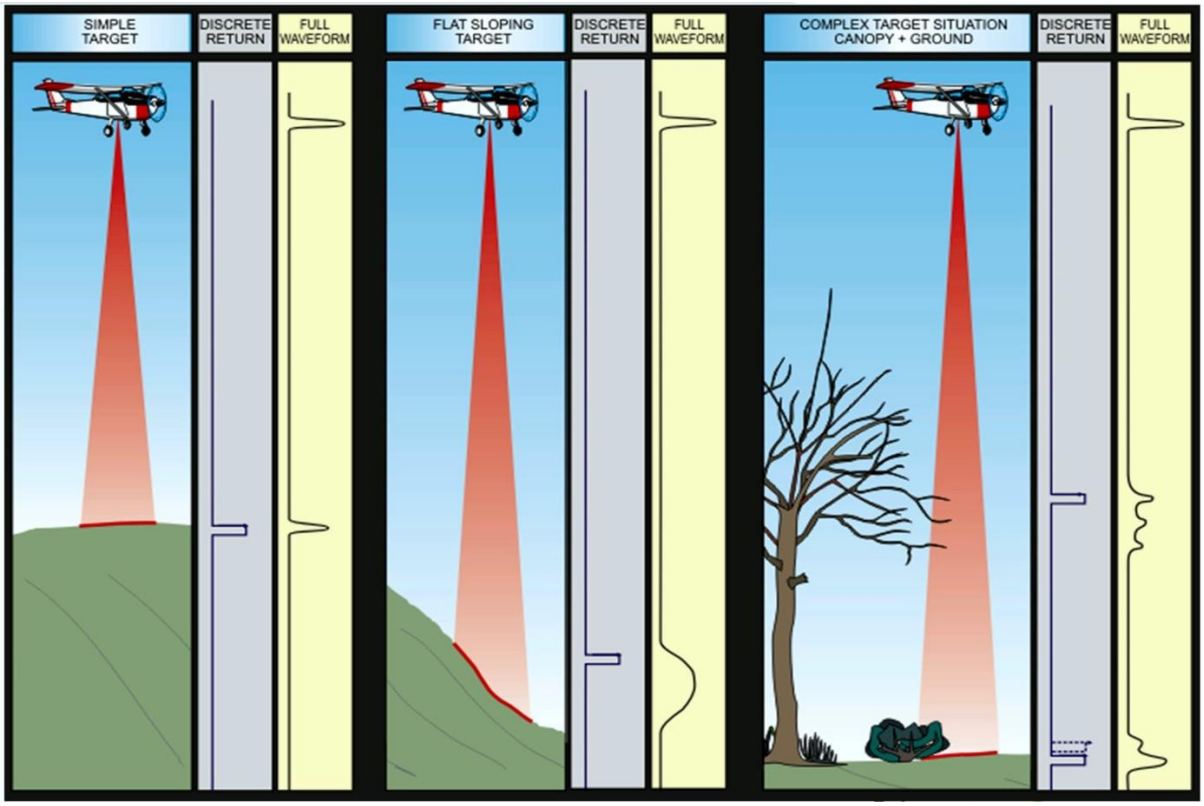


Fig. 4 Amplitude comparison received from the various objects

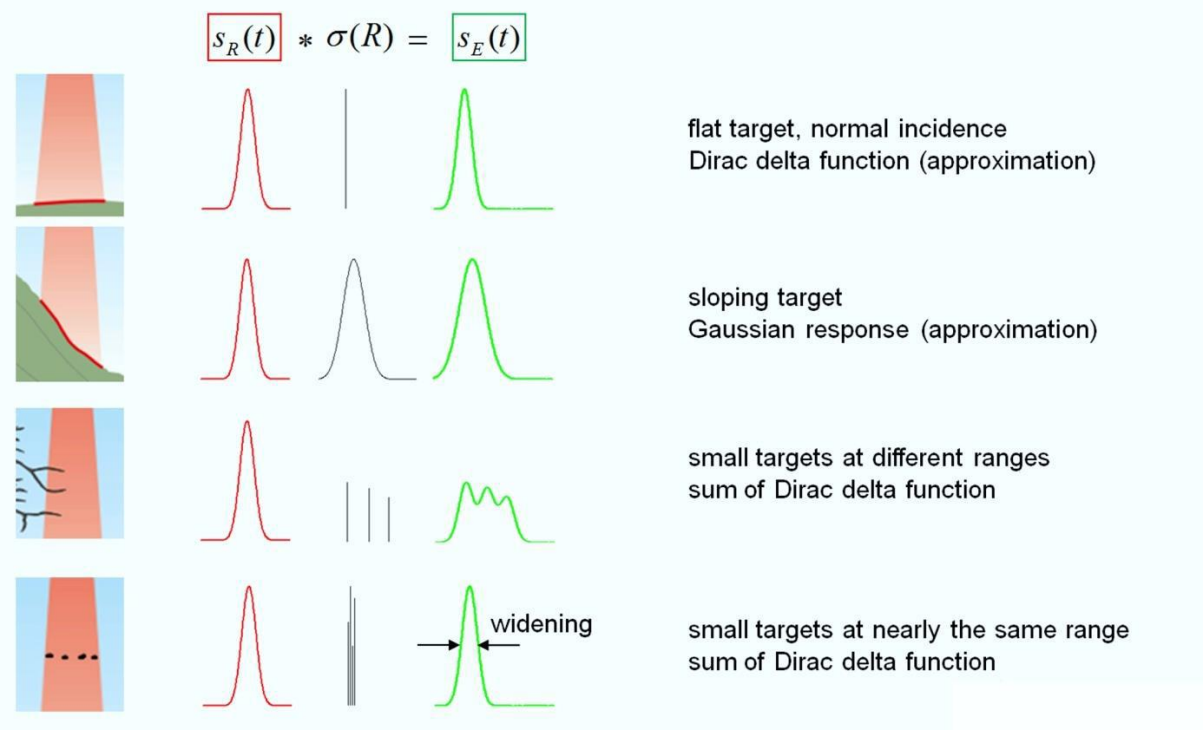
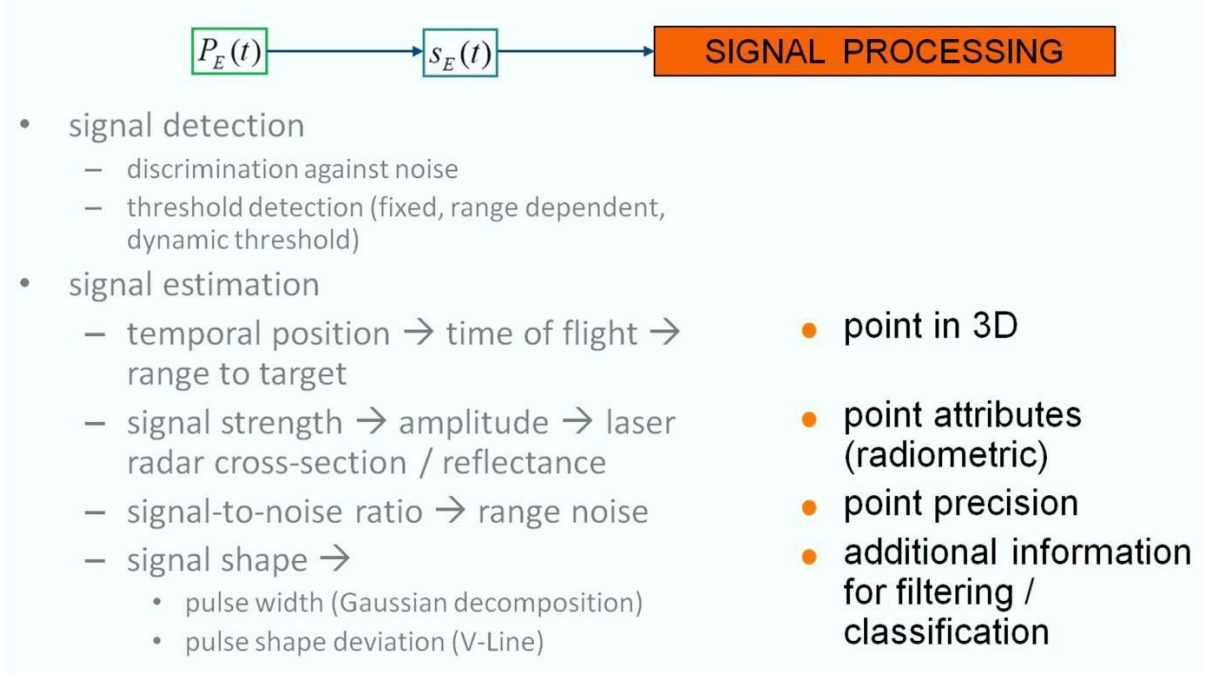


Fig. 5 Tasks and results of the waveform analysis implementation



The reflecting ability of the objects represents another important characteristic, which is directly related to the wavelength of the laser pulse fig. 2.