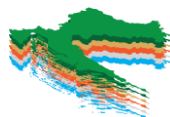REPUBLIKA HRVATSKA

DRŽAVNA GEODETSKA UPRAVA

**State Geodetic Administration
and LIFE CROLIS project:**

Development of DSM for Croatia

Ljerka Marić, Tomislav Ciceli, Sonja Debeljuh Novosel

LIFE **CROLIS**

INTRODUCTION

For the implementation of the National Land Information System LIFE19 GIC/HR/001270 - CROLIS - CROatian Land Information System (hereinafter referred to as LIFE CROLIS), the State Geodetic Administration has undertaken to create a Digital Surface Model – DSM.

As part of the LIFE CROLIS project, the following terminology is used for the development of a Digital Surface Model (DSM):

DIGITAL SURFACE MODEL – DSM - is a digital elevation model of the Earth or a part of the Earth that shows the Earth's surface including all natural and built objects on the Earth's surface.

LIDAR - Light Detection and Ranging is an optical instrument that emits laser beams that bounce off very small particles scattered in the atmosphere (aerosols, cloud droplets, etc.) and are then registered in an optical receiver (usually a telescope).

The DSM data can be collected using different methods and technologies, and its quality depends on this.

COLLECTING OF DSM OF RADAR METHOD - THE TANDEM-X, AN INTERFEROMETRIC SAR (SYNTHETIC APERTURE RADAR) MISSION FROM MINISTRY OF DEFENCE REPUBLIC OF CROATIA

For the pilot areas, 12 locations on the territory of the Republic of Croatia were selected on the official base maps of the State Geodetic Administration (DOF5) (Figure 2). Location that are completely or predominantly covered vegetation were selected and they were distributed across different regions of the Republic of Croatia in order to obtain the most relevant results of the pilot project, taking into account the diversity of relief and cover. The areas are defined by squares 2500x2500 meters (Figure 1).
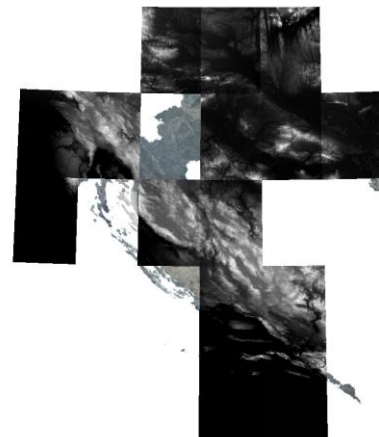

Figure 1: Pilot areas locations

Figure 2: Overlay of DSM with DOF5

The DSM data was collected as part of the TanDEM-X, an interferometric SAR (Synthetic Aperture Radar) mission. The synchronous operation of two radars (satellites) collected high-resolution images for monitoring land areas and coastal processes, particularly for agricultural, geological and hydrological

applications. The radar is able to collecting data relatively quickly even in unfavorable weather conditions (cloud cover) and penetrate vegetation down to ground level.

The collected DSM has the following characteristics:

- Output format: GeoTIFF (32-bit) divided into regular sheets (1°x1°)
- Resolution: 12 x 12 meters
- Elevation accuracy: relative < 2 m, absolute < 10 m
- Horizontal reference system: WGS84
- Vertical reference system: EMG2008
-

Analyzing the results, it was conclude that the DSM data obtained by a radar do not provide satisfactory results. A DSM is a quite dynamic product, as every tree or every new housed change the surface height (height of a tree or a house).

In order to obtain satisfactory results, it is necessary to use the most up – to – date DSM collected from LIDAR data, which would fulfil with its accuracy the required demands of the LIFE CROLIS project.

COLLECTING OF DSM FROM LIDAR DATA OBTAINED FROM THE PROJECT *"MULTI-SENSOR AERIAL SURVEY OF THE REPUBLIC OF CROATIA FOR THE PURPOSES OF DISASTER RISK REDUCTION ASSESSMENT"*

LIDAR is based on the principle that a device emits directional pulses of light towards an object or the ground and measures the time it takes for the signal to bounce back and return. How detailed the specified area is recorded with the LIDAR system depends on the density of the points, which is expressed by the number of points recorded per unit area (n points/m²).

After the image is taken, the data is processed on the computer. The result of laser scanning the terrain is a large amount of raw data in the form of a group of „point cloud".
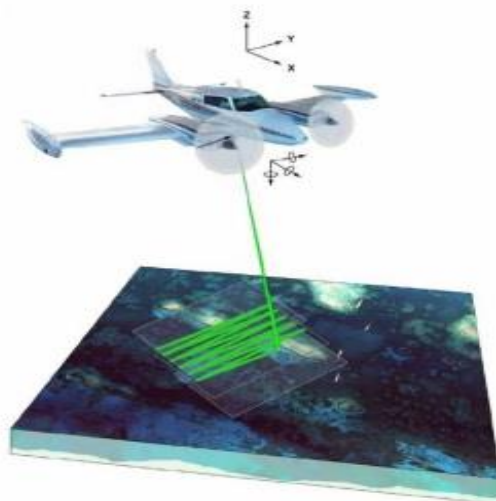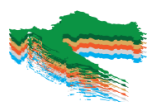

Figure 3: LIDAR scans

Each point in the point cloud has its XYZ coordinates in the HTRS96 system (official coordinate system of the Republic of Croatia). Based on the density of the points, we can deduce how detailed a particular area has been mapped.

The LIDAR scans of the Republic of Croatia achieved a minimum point density of 4 points per square meter in non-urban areas (uninhabited and sparsely populated places) and a minimum point density of 8 points per square meter in urban areas (cities and settlements with higher density).

LAS class	Description	Required class	Grid models (used classes) DTM	Grid models (used classes) DSM
0	Unclassified (unprocessed data)	x		
1	Unclassified (processed data, not assigned to any class)	x		
2	Soil/terrain (points under bridges, overpasses and similar)	x	x	x
3	Low vegetation	x		x
4	Medium vegetation	x		x
5	High vegetation	x		x
6	Buildings (roofs and facades)	x		x
7	Noise	x		
9	Water (također točke voda ispod mostova)	x	x	
17	Bridges, Viaducts	x		x
	Total	**10 classes**		

Table 1. Classification of laser points

LIDAR data are classified into 10 classes, of which classes 2 and 9 contain DTM data, and classes 2, 3, 4, 5, 6 and 7 contain DSM data (Table 1).

The collected DMS and DTM have the following characteristics:

- Output format: TIFF/TFW
- Resolution: 1 x 1 meters
- Projection coordinate system: Projection coordinate reference system RH - HTRS96/TM
- Height system: Height reference system RH - HVRS71

LIFE19 GIC/HR/001270 - CROLIS - CROatian Land Information System
The LIFE CROLIS project is co-funded by the LIFE Programme of the European Union.

4