Project management perspective on UAV data collection: water management case study Baroch

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Abstract— **Currently, environmental protection is one of the main priorities. Vegetation cover as a complex system and water bodies are examples of land cover types that are observed and understood as important parts of our environment and need to be cared for. It is very important to collect up-to-date data on such systems. The use of unmanned aerial vehicles for data collection has become very used in recent years due to its scalability, efficiency, and instrumentality in various fields. Managing data collection projects using UAVs can be quite complex and challenging. This text examines the use of the Agile Scrum methodology in realization such a project.**

Keywords — data collection, drone, project management, scrum, UAV

I. INTRODUCTION

Remote sensing [1] is the process of collecting and analysing information about the earth's surface from a distance, typically using satellites or aircraft equipped with sensors that capture images or data in various wavelengths of the electromagnetic spectrum. The data collected through remote sensing can be used to study and monitor a wide range of natural and human-made features, including land cover, vegetation, water resources, urban development, and weather patterns. Remote sensing techniques [2] are based on the principle that different materials and features on the earth's surface reflect or emit different amounts of electromagnetic radiation at different wavelengths. By analysing the reflected or emitted radiation captured by sensors, scientists and researchers can identify and map different features on the earth's surface and monitor changes over time.

Remote sensing is widely used [3] in various fields, including agriculture, forestry, environmental management, and urban planning. It can be used to monitor crop health and growth, assess forest cover and changes, track land-use changes, and monitor natural disasters such as floods, droughts, and wildfires.

Land cover [4] refers to the physical and biological material on the surface of the earth, such as vegetation, water bodies, bare ground, and urban infrastructure. It can be classified into various types based on characteristics such as vegetation density, soil type, and topography. Land use, on the other hand, refers to the activities and functions that humans carry out on the land, such as agriculture, forestry, residential development, industrial activity, and transportation infrastructure. Land use describes how people use the land to meet their needs and can be influenced by social, economic, and political factors.

Both land cover and land use (LULC) [5] are important for understanding how humans interact with and impact the natural environment, as well as for informing land management decisions and policies.

Water management [6] is a part of LULC and its the process of efficiently and sustainably managing the use, treatment, distribution, and conservation of water resources. It involves the development of strategies, policies, and practices to ensure the adequate and equitable provision of water for various human needs, including drinking, irrigation, industrial processes, and environmental protection. Water management typically involves a range of activities, including the collection, storage, treatment, and distribution of water for human consumption and other uses. It also involves the management of wastewater, stormwater, and other sources of polluted water to ensure that they do not pose a threat to public health or the environment.

Effective water management [7] requires a comprehensive understanding of the water cycle, including the sources and availability of water resources, as well as the social, economic, and environmental factors that influence water use and availability. It also involves the engagement of stakeholders, including water users, policymakers, and communities, to develop and implement sustainable water management strategies that balance competing demands for water resources.

Unmanned Aerial Vehicles (UAVs), also known as drones [8], are aircraft that are controlled remotely or autonomously. They are typically equipped with sensors and cameras and can be used for a wide range of applications, including surveillance, mapping, inspection, and delivery. UAV is a part of remote sensing, which provides images with very high

spatial resolution. For capturing long term observation is required planned flight.

The planned flight [9] can be called the automatic flight. During the automatic flight, the UAV is monitored and controlled by an operator (pilot) on the ground, who uses a remote control or computer system to guide the aircraft. Thru the automatic flight the pilot can hit the drone controls at any time to interrupt flight. The planned flight, see Figure 1. , provides a set of images which can be combined into one complete image called mosaic.

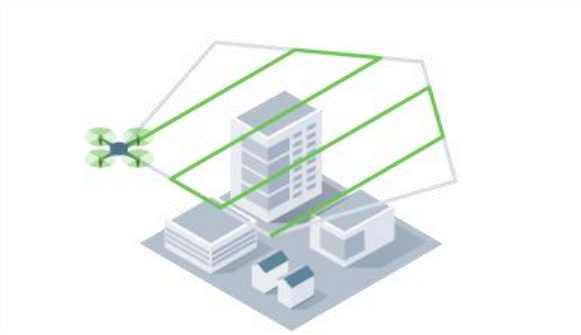

Figure 1. Scheme of planned flight

Source: [10]

By using automatic flight, drone flights effectively to ensure that the drone collects high-quality data for creating accurate and high-quality mosaic.

Due to the nature of the tasks solved, it seems appropriate to apply agile methods, originally intended for software development. To solve a project, we often ask ourselves the questions How to ensure that employees work as a team? How to ensure competition between teams but also cooperation? How to ensure timely completion of the project? Agile methodologies are among the methods to solve these questions. The first methods began to be developed already in the 1990s. We have been talking about the term agile method since the beginning of the first decade of the 21st century, when the Agile Programming Manifesto was published in the USA. In general, agile methodologies are based on the following principles [11]:

The requirements for the final product do not remain unchanged, they adapt to the needs and wishes of the customer

The priority is to satisfy the customer by fast delivery of a quality product

Personal meeting and communication is the basis of success

We select motivated team members and provide them with a good working environment and support

Cooperation with the customer is constant and consistent

The schedule is built so that new features / deliverables can be delivered frequently, even daily.

Scrum is probably the most well-known agile programming method. It was created in the early nineties of the twentieth century and gradually spread throughout the world. The development team also aims to complete the product as required by the customer. Instead of providing a complete and detailed description of how to build a project, it's left to the development team to do their best to get the whole project built right. It proceeds using iterations, which are called sprints. These iterations last two to four weeks. SCRUM is especially suitable for SW development projects, for projects where there are urgent and frequently changing requirements from the customer for the activities of the resulting system, but it can be used for any suitable type of project [12].

II. CURRENT SOLUTIONS – STATE OF ART

The use of Scrum methodology in managing or processing UAV data processing projects has already been proposed in the past studies. In [13] authors propose an application that can obtain plantation image data and analyze the calculation of the number of oil palm trees. Input data was collected by UAV and SCRUM methodology was used as a software system development method.

In the study [14] was developed an autonomous UAV, equipped with a GPS tracking system. This UAV was designed for the small scale autonomous geographical region mapping and scrum methodology was used in the realization of this project.
SafeScrum method (which augments the traditional SCRUM process) is applied on the UAV system project in[15].

TABLE I. show searched terms in two biggest scientific databases. By results of searching, there is very low count of articles focus on project management and UAV with some LULC area. Here exists a space for research.

TABLE I. SEARCH TERMS IN DATABASES SCOPUS AND WOS. SOURCE: AUTHORS.

Search term	Scopus	WOS
"water management"	390394	69122
"project management"	222338	40843
"UAV"	180258	45911
"UAV" AND "water management"	3619	150
"project management" AND "water management"	2673	84
"UAV" AND"project management"	991	37
"UAV" AND"project management" AND "water management"	30	1

III. METHODOLOGY

For project planning, we used the procedures defined in the Scrum methodology. The roles in the solution team are as follows: the Product Owner is responsible for defining the

project goals, he maintains a product backlog and requirements; the Scrum Master supports the Product Owner, coaches the team, is responsible for the Scrum process, its correct implementation, and ensures that the team follows the Scrum framework. Finally, the Development Team is responsible for delivering the project increments defined in product backlog in predefined sprints [16].

In accordance with the scrum methodology, individual phases of the project will be divided into sprints. The duration of the sprint is assumed to be one week. Firstly we define all necessary activities within the product backlog which includes: locality selection; delineation of the area of interest in the locality; verification of prerequisites for flight - geozones, obstacles, permits, etc.; flight planning according to the specified parameters; pre-flight inspection (arrival at the location, condition check, etc); flight; post-production processes (mosaicking, data archiving, etc); transfer of source data to storage and organization; data processing (creation of a 3D model, DTM, DSM, creating an orthophoto map; data disclosure (servers, articles, etc.) Set of work items we plan to complete during a project sprint is a sprint backlog and, in our project, we have defined 8 sprints.

Sprint of locality selection; delineation of the area of interest in the locality.

Location of this study is nature reservation pond Baroch. The pond Baroch is situated north of city Pardubice, close to University of Pardubice. Area of interest is open area of this pond, where are situated islands. Near the study area is public road 324. North of the area of interest there is a power line. Both public line constructions, see Figure 2. , are distant from the area of interest, so they do not disturb the area itself, then an UAV flight can be applied.

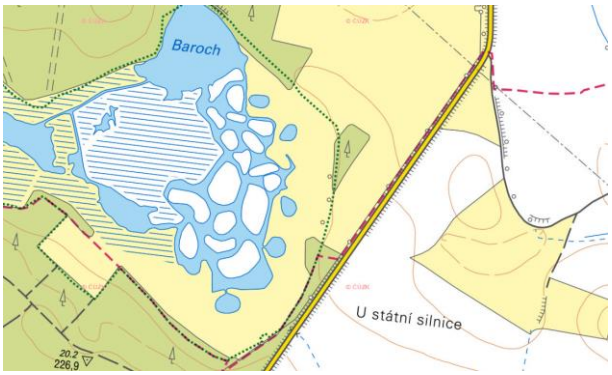

Figure 2. Location of study with line public constructions (yellow line and dot-and-dash code line)

Source: [17]

Sprint of flight planning according to the specified parameters; pre-flight inspection.

Part of pre-flight inspection is lead to national regulation of flight with drones. The location of study area is distant from buffers of lines constructions, but its inside of MCTR area [18], where is flight limited. Limitation is weight to 0,91 kg and closer to center of MCTR is maximal flight level given by height of buildings. The pond Baroch is located at edge of MCTR. By the grid of MCTR is maximal flight level 100 m in this location.

Figure 3. Area of interest on map viewer by regulations of flight with UAV

Source: [18]

For this study a planned flight was created by using application Pix4Dcapture (version 4.13.1). The planned flight cover area where are located islands and size of this cover area is 280 x 394 meters, see Figure 4. For observation area was set 60 m of flight altitude, 90° view angle of the camera, 65% overlap in both dimensions and sunny setting of white balance, see Figure 5. Output spatial resolution is 2,16 cm/px.

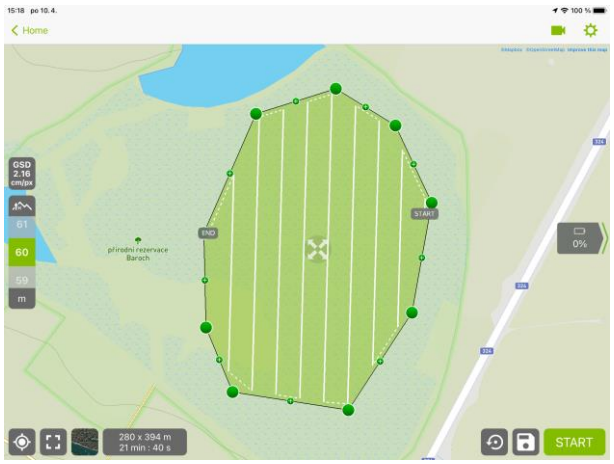

Figure 4. Polygon of area of interest

Source: Authors

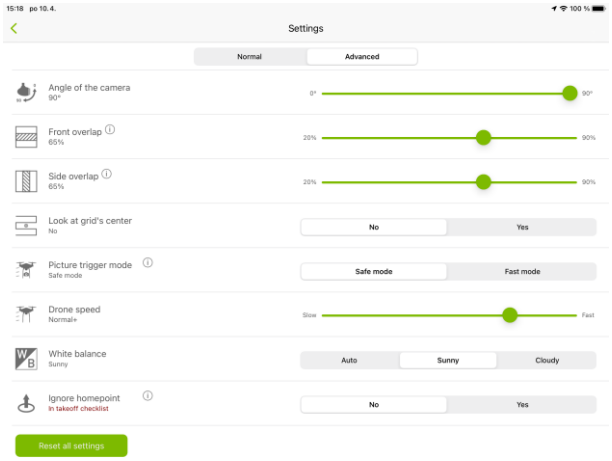

Figure 5. Area of interest with line public constructions

Source: Authors

Sprint of flight.

Flight itself were performed by DJI Mavic 2 ZOOM. The DJI Mavic 2 DUAL Enterprise [19] is a small size drone with 899 grams take-off weight and maximal take-off weight 1100 grams. Maximal flight time is 31 minutes. The drone has built-in camera with 1 / 2.3" CMOS sensor, angle of view 83°, 12 Mpx resolution and 3-axis stabilization.

Sprint of post-production processes (mosaicing, data archiving, etc); transfer of source data to storage and organization.

Sprint of data processing - creation of a 3D model, DTM, DSM.

Sprint of data processing - creating an orthophoto map.

These sprints (post-production, data processing – DTM, DSM, 3D, and data processing - orthophoto map) was processed in special software. Special photogrammetry software Pix4Dmapper was used. Pix4Dmapper (version 4.7.5) [10] is powerful commercial software for professional drone mapping. This software tool creates many outputs depend on input data and by processing input data. Most often used outputs are orthophoto map, digital surface model, digital terrain model, and 3D model.

Sprint of data analysis, creation of outputs / disclosure.

After processing and post-production processing sprints continue sprint of data analyses and output creating. This part is focused on GIS. The outputs from previous sprints are files which can be processed in GIS software. The ArcGIS PRO (version 3.0.1) from ESRI was used for data analyses and creating outputs maps and images.

IV. RESULTS

After apply scrum method to whole process of getting data by an UAV, we get complex workflow of this process. This complex workflow can be applied into any kind of data collection by an UAV.

Complex workflow can be described by follow main steps:

1. Choosing location and choosing area of interest
2. Preplanning of flight – rules, flight parameters
3. Data collection – flight itself and data backup
4. Processing of data – creating ortho photo or model
5. Data analyses – processing obtained data by GIS
6. Data interpretation – visualization of result

Complex workflow by main steps applied on case study:

The first step depends on study or research, this paper focusing on water management, from that reason was chosen near pond.

The second step leads to flight legislation, restrictions etc. Near pond Baroch is just limited flight level.

The third step is based on planned flight of flight itself. Output of planned flight is 128 individual images.

The fourth step is demanding on hardware and software. Input data obtained by an UAV are combined into single image called mosaic and models are built.

The fifth step using GIS software for analyses, classification, map algebra etc, see

Figure 6. Mosaic insered into GIS software

Source: Authors

The last step creates output images or map from results of previous step. The Figure 7. shows output image classified by supervised method.

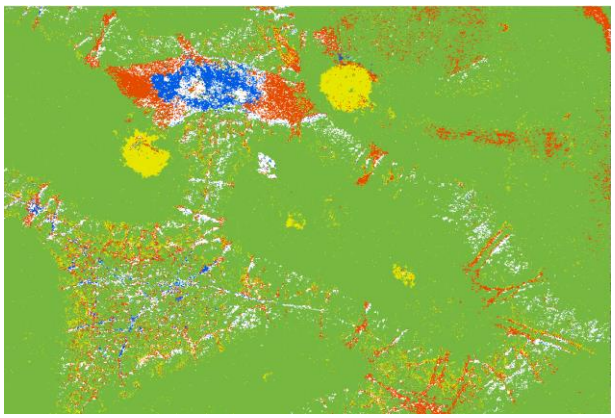

Figure 7. Classified image

Source: Authors

V. Conclusion

This article shows how to use project management approach for data collection by an UAV for water management study area.

In our study case, we are collecting data in time series for whole year by each month. This workflow can help users how to achieve correct data collections, even if somebody else is going to use collect identical data.

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