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by Surya Hermawan

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THE UTILIZATION OF THE DRONE AND SONAR FOR FLOOD DESIGN IN CONSTRUCTION ERA 4.0.

Surya Hermawan[1*] , Joko Purnomo[2] , Daniel Tjandra[3], Welly Pontjoharyo[4], Dalrino[4]

[1,2,3] Departement of Civil and Environmental Engineering, Petra Christian University
[4] Polytechnic State Padang
*shermawan@petra.ac.id

Abstract

Climate change caused by global warming has become an interesting study in recent years which is indicated by an increase in seawater temperature, sea-level rise and flooding. In the research area at Jabon District Sidoarjo was affected by sea flood in December 2017 within material loss about 5 billion rupiahs. This research aims to utilise the recent technology in construction era 4.0 with photogrammetric techniques using Unmanned Aerial Vehicles and sonar tools to analyse flooding events by making bathymetry maps with low and affordable costs in watersheds, including the effects of tides was also carried out. The method in this research was carried out the right photogrammetric technique and processed to provide a 3-dimensional appearance. Also, sonar tools use as benchmarks with high accuracy in the bathymetry mapping and river sedimentation occurrence. The outcome of this study proves that the watershed at the study site was a tidal influence on the condition of the highest high water level, which caused seawater to pass through the river bank as high as 10 centimetres. Fur further to overcome this problem, it recommends to do dredging of the riverbed, and the appropriate construction of river banks/embankments are higher and more durable.

Keywords: drone, sonar, flood design, construction era 4.0, global warming

INTRODUCTION

The industrial revolution 4.0 was officially born in Germany when the Hannover Fair held in 2011 (Kagermann et al. 2011). Industry 4.0 has three concepts: Cyber-Physical Systems (CPS), Internet of Things and Internet Service (Pikkarainen, Pekkarinen, Koivumäki, & Huhtala, 2018). Cyber-Physical Systems (CPS), which is a combination of the physical and virtual worlds, the Internet of Things prioritises automation using artificial intelligence (Ungurean, Gaitan, & Gaitan, 2014). But since the industrial revolution began, CO2 content accumulated in the atmosphere has increased because of the use of fossil fuels by humans (Khan, 2019). It causes the greenhouse effect that drives global warming.

Global warming is one of the factors causing a sea-level rise. Over a long time can result in increased coastal abrasion, coastline erosion, inundation of a land area and can drown small islands and increase the intensity and frequency of flooding (Tamba et al., 2016). Indonesia consists of large and small islands which number approximately 17,504 islands. Three-quarters of its territory is the sea, with a coastline length of 95,161 km, the second-longest after Canada (Shalihati, 2014). Most big cities are on the coast, so the effect of seawater level (SLR) for Indonesia has a big influence.

Climate change caused by global warming has become an interesting study in recent years, due to rising air temperatures and rising sea levels (Hermawan et al. 2018a). Zedillo (2008) explains that one of the impacts of climate change due to global warming that needs to watched is sea-level rise. Sea level rise as a result of the global warming process is an important issue in the coastal area. Sea level was quite stable over the past 3,000 years until around the 19th century. During the 20th century, sea level began to rise at a global average rate of 1.7 mm/year. The average increase is currently 3.1 mm/year, a 50% increase over the past two decades (Williams, 2013).

The project located in Sidoarjo Regency East Java Province. The choosing a research location at Tegalsari Sub District Jabon whereas in a watershed prone to flooding and river banks that collapsed due to erosion when rainfall rose. This occasion caused flooding in seaweed ponds were the main livelihoods of residents in the study site (Hermawan et al. 2018b,c)

The Utilization of* Unmanned Aerial Vehicles (*UAV*) / *Drone and Sonar as Construction 4.0 Device: Photogrammetry/ Aerial Photo

To avoid sun glint, the high intensity of the sunlight can result in the presence of sun glint in the form of flashes of light on the surface of the water, resulting in data in the form of images can not be processed properly. Besides, windy weather conditions that are too fast will also affect the balance of the UAV when collecting data.

According to Valeria (2016), aerial photography techniques in bathymetry mapping influenced by four factors,

$$LT(\lambda) = LB(\lambda) + LC(\lambda) + LS(\lambda) + LP(\lambda) \quad (1)$$

Where:

LT(λ) : Results of spectral rays observed by UAV (μm)

LB (λ) : Beams of light reflected from the riverbed (μm)

LC (λ) : Beams of light from bodies of water (μm)

LP (λ) : Path of light from the atmosphere(μm)

Wavelength (λ) is a sum of 4 components. Under conditions of homogeneous and relatively clear water, shallow streams, precise display geometry, low UAV elevations, favourable light conditions, consider neglect of the radiant components LC (λ), LS (λ), LP (λ). The results of bathymetry mapping using photogrammetric techniques will be greatly influenced by these factors, with the loss of one of these factors will reduce the accuracy of the results of bathymetry mapping using UAV with photogrammetric techniques.

Single-Beam Echosounder

Single-beam Echosounder (SBES) is a water depth measurement tool that uses a single sound wave signal sender and receiver. The working principle of the single-beam echosounder is to use the principle of measuring the phase difference of pulses by calculating the difference in the emission and reception of acoustic pulses. Acoustic waves emitted from the transducer. The transducer is one part of a recording device that converts electrical energy into mechanical energy and then produces acoustic waves. The acoustic waves then travel through the water with known propagation, until they touch the seabed and return to the transducer. The formula used to calculate bathymetry using acoustics is as follows:

$$Di = 1/2\ v\ \Delta t \quad (1)$$

Where:

including the depth of measure (m)

v : acoustic wave velocity (m/s)

Δt : the time needed for the acoustic waves to be emitted to bounce back to the transducer (s)

The data that has acquired will then be recorded in digital form (Wijonarko et al., 2016). In contrast to land topography, Hell (2011) explains bathymetry as an uncertain height in many parts of the world. The definition of bathymetry according to Febrianto (2016) is a measure of height and height of the seabed, so that the bathymetry map provides information about the seabed, this information can provide benefits in several fields related to the seabed, such as shipping lanes for people's vessels.

METHODOLOGY

This research located in Tegalsari District Jabon Sidaoarjo (see Figure 1a). The research method starts from the observation stage, the acquisition of tools, surveys, data analysis, and research results. The observation stage was done by requesting permission at the research location and discussing with residents about the problems that occurred in Tegalsari District can be seen in Figure 1b; the research team was conducting discussions.

Figure 1: Research Location and Observation Stage at Tegalsari District Jabon Sidoarjo Regency East Java

At the stage of acquisition of a Drone device, a number of aerial photographs are conducted in the morning, afternoon and evening with various heights to obtain height and time to produce optimum aerial photo data, while the acquisition of a sonar device is carried out to determine the accuracy and how to use the correct tool. As can be seen in Figure 2 was conducting a tool acquisition.

Figure 2: Stage of Acquisition of Drone, Sonar Tools with Measuring Tub and Weather Station

Then, at the survey location of the research is the data measurement/collection stage as can be seen in Figure 3 with equipment such as Drone Phantom 3 Advanced, Deeper Sonar Pro +, Wheather Station, Geodetic Reciever, Yalon, and meter. From the survey stage, wind speed data from the Wheater Station will obtain, the depth of the river using Drones and sonar devices and the effects of tides. After the data is collected, the data analysis stage is carried out using Menci APS and ArcGIS software to obtain bathymetry maps using Drones. For sonar tools, lake book is used first before entering into ArcGIS to get the bathymetry map with sonar tools. Besides, Surfer Software is also used to display contour results in 3 dimensions. The next stage is the research results obtained include the results of contour analysis in the form of a bathymetry map of the study site using sonar and Drone tools, the water level of the tidal influence, and the right construction design for this problem.

RESULT AND DISCUSSION

Since the industrial revolution 4.0 was officially born in 2011, this research project get benefit, especially for the surveying device in order to get information from data measurement. The optimum aerial photography altitude acquisition result is 80 meters, where the acquisition of sonar equipment is known to have

high accuracy for bathymetry mapping by comparing the results of in research location using a measuring instrument. Tidal results using Tides can use because they show the same results as direct measurements in the field.

Figure 3: Data Measurement

At the research location Drone data results in the form of photographs taken from a height of 80 meters with overlap 80%. After the photo merging process and obtaining the Digital Terrain Model using Menci APS software, the results of the bathymetry contour and layouts using ArcGIS software as shown in Figure 4a. As can seen in Figure 4b, the results of the sonar data tool in the form of xyz data which are coordinates and depth are processed using ArcGIS software to obtain contours and mapping Bathymetry. The results of the Surfer software for 3-dimensional display can see in Figure 5.

Since the results of the data obtained during measurements in the field, the effect of tides is gain at the study site by field measurements which use sonar devices and Tides applications. In situ results from the acquisition of sonar tools and measuring tanks confirm the same results with high accuracy so that in situ measurements using sonar tools can be done.

From the tidal analysis of 10 years from 2010-2019 using Tides, the condition of the Highest High Water Level is at the height of 210 cm above the MSL. Thus the water level will be known at the Highest High Water Level from the river bed is 540 cm. Given the height of the riverbank is 60 cm above the HWL, the total height of the riverbank is 530 cm, and in this condition, runoff water will pass

through the river bank by 10 cm (end of 2017) and will have a flood effect in the area around the pond in the Hamlet Tegalsari. For more details, see Figure 6.

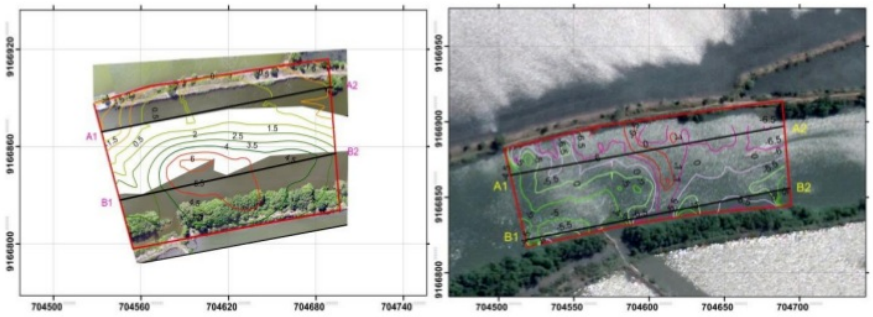

Figure 4. Results of Contour from Drone and Sonar
Universal Transverse Mercator 49S (m)

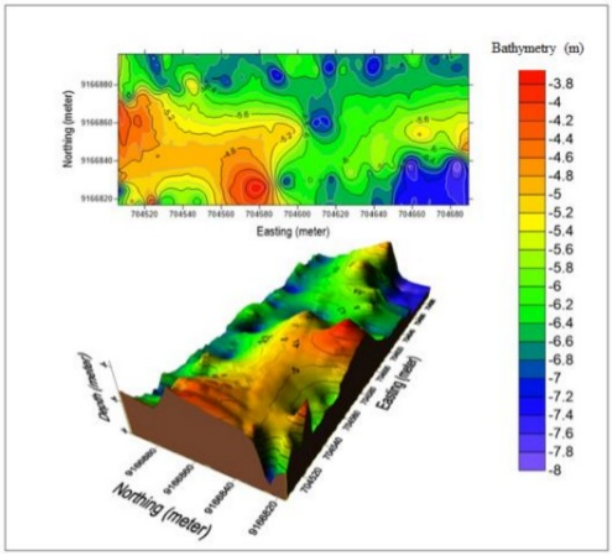

Figure 5. Results of 3-dimensional River Contour Maps (UTM 49S)

From the results of bathymetry mapping using Drones and sonar devices, there are the same results. It shows that there is sedimentation or shallow siltation in the river bed area to the right of the river from the upstream in Tegalsari District so that it will cause runoff water to the people's ponds during high rainfall. The effect of tides was also obtained at the study site by in Situ measurements using sonar devices and Tides applications.

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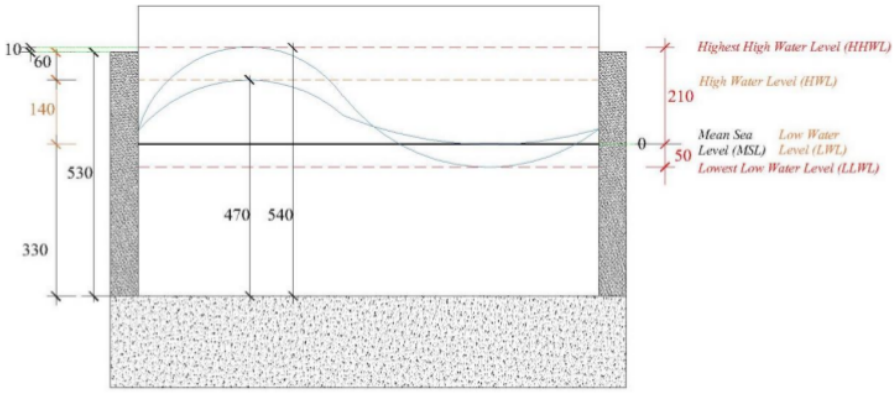

Figure 6: ***WaterLevel Measurement Analysis*** **(cm)**

CONCLUSION AND RECOMMENDATION

The three concepts of Construction Era 4.0 carry out in this research project, including Cyber-Physical Systems (CPS), Internet of Things and Internet Service. Thus, the conclusion and recommendation including:

a. The recent technology in construction era 4.0 with photogrammetric techniques using Unmanned Aerial Vehicles and sonar tools are able to analyse flooding events by making bathymetry maps with low and affordable costs in watersheds,
b. This research project proves that the watershed at the study site was a tidal influence on the condition of the highest high water level, which caused seawater to pass through the river bank as high as 10 centimetres.
c. The recommendation is to dredge the sedimentation that occurs on the right side of the river from upstream in Tegalsari District, then no runoff water that

leads to the population's ponds. Bathymetry mapping in photogrammetric techniques using drones will give better results if done in the morning or evening. It is making the design of construction of civil engineering buildings on eroded river banks as well as critical flood points at sustainable research sites.

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