Mapping water inundation and inundated landuse which will formed due to development of Karian dam, Ci Berang Sub-Basin, Lebak Regency, Banten Province

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Abstract. Overpopulation and development in Java Island have caused changes in land use from productive into non-productive land. One of the changes occurring in Indonesia is the development of the Karian Dam as a Multi-Purpose Dam in the Ci Berang Sub-Basin. This study aims to determine the area of inundated water will covering land use and many villages caused by the construction of Karian Dam. The dam was started the construction in the year 2015 and will complete in the year 2019. The variables used in this study is the elevation of inundated water and the land use of the Ci Berang Sub-Basin. The data for inundated are water level at minimum, normal, and maximum, which combined with digital elevation model (DEM). The research used the landcover data generated from Landsat 8 OLI. The results explained that the Ci Berang Sub-Basin area would be affected by the inundated water is 1,479 Ha. The changes caused by the water inundation will affect the land use in the northern area of Ci Berang Basin those are shrubs, wetlands, plantations, and urban areas more than 54.57 Ha and vacant lots 16,14 Ha. The land use, which has the highest area of inundated water coverage was shrubs 53 % and wetlands 22 %. The inundated water caused many villages covered by water with the highest land use change was Tambak Village with 335.48 Ha, and the lowest was Sindangsari Village with 3.73 Ha.

Keywords: Karian dam, ci berang sub-basin, landuse change, DEM, landsat 8

1. Introduction
The increase in population growth and development in Java Island has driven land use change from productive agriculture to non-agricultural, such as industry, settlements, public infrastructure, and infrastructure [1]. The impact of changes in land use from forests to non-forests and agriculture to non-farms has benefited both socially and economically [2]. However, the existence of development will impact social, infrastructure, and physical conditions [3]. One sample of the negative impacts of the development on Jatigede Reservoir, where are the people living around the reservoir are negatively affected by the loss of land for farming caused the production of paddy fields by the peasants is reduced by 56.29 % [4]. In order to know how much an impact of such dam, there is a need for research on the construction of other dams, for example, Karian Dam.

Dams, reservoirs, and basins have meanings that interpolate with each other. Dams are constructions that are built to hold water and make big and small reservoirs from a basin [5]. The reservoir is a large body of water that was created from run-off caused by water moving off land use in a basin.
Basin, catchment area, or watershed is an area where water or stream networks are moving to one body of water or river [6]. Basin is an area which is bordered by topographical points from the highest to the lowest region. The research finding of a region of a basin or sub-basin used the Hery algorithm [7].

Digital Elevation Model or DEM is a digital model that represents the surface topography of our earth in the form of three dimensions. The development of DEM technology also followed by the availability of global DEM data which is free and can obtain by downloading data from various sources [8]. Another meaning of DEM is a digital data that describes the geometry of the earth's surface shape or its part consisting of a set of coordinate points of the sampling result from the surface with an algorithm that defines the surface using a set of coordinates [9].

Land use is a manifestation of human activity in an area of land [10]. Another researcher concluded that land use could be associated with human activities in a plot of land use, and land use is usually used to refer to the use at present [11]. The land use in this research formed from Classified Classification of Landcover obtained from Landsat 8 OLI. Then it is classified into rivers, lakes, shrubs, wetlands, plantations, urban areas, moors and vacant lots. For land use imagery and altitude validation made through remote sensing modeling, a field survey was conducted in the research area, using Ground Truthing method. Ground Truthing is done to get the accuracy of a satellite image. Ground Truthing obtained from field validation or field survey in the research area [12]. For land use imagery and altitude validation made through remote sensing modeling, field surveys conducted in the research area. Steps for determining the samples for each class of image data used or land use and elevation of inundation [12, 13].

In 2010, the Banten Provincial Government built a Spatial Plan to build large dams in Lebak District from 2010 to 2030. The dam in question is Karian Dam, Pasir Kopo, Cilawang, Tanjung, Sindang Heula, Krenceng, Pamayarang, and Ciliman. Karian Dam built starting from 2015–2019 in Lebak Regency according to Ministry of Public Works and People's Housing [5]. The location of the dam located in downstream Ci Berang, Rangkasbitung Sub-district, and the reservoir will cover an area of 2,226.4 Ha in four sub-districts, namely Rangkasbitung, Muncang, Cimarga, and Sajira districts. According to the Report of Commission V of the House of Representatives of the Republic of Indonesia on 20 February 2017, the Karian Dam development shows physical progress of 25.15 %, and the land that has released is 1,049.51 ha or 47.14 % of the total land plan of 2,226.4 Ha [6]. Based on the current construction of the Karian Dam, this research focuses on the impacts of the dam after it built. This study aims to obtain information on how large the area of inundation will form and the land use that will be covered by inundation in the area affected by the Karian Dam development. Know the effect of Karian’s damming on land use in the research area. The research assessed the relationship between water puddle and land use change to a village in the research area.

2. Method

Ci Berang Sub-Basin has a geographical location at 6°25′ 55.95″–6°43′ 18.92″ South Latitude and 106°17′ 13.29″–106°29′ 4.81″ East Longitude. Location of Ci Berang Sub-Basin located in two regencies of Lebak Regency, Banten Province, and Bogor Regency, West Java Province. The sub-basin has an area of 283 km². With the Karian Dam as an outlet which located at 6°24′ 27.76″ South Latitude–106°17′ 14.77″ East Longitude. The data used in this research consists of spatial data and numerical data. Spatial data include Landsat path image 122 rows 65: 2017, SRTM Arc1 v3 in 2017. Numerical data includes Karian Dam GPS data point and inundated water elevation. The equipment used is a set of computers equipped with Arcmap 10.2, ENVI 5.1, GlobalMapper 16, Microsoft Office 2016, Global Positioning System (GPS) software, printers, cameras, mobile phone, and stationery.
This research focused on finding the inundated water covering land use in Ci Berang Sub-Basin on different water levels or water height inundation (figure 1). The variables used are land use, river network, DEM, and water level/water inundation height. The first to be processed is the secondary data, which include river and DEM network data to form the basin/watershed of Ci Berang Sub-Basin. After the research area formed and then insert the water level data that has three levels of inundation using Simulate Water Level Rise/Flood to form 3 models based on altitude classification, each model will overlaying with a land use map obtained from the processed Supervised Classification Landsat 8 OLI satellite image which had been validated using field survey. Each model will show the extent of the inundation contained in each altitude classification, and after that, it will overlaying with the land use map, which will result in the final model of inundated water covering the land use. So, the outcome will be the Mapping Water Inundation and Inundated Landuse Which will form due to the development of Karian Dam, Ci Berang Sub-Basin. Then it can be analyzed by using the village boundary in the research area.

3. Results and discussion
The total area of land use in the research area is 28,343.79 Ha, and the inundated water consumes a total of 1,479.47 Ha, so the total area of land use covered by water is 5.22 %. The remaining areas that are not affected by the dam are 26,864.32 ha or equivalent to 94.78 %. Low inundation covers a total area of 288.29 Ha. Regular inundation is 12,90.02 Ha, and High inundation has an area of total 189.44 Ha. The most dominant land use is Forest with a total area of 13,762.7 Ha, Shrubs 4,901.99 Ha, Wetlands 4,782.30 Ha, Moors 1,263.81 Ha, Settlement 681.98, Plantation 271.86 Ha, River 209.71 Ha, Empty Land 23.56 Ha, Sand 3.27 Ha and Lake 0.61 Ha.

There are four classifications of inundation that modeled, which are low, normal, high, and un-inundated water. From a field survey that has done, the results obtained can see in table 1. With the total of 55 samples, there were samples between the satellite image and the field survey, which have the same results, low five samples, medium six sample, large three samples, and un-inundation a total of 30 samples. The overall accuracy score of 80 % shows a good relationship, and Kappa Coefficient/Khat Kappa 0.672 indicates a moderate or sufficient relationship between satellite image and field survey.
Field data retrieval is performed using a GPS to get the point data on a grid, and then it is compared to the land use the most widely covered area on the grid. The results show that between the field survey and satellite imagery the samples with the same results are forest 5 samples, sample 2 Plantation, Settlements 13 samples, Rice 4, shrubs seven samples, Vacant one samples, and moor 12 samples. Then from ground-truthing land use the overall accuracy 78.18 %, stating that from a total of 55 samples taken, there are 43 of the same land use modeling and from the field survey. As for the Kappa Coefficient, the results Khat 0.731, indicating high accuracy from the satellite image.

Inundation modeling maps or reservoirs on land use get the results of the map, which can see in figure 2. The inundation formed is the result of Water Level Rising in DEM. Based on the use of land that is covered by water and inundation, the biggest cover is the use of Shrubland with an area of 781.95 Ha. For land use with the least amount of cover is Empty Land with an area of 16.14 Ha.

Figure 3 explained that there are ten villages directly affected by the construction of the Karian Dam with the inundation of water on land use. Villages from current land use to be flooded are Sindangmulya, Pasirjantung, Pajangan, Tambak, Calungbangur, Bungurmekar, Mekarsari, Sukareme, Sajira and Sindangsari villages. As for the rest of the village in Lebak is not affected and the village in Bogor Regency is not affected by the Karian Dam construction at all. The use of land located in the southern part of the village of Jasiramekar and it is not inundation at all, and there is no water inundation caused by the Karian Dam construction.

The data of inundation and land use can see in table 1. Based on water inundation, which experienced the most significant closure was the shrubs with an inundation of 781.95 Ha. For land use with the least inundation is the vacant lots with an area of 16.14 Ha. In addition to shrubs, land use with the second-largest closure is wetlands with 320.86 Ha. The land use on Low inundation has a total closure area of 19.49 %, 67.71 % normal and 12.81 % in High Inundation, can be seen in figure 3.

Out of all land use, the most massive inundation occurred at the average water level, with each exceeding 50 % except in the use of river land (table 1). Agricultural land use is affected the most with over 70 % of all agricultural land to be covered by water. Low water level plantations have the smallest closure among all the treated data with 0.32 Ha closure or 0.02 %.

The total area of covered land use due to water is 5.22 %, or from 28,343.79 Ha and which was covered by an area water 1,479.47 Ha. Other land uses that experienced a large closure of the Vacant Land, where the total area of vacant land in the Ci Berang Sub-Basin is 23.56 Ha decreased 16.14 % or total 68.51 % decreased due to being flooded. The land use, which has the smallest closure is agricultural land, which only decreases by 1.97 % of all Ci Berang Sub-Basin.

| Table 1. Land use inundated by water. |
|---------------------------------------|
|                                      | Area (Ha) | Inundated by water (Ha) | Inundated by water percentage (%) |
|---------------------------------------|
| Shrubs                                | 2,713.86  | 53.57                   | 1.97 %                               |
| Urban                                 | 681.98    | 60.96                   | 8.94 %                               |
| Wetland                               | 4,782.3   | 320.86                  | 6.71 %                               |
| Agricultural                          | 4,901.99  | 781.95                  | 15.95 %                              |
| River                                 | 209.71    | 108.34                  | 51.66 %                              |
| Vacant                                | 23.56     | 16.14                   | 68.51 %                              |
| Moor                                  | 1,263.81  | 137.65                  | 10.89 %                              |
| Total Land use Not Inundated           | 14,577.21 | 1,479.47                 |                                       |
| Land use Not Affected                 | 13,766.58 |                        |                                       |
| Total Area of Land use                | 28,343.79 |                        |                                       |
As seen in figure 4, there is various land use in inundated water. The land use of covered by inundated land are shrubs with an area of 781.95 Ha, wetlands with 320.86 Ha, agricultural 137.65 Ha, river 108.34 Ha, urban 60.96 Ha, plantations 54.57 Ha and vacant land 16.14 Ha.
4. Conclusion

Based on the results of the research, the Karian Dam influences the land use by holding water from Ci Berang Sub-Basin. The resulting inundated water has an area associated with large bodies of water, the higher the water level, the wider the inundated water area. The total area of the inundated water is 1,479 Ha. Based on the results of data processing will cover land use within the low water covered 288 Ha, the medium water covered 1,290 Ha, and the high water covered 1,479 Ha. The results of this study indicate that with the construction of Karian Dam, will result in the formation of inundated water of large bodies of water covered land use such as shrubs, wetlands, plantations, urban areas, and vacant lots. Of the total land use that will be covered by inundated water, the most massive inundation is shrubs at 53 % and 22 % of wetlands. Due to the location of villages adjacent to the Karian Dam, there were ten affected villages. The most affected village is Tambak village with 335 Ha of inundation area. The least affected village is Sindangsari village with 4 Ha of inundation water.

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