Changes of mangrove area in Pangpang Bay, Banyuwangi 2014-2018 using Landsat-8 imagery

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Abstract. The existence of mangrove has important role for environment and living creatures. Mangrove is a habitat for various types of animals and can produce various environmental services, such as stabilizing coastlines. With many important roles of mangrove, monitoring the changes of mangrove area become important to give us the information. One of the effective ways in monitoring mangrove is using remote sensing system, in this case, Landsat 8. This research aims to identify the changes of mangrove area in Pangpang Bay conservation area during 2014-2018 by using Landsat 8 imagery. Composite of 564 RGB on Landsat 8 imagery was used for identification of mangrove and the classification method used in this research was maximum likelihood classification (MLC). The classification result indicated 3 land cover classes: water bodies, land and mangrove. The result of 564 RGB composite on Landsat 8 imagery showed that there was an increase of 283.04 ha in total mangrove area from 2014 to 2018. Pangpang Bay experiencing expansion of mangrove area from 2014 to 2018 because that place is a mangrove conservation area, so that the sustainability of mangrove is maintained.

1. Introduction

Wetlands cover a small part of the earth's surface, but are very important ecosystems because there is a high biodiversity and serves as a source of large amounts of chemicals and biology. Mangrove wetlands are ecosystems that are located and developing around the coast and estuary land. The mangrove is a transition area between land and sea along the coast so it has an important role to protect the surrounding ecosystem. Mangrove forests provide to prevent tides, mitigate climate change, coastlines stabilization, as habitat for coastal fish and wildlife. At this time there was a worrisome global decline in the mangrove ecosystem due to rapid population growth, industrial and urban development and global warming.

Mangroves are commonly located along the coast in Indonesia, where Pangpang Bay is one of the mangrove areas. Pangpang Bay located in Banyuwangi regency, bordered by the Bali Strait in the east and Indian Ocean in the south. Geographically, Pangpang Bay is located between 8°27’052” - 8°32’098” South latitude and 114°20’988” - 114°21’747” East longitude. Pangpang Bay has ± 8 km length, ± 3.5 km width with wide ocean about 3.000 ha. Mangrove ecosystems that contained in Pangpang Bay area consist of many species, such as Bruguiera sp, Rhizophora sp, Avicennia sp., Sonneratia caseolaris, and so on. Mangroves that located around east side of Pangpang Bay are mangrove forest that managed by Perhutani (Indonesian state forestry company). A lot of mangrove...
area has been experience wetland conversion into pond. Right now, there is rehabilitation effort to planting ± 200 ha of mangroves.

In anticipating land changes, especially mangrove land cover in the Pangpang Bay, information is needed regarding the changes of the area. Monitoring information about changes in land cover can be achieved by utilizing remote sensing technology. In general, remote sensing technique is the only way to detect and collect information about objects on earth without making direct contact with the observed object. Sensors are categorized into two, active sensors and passive sensors. A passive sensors will detect the incoming radiation of sunlight from the reflection of the earth and thermal radiation seen in the electromagnetic and infrared spectrum. It does not emit radiation itself but instead receives light radiation and heat radiation from the surface of the earth. Landsat, Quickbird, IKONOS, SPOT, and Worldview are types of passive sensors that have been used to monitor land use and land cover. Active satellite sensors have a function to emit an artificial radiation from the earth's surface to monitor atmospheric features. Light Detection and Ranging (LIDAR) is one example of an active sensor, which uses short pulses of electromagnetic radiation in the spectral range of active microwave. These sensors are not dependent on daylight and also affected by fog, clouds, dust and wind, and weather conditions. Whereas active sensors are used for the introduction of vegetation structures and ground level.

This research used Landsat 8 OLI for 2014-2018. The Landsat 8 satellite payload consists of two science instruments: the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS) which have 11 bands, from band 1 to band 9 are located in OLI, where band 10 and 11 are located in TIRS. Data from Landsat 8 satellite provide spatial resolution of 30 meters (band 1-9), where the panchromatic has 15 meters resolution and 100 meters resolution in TIR-1 and TIR-2. The purpose of this research is to identify changes in mangrove area in Pangpang Bay, Banyuwangi 2014-2018.

2. Materials and Methods

The research area is located in Pangpang Bay, Banyuwangi Regency, East Java Province (Figure 1). Pangpang Bay is located at coordinates 8°27'052'' - 8°32'098'' S and 114°20'988'' - 114°21'747'' E. Pangpang Bay is a coast located in northern part of Banyuwangi, bordered by the Bali Strait in the east and Indian Ocean in the south. Mangrove in Pangpang Bay spread along coastline and near the ponds. There are many mangrove species and Bruguiera sp., Sonneratia caseolaris, Rhizophora sp, Avicennia sp are the dominant mangrove species.

Data used in this research are Landsat 8 OLI from 2014-2018. The images were downloaded from the USGS (United States Geological Survey) of path 117 and row 66, acquisition from 26th September 2014, 13th September 2015, 19th January 2016, 6th June 2017 and 14th April 2018. All imageries were geo-referenced to UTM (Universal Transverse Mercator) map coordinate system, datum WGS84 and zone 50 S. The imageries also corrected with geometric correction and radiometric correction. Correction for radiometrics is done to reduce or correct errors in the number of digital images, while the atmospheric correction is to eliminate the effects of scattering and absorption from the atmosphere to get the characterization of surface reflectance (surface properties).

The images are cropped to get more concentrated research area. Then, making composite image to refine mangrove classification using ENVI 4.1 software. RGB composite process is done with making combination of basic color: red, green and blue that contained in the band's channel. Composite images that exist in this research to see the mangrove area using 5-6-4 bands (Figure 2).
Figure 1. Location of research area.

Figure 2. 564 RGB composite of Pangpang Bay on Landsat-8 Imagery.

Supervised classification is a guided classification where researchers can determine their own classes in the image. The maximum likelihood classification can be assumed that the statistics for each class in each band are normal distribution and the calculation of the probability for a given pixel belongs to a certain class. Each pixel is assigned to the class that has the highest probability. In this process, minimum of 13 polygons are drawn in each class. There are three classes representing mangrove vegetation, land and water bodies. Then the classification results are stored with vector format. The vector format then changed into shapefile format, so the area can be calculated using ArcGIS 10.1 software.

3. Result and Discussion
Figure 3 showed land cover of mangrove in Pangpang Bay 2014 using Landsat 8 imagery that recorded in 26th September 2014. Green is representation from mangrove, blue from water bodies and white for land. Mangrove area was calculated using ArcGIS software with calculate geometry tools. In
2014, the mangrove area was 288.64 ha (Table 1). Figure 4 recorded by Landsat 8 in 13th September 2015, and we can see that the green color has expanded in just a year. Mangrove area in 2015 was expanded into 327.28 ha. Figure 5 showed land cover that recorded in 19th January 2016, and the mangrove area expanded into 382.81 ha. While in Figure 6 and 7, the green color looks much bigger than other years. That means, mangrove land cover became wider than previous years. The reason why the mangrove area in Pangpang Bay became wider from year to year, because Pangpang Bay is a mangrove forest conservation area so that the sustainability of mangrove is maintained.

Figure 3. Mangrove area in 2014

Figure 4. Mangrove area in 2015

Figure 5. Mangrove area in 2016

Figure 6. Mangrove area in 2017
Table 1. Mangrove area in Pangpang Bay.

| Year | Area (Ha) |
|------|-----------|
| 2014 | 288.64    |
| 2015 | 327.28    |
| 2016 | 382.81    |
| 2017 | 460.65    |
| 2018 | 571.68    |

4. Conclusion

Remote sensing technology can be used for monitoring mangroves area. Landsat-8 is a satellite that has 11 bands, from band 1 to band 9 are located in OLI, while band 10 and 11 are located in TIRS. Data from Landsat 8 satellite provide spatial resolution of 30 meters (band 1-9). Composite of 564 RGB in Landsat-8 showed that mangrove area in Pangpang Bay, Banyuwangi is increasing from 288.64 ha in 2014 to 571.68 ha in 2018. Pangpang Bay experiencing expansion of mangrove area from 2014 to 2018 because that place is a mangrove conservation area, so that the sustainability of mangrove is maintained.

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