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FOREWORDS

The 6th Indonesia Japan Joint Scientific Symposium (IJSS) held at Universitas Gadjah Mada, Yogyakarta, Indonesia from 29th October to 30th October 2014 is the premier event in the collaboration between Universitas Indonesia and Chiba University. This symposium is the sixth in the series held earlier at Chiba University and Universitas Indonesia. This symposium provided a venue to share and discuss various issues and development in the multi-field of scientific and technology.

The symposium accepted eighty three papers from students and researchers in Indonesia, Japan, and many other countries. The papers are derived from twenty four different themes as follows:

- Antenna and Microwave	- Industrial Design and Management
- Architecture	- Mathematics
- Agriculture	- Mechanical Engineering
- Biomedical	- Medicine
- Coastal and Watershed Management	- Micro satellite and UAV
- Computer and Information Technology	- Nursing
- Disaster Management	- Pharmacy
- Electronic Circuit	- Remote Sensing and Geo-Information Science
- Energy and Power System	- Social Sciences and Sustainabilities
- Environmental Chemistry	- Socioeconomic Relations
- Environmental Science	- Vision and Biological Functions
- Humanities	
- Image and Signal Processing	

Through these documented proceedings, may all findings enforce progress, stimulate growth and advance the state of knowledge between students from Indonesia and Japan, as well as those from other countries around the world. It is also hoped that these proceedings will be useful source of reference to scientific students, researchers, and professionals in other scientific-related fields.

Thank you.

General Chairman of
The 6th Indonesia Japan Joint Scientific Symposium (IJSS)

Prof. Dr.*rer.nat.* Muh Aris Marfai, M.Sc.

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Monitoring Shoreline Change and Its Impact on the Ecosystem Surrounding Rawa Pening Area

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Abstract

Rawa Pening is a lake located in Semarang Regency, Central Java Province, Indonesia. It has environmental problem like sedimentation. Sedimentation caused by many factors, such as nutrient enrichment followed by eutrophication. Eutrophication and human activity are important factor to the shoreline change. Shoreline change nowadays threatening the inhabitant in surrounding Rawa Pening. The aims of this research are to analyze trends of shoreline change in Rawa Pening, and to know the side-effect of shoreline change on the ecosystem surrounding Rawa Pening area. We conducted this research by using GIS and remote sensing techniques. Shoreline data were digitized from corrected images of 1972, 1991, 1994, 2002, 2004, and 2008. Field survey was also conducted to get recent condition, i.e in-depth interview with key person and field observation surrounding Rawa Pening at February 2013. The results show that the area of Rawa Pening decrease until 373.95 ha for 36 years. The decelerating rates of Rawa Pening is about 10.38 ha/yr. Shoreline changes especially located in Torong, Panjang, and Galeh river in the western part and Legi, Parat and Sragen river in the south eastern part. That is associated with high rate of sedimentation in that river. Another impact of shoreline change are paddy fields harvest loss and rats also more wide spreadly through water hyacinth (*Eichhornia crassipes*). Settlement in Banyubiru and Rowoboni village has suffered from the impact of Rawa Pening shoreline change. Some mitigation have been built to face the inundation like build dyke to protect the village from flood.

Keywords

Shoreline change; Ecosystem; GIS; Impact; Rawa Pening

1. Introduction

Rawa Pening is located in Semarang Regency, Central Java Province, Indonesia. Physically, It is located in four subdistricts, including Banyubiru, Tuntang, Bawen, and Ambarawa. Water in Rawa Pening comes from Telomoyo, Ungaran and Merbabu volcanoes. There are nine sub-watershed in Rawa Pening, including Galeh Sub-watershed, Torong Sub-watershed, Panjang Sub-watershed, Legi Sub-watershed, Parat Sub-watershed, Sragen Sub-watershed, Rengas Sub-watershed, Keding Ringin Sub-watershed, and Ringis Sub-watershed. The outlet of Rawa Pening is used to electricity hydropowerplant on Jelok and Timo hydropowerplant.

Rawa Pening has various potential, such as ecotourism, community cultural life, traditions and customs, handicraft, traditional art, and others. The economic value of ecotourism is estimated at Rp 1,65 billion for total benefit per year (Hakim, et.al, 2011). Due to exploitation of its resources and unsustainable practices, Rawa Pening is one of the lake in Indonesia which has encountered environmental problems. The main environmental issues in Rawa Pening are sedimentation, water hyacinth blooming, and flooding. Sediment content comes from massive agricultural activities and conversion of land-use in the upland area. Sediment is transported through the river into Rawa Pening. Nutrient accumulation in the base of Rawa Pening has triggered eutrophication processes. So, the capacity of Rawa Pening decreases year a year. Environmental management becomes an important things as an effort to reduce the sedimentation.

Without good environmental management, Rawa Pening is predicted become land in 2021 (Soeprbowati, 2011).

Shoreline change is also become problem in Rawa Pening. It is caused by high sedimentation due to high concentration of sediment which is settle in the base of Rawa Pening. Shoreline change in Rawa Pening has caused the decrease of water supply for Jelok and Timo hydropowerplant. It will also affected electricity supply for people. Recently, Jelok dan Timo hydropowerplant only produces 4 megawatt (MW) from the normal production 15 MW (Sugiharto, 2012). The electricity supply decrease and could not services the people in the city surrounding Rawa Pening properly. Concerning about the condition of Rawa Pening, the study of shoreline change is indispensable. The aims of this research are to analyze trends of shoreline change in Rawa Pening, and to know the side-effect of shoreline change on the ecosystem surrounding Rawa Pening area.

2. Material and Methods

We conducted this research in several stages by using GIS and remote sensing software packages (Arc-GIS 10 and ENVI 4.8). In this research, some of satellite images was used in order to monitor the changes of shoreline in Rawa Pening. The data were collected from different year to get the information about the changes in Rawa Pening. List of the data were used in this study as shown in Table 1. First, we geometrically corrected the images of 1972, 1991, 1994, 2002, 2004, and 2008 by using topographical map and corrected images. All of collected spatial data were georeferenced to get the same coordinate system. The Landsat images data were collected from Global Land Cover Facility University of Maryland, and ASTER VNIR image was collected from Faculty of Geography, Universitas Gadjah Mada. Topographic maps for 1998 (scale 1:25,000), used for geometric correction of the images was obtained from the Information Geospatial Agency (BIG), Bogor, Indonesia. Second, we digitized shoreline of Rawa Pening based on the image data. We studied temporal change in shoreline within Rawa Pening by using Landsat MSS, Landsat TM, and ASTER data.

Field activities were conducted in two activities, i.e in-depth interview with key person and field observation surrounding Rawa Pening. During field survey, in-depth interview was conducted in order to get the information about ecosytem impact in Rawa Pening. The local authorities both leader of the village and leader of the hamlet were chosen as source of the information. We also conducted in-depth interview with inhabitants to know information and impact of shoreline change and land-use change in the border of Rawa Pening. From the interview, information about current land-use in the border of Rawa Pening was obtained. The interview was conducted in Bejalen Village, Banyubiru Village, and Rawaboni Village. Visual observation of Rawa Pening was conducted to get the information about recent condition of land surrounding Rawa Pening area. In this section, the impact of shoreline change on the ecosystem was also observed. The final step of post-field work is data analysis. All of the data such as satellite image, literature, indepth interview, and results of field observation were combined to analyze the impact of shoreline change on the ecosystem in Rawa Pening.

Table 1 List of data used in this research

Name	Type	Meaning
Rp_Topomap_1998	Raster	Scanned topographical map of 1998
Rp_MSS_1972	Raster	Landsat MSS image. Acquisition date: 28-09-1972
Rp_TM_1991	Raster	Landsat TM image. Acquisition date: 28-06-1991
Rp_TM_1994	Raster	Landsat TM image. Acquisition date: 20-06-1994
Rp_ETM_2002	Raster	Landsat ETM image. Acquisition date: 21-08-2002
Rp_ETM_2004	Raster	Landsat ETM image. Acquisition date: 07-06-2004
Rp_ASTER_2008	Raster	ASTER VNIR image. Acquisition date: 2008
Interview data	Hardcopy	Data is taken from field survey
Statistics data	Digital	Village potency 2011

3. Results and Discussion

3.1 Shoreline Generation

This research use two different images, Landsat image for 1972,1991,1994, 2002, 2004 and ASTER image for 2008 (Figure 1). The first image, Landsat, is the longest running enterprise for acquisition of imagery of the earth from space. It was launched in 1972; LANDSAT TM (Thematic Mapper), first operational on LANDSAT-4. TM sensors primarily detect reflected radiation from the Earth surface in the visible and near-infrared (IR) wavelengths, but the TM sensor provides more radiometric information than the MSS sensor. The wavelength range for the TM sensor is from the visible (blue), through the mid-IR, into the thermal-IR portion of the electromagnetic spectrum. The TM sensor has spatial resolution of 30 m for the visible, near-IR, and mid-IR wave lengths. Second image is ASTER VNIR, this image has 20 m spatial resolution.

Figure 1. Multitemporal of Rawa Pening Images

Six images were georeferenced with Ground Control Point (GCP). The aim of this step is for place images in proper planimetric location so they can be associated with other spatial data. According to Jensen (2005), there are 2 steps in radiometric correction; spatial interpolation and intensity interpolation. Spatial interpolation concerning with the geometric relation between pixel location and map or Earth surface. In this research Ground Control Point (GCP) is obtained from corrected image, Landsat TM 2002. Indicator for geometric correction quality is shown as RMSE. Each image achieves different error is shown in Table 2.

Table 2. Error Estimation of Images

No	Image-year	RMSE	error estimation
1	Landsat- 1972	;-	;-
2	Landsat- 1991	0.340	10,2 m
3	Landsat- 1994	0.347	10,2 m
4	Landsat- 2002	;-	;-
5	Landsat- 2004	0.449	13,47 m
6	Aster- 2008	0.459	9,18 m

Shoreline is boundary between land and water body. The term is considered synonymous with coastline but it considers as different so the precise definition of shoreline given by Coastal Engineering Research Center (CERC). Shoreline is defined as the line contacting between the mean high water line and the shore (CERC, 1984). Remote Sensing images is widely viewed as a time and cost efficient way to process with

large scale monitoring of shoreline. Shoreline features from image were obtained by on screen digitizing along dry-wet boundary. Shoreline was determined from the physical appearance of the shore. Shoreline was assigned as mean high of water. That boundary can be recognized from different tonal and color of composite images. Color composite images are used to emphasize each band's information at one display, so it is easier to visually interpret the image. This image is a combination of three bands, which assigned to red, green, and blue color on each band. The colors appeared on composite image are combination of object's brightness level on each band used.

Landsat TM and ASTER have the number of available band. Visible and near infrared especially, are detectable variable associated with water content and vegetation spread. The different tonal was caused by amount of water in surface. Much water will make pixel darker, because electromagnetic energy was absorbed. In other hand, reflectance of vegetation is increase, so vegetation have more light tone.

3.2 Shoreline Change Assessment

Shoreline changes especially located in lower part of Torong, Panjang, and Galeh river in the western part and Legi, Parat and Sraten river in the south eastern part (Figure 2). The results show that the area of Rawa Pening decrease until 373.95 ha for 36 years (Table 3). The decelerating rates of Rawa Pening is about 10.38 ha/yr. Sediment from the river has important role on the shoreline change. According to PSDA Central Java, 2008 in Jayanti (2009), the highest erosion rate and sedimentation is located in Legi river (Table 4). The decelerating rates of shoreline change is associated with the river which has high sediment content.

Figure 2. Shoreline change in Rawa Pening

Table 3. Areal of Rawa Pening from 1972-2008

No	Image-year	Area (m ²)
1	Landsat- 1972	18.999.200
2	Landsat- 1991	18.753.700
3	Landsat- 1994	18.728.100
4	Landsat- 2002	17.210.800
5	Landsat- 2004	16.459.900
6	Aster- 2008	15.259.700

Table 4. Erosion Rate of Rivers which have outlet in Rawa Pening

Nr.	River	Area (ha)	Erosion rate (ton/year)	Sedimentation potency (ton/year)
1	Legi	931,5	405,23	215,58
2	Parat	3.744,00	381,27	164,71
3	Galeh	6.121,00	303,75	116,03
4	Torong	2.687,00	115,75	54,16
5	Panjang	4.893,24	73,37	29,13
6	Sraten	2.822,26	290,49	133,92
7	Kedungringin	918	76,47	41,75
8	Rengas	1.751,00	29,15	14,49
9	Muncul	1.211,00	17,84	9,15
Total		778,93		

Source: PSDA Central Java, 2008 in Jayanti, 2009

3.3 Impact of Shoreline Change on the Ecosystem surrounding Rawa Pening

Anthropogenic pollutants that come from intensive use of fertilizer and pesticide in agriculture, household waste, atmospheric deposition and terrestrial drainage impacted the Rawa Pening. It makes nutrient enrichment which contain nitrat, phosphat, and other chemical contents through the lake (Rovita, et al, 2012). Fishpond in Rawa Pening also contribute to the nutrient enrichment. Artificial feed fish contain high percentage of nitrogen and phosphorous, both of them are main trigger for eutrophication (Irianto & Triweko, 2011; Yosmaniar, 2010).

Eutrophication in Rawa Pening makes blooming of aquatic vegetation and phytoplankton. Characteristic of nutrient enrichment in lakes which easily to observe is the abundance of water hyacinth (*Eichornia crassipes Solms*), It is kinds of floating aquatic vegetation. The abundance of water hyacinth and phytoplankton have impact to high rate of Biological Oxygen Demand (BOD) in lakes so the Dissolved Oxygen (DO) will decrease drastically. Low rate of DO will create anaerob condition in lakes, so the aquatic aerob organism like fish will die. Anaerob condition will trigger the algae blooming and some of them are toxic. Rawa Pening lake are more dominated by diatom species especially *Melosira italic*. In addition, high number of *Euglenoids* species in Rawa Pening also indicates that this lake is polluted by organic materials (Sulastri, et al, 2012).

Contamination from organic and anorganic sediment in Rawa Pening is impacted to water quality. Groundwater surrounding Rawa Pening has yellow color and odor, so the people use water from water national company (PDAM). Based on data from Pusat Sarana Pengendalian Dampak Lingkungan (PSPDL, 2011) Rawa Pening lake have high rate of BOD and phenol which over the water quality criteria. Highest rate of BOD in inlet of Ngaglik river at 6,11 mg/L, and second are outlet to Tuntang river at 5,06 mg/L. Phenol rate between 0,009 mg/L – 0,044 mg/L. Highest phenol rate is found in spring source and between fishpond.

Based on observation and in-depth interview, terrestrial ecosystem which affected by shoreline change are settlement and paddy field. Shoreline change on Rawa Pening made chain effect and direct/indirect effect to human. Settlement in Banyubiru and

Rowoboni village has suffered from the impact of Rawa Pening shoreline change. In wet season, settlement area will be inundated by water from Rawa Pening. Inundation duration occurs until 1 - 2 month. Inundation in settlement area will cause itchinness, low water quality, and disturb human activity. Inundation also causing building structure damage so the human safety has threatened. Some mitigation have been built to cope the inundation such as build dyke to protect the village from flood (Figure 3). The height of dyke is 0,5-1,5 m from the river base. If inundation in big event and the people cannot cope, the people will temporary shifting to save area like their family or neighbour. It is some kinds of coping strategies to reduce the inundation effect.

Figure 3. Raising the building as adaptation measures to prevent from flooding

Paddy field developed since 1940's and built in tidal land (Figure 4). Paddy field areas in tidal land are varying between dry and wet season. Tidal land can be planted only once a year only on dry season. Flood usually happens in Kesongo period or December-January-February when the rainfall in high intensity. When flood happen, water hyacinth also spread into paddy field and sometimes they act as a pest vector like rats.

Rawa Pening shoreline change also affects to the hydro-powerplant. The volume of Rawa Pening have decreased in line with increase of sedimentation. Nutrient enrichment cause water hyacinth blooming and it will disturb the flow direction. Because of it, the energy from water cannot be converted into electric energy optimally. Based on Indonesia Power Statistic Report (2011), Rawa Pening waterflow is used to generate Jelok and Timo hydro-powerplant. Jelok have four power plant with 5,12 MW capacity each of them and Timo have three power plant with 4 MW capacity each of them. Sedimentation and water hyacinth in Rawa Pening make both of hydro-powerplant cannot be used optimally.

Figure 4. Paddy field in tidal land, Bejalen village

To increase the income, peoples use water hyacinth to create handycraft and sell them. Sittadewi (2007) mention that water hyacinth can be used for growing media, It will support organic farming and minimize the use of chemical materials. Water hyacinth for handycraft can be reduced the population, but if they left the leaves and root in lake, it can be contributed to sediment. It needs control and monitoring for water hyacinth growth in Rawa Pening. Example of technology to control movement of water hyacinth is concrete fence. It can select and regulate water hyacinth so it cannot be flow to Tuntang river and the hydro-powerplant would not disturbed (Amariansah, 2011).

4. Conclusion

According the results of conducted research in Rawa Pening can be concluded that:

- Shoreline changes especially located in lower part of Torong, Panjang, and Galeh river in the western part and Legi, Parat and Sraten river in the south eastern part. The results show that the area of Rawa Pening decrease until 373.95 ha for 36 years. The decelerating rates of Rawa Pening is about 10.38 ha/yr. The decelerating rates of shoreline change is associated with the river which has high sediment content.
- Shoreline change on Rawa Pening made chain effect and direct/indirect effect to human. Nutrient enrichment that caused by water hyacinth (*Eichornia crassipes Solms*) blooming have impact to high rate of Biological Oxygen Demand (BOD). Anaerob condition will trigger the algae blooming and some of them are toxic. Settlement in Banyubiru and Rowoboni village has suffered from the impact of Rawa Pening shoreline change. In wet season, settlement area will be inundated by water from Rawa Pening. Inundation duration occurs until 1 - 2 month. Some mitigation have been built to cope the inundation such as build dyke to protect the village from flood.

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