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Utilization of ETM+ landsat Imagery and operational land imager for river pollution analysis in Jember Regency, Indonesia

F A Kurnianto^{1*}, Yushardi¹, E A Nurdin¹

¹ Department of Geography Education, University of Jember, East Java, Indonesia

*email : fahmiarif.fkip@unej.ac.id

Abstract. The purpose of this research was to analyze the pollution of rivers in Jember Regency by utilizing landsat ETM + and the Operational Land Imager. The method used in this research is the overlay and buffering. The entire site will be observed with techniques of interpretation of landsat imagery and geoEye. Then do the check field that aims to strengthen the image of the interpretation of the results. The data collected using the landsat 8 imagery digitation and registration (data water polluter), and also the image of geoEye (land cover data). Pollution of the river analyzed by several indicators, among others: household waste, sediment, land use. The results showed that pollution of rivers in Jember district by activity centers located in the middle of the city, residential area anti-pollution of rivers, erosion material from upstream not have a significant influence on river pollution. Jember town centre is a region with the highest pollution index because there are many compact neighborhoods located around the river. This affect will on public health when there is no attempt to resolve these problems.

1. Introduction

Rivers are an significant feature of a landscape. Rivers are water bodies and habitats for various kinds of biota. The biota is against global-scale changes in climate and direct human intervention through containment, irrigation and waste. However, the extent of the area often analyzes river pollution difficult to do. Technological advances have made it possible to store and process large data needed for high-resolution rivers. Also the launch of Landsat 8 has been able to guarantee the availability of high resolution data for the past, present and future.

This progress offers new and unusual opportunities to study river areas and areas that are affected by the presence of the river. Landsat ETM + has the advantage of analyzing water bodies in large regions (all districts, provinces, watersheds). Several previous studies related to water bodies that have been carried out are as follows: landsat multi time series images were able to analyze the Total Suspended Matter of the Krueng Aceh estuary [1]. Batanghari River experienced physical changes involving both river bodies, river environments and water quality through interpretation of landsat images [2].

The USGS archives available on Landsat imagery and develop pixel-based methods that estimate the likelihood that a pixel will become water. None of these approaches explicitly overcomes the seasonality of all water bodies. However, one challenge facing global remote sensing is to choose which image to use in the river in a multitemporal manner. Similarity of multitemporal images generally requires a picture of a partner both obtained from the same season or for each change in season. If the pair of images is not seasonally consistent, the seasonal variability of the water body cannot be distinguished.

Interpretation of the local spatial scale is relatively easier to implement in one period to choose seasonally consistent images. However, on a regional to global level, many seasonal cycle differences vary, so that interpretation must be done more complex. Date ranges in the image allow comparison over time, similarities between spaces will also illustrate the presence of anomalies. For example, at the same time as one area in the rainy season, neighboring regions may be in the dry season.



Therefore, the date range for selecting images were be identified for each location based on the region's local seasonal.

River pollution problems currently occur in Jember Regency. Bedadung River is one of the main rivers in Jember Regency which is polluted by various pollutants, including polluted by household waste and sediments resulting from upstream river erosion. In fact, the test results of the UPT of the Jember Regency Environmental Agency in 2017 stated that the river bedadung condition was at level 4 because of its high pollution. If this is left unchecked, the Bedadung River will lose its function as a water body that contributes hugely to sustaining the life of the Jember community.

Bedadung River pollution must be mapped so that the locations that are the largest contributors to pollution must be identified and so that levels of pollution at each point along the bedadung river are known. Therefore, landsat ETM+ imagery and land imager operations was utilized so that the location mapping and pollution analysis in each location were carried out effectively and efficiently.

2. Method

The location of this study is the entire main river of Jember Regency. All of these locations will be observed with interpretation techniques of Landsat 8 imagery, and geoEye. As for strengthening the interpretation results, it is necessary to check the field technique which aims to increase the results of image interpretation. The field observations were carried out in Jember Kota, Ambulu, and Kencong. Data was collected using registration techniques and digitization of Landsat 8 images (water pollutant data), and geoEye images (land cover data). To analyze the data that has been collected, the following formula used.

$$\text{Net} = P + \text{KM} + \text{E0} \quad (1)$$

Where,

Net : Pollution Index
 P : Waste of Household
 KM : Land Use
 E0 : Sediment thickness

The formula is used to analyze the data obtained by the image with a spatial resolution of 0.5 x 0.5. River pollution shows (1) garbage, (2) sediment, (3) water color. Presiptation shows the rainfall that occurs in an area. Land cover shows the presence of percolation barrier. The results of data processing are adjusted to the dean of the river pollution index classification as follows:

0-2: very low
 3-4: low
 5-6: moderate
 7-8: high
 9-10: very high

3. Results and Discussion

Based on information and data processing, the findings found were pollution of rivers in Jember district by activities located in the middle of the city, residential area anti- pollution of rivers, erosion material from upstream not have a big influence on river pollution. Finding it can be changed in the following data,

Table 1. The results of observation

No	Sub District	Sediment Thickness	Land Use	Household Waste	Pollution Index	Pollution Index Average
1	Ajung	6	7	6	19	6,3
2	Ambulu	7	7	8	22	7,3
3	Arjasa	5	8	8	21	7
4	Balung	7	7	7	21	7
5	Sumbersari	6	9	9	24	8
6	Wuluhan	7	6	8	21	7
7	Semboro	7	5	6	18	6
8	Tanggul	6	6	5	17	5,7
9	Kencong	8	7	7	22	7,3
10	Bangsalsari	6	6	6	18	6
11	Rambipuji	6	6	5	17	5,7
12	Sumberbaru	6	5	7	18	6
13	Panti	4	6	7	17	5,7
14	Puger	8	6	7	21	7
15	Mayang	7	6	6	19	6,3
16	Silo	6	6	4	16	5,3
17	Ledokombo	6	5	6	17	5,7
18	Gumuk Mas	8	7	6	21	7
19	Jelbuk	4	4	4	12	4
20	Jenggawah	6	7	7	20	6,7
21	Jombang	7	6	8	21	7
22	Kaliwates	7	9	9	25	8,3
23	Mumbulsari	6	6	7	19	6,3
24	Pakusari	5	6	6	17	5,7
25	Patrang	4	8	8	20	6,7
26	Sukorambi	5	5	5	15	5
27	Sukowono	4	6	6	16	5,3
28	Jambe	5	5	6	16	5,3
29	Tempurejo	5	4	7	16	5,3
30	Umbulsari	7	7	6	20	6,7
31	Kalisat	6	6	7	19	6,3

Source : Observation (2018)

Human activities in the center of Jember Regency consist of education centers, service centers, government centers, and trade centers. This will have a sharp influence on the area built in this region. The height of the zones that are built will affect the flows that can erode the masses in the region. The magnitude of the eroded coral will increase the level of river turbidity.

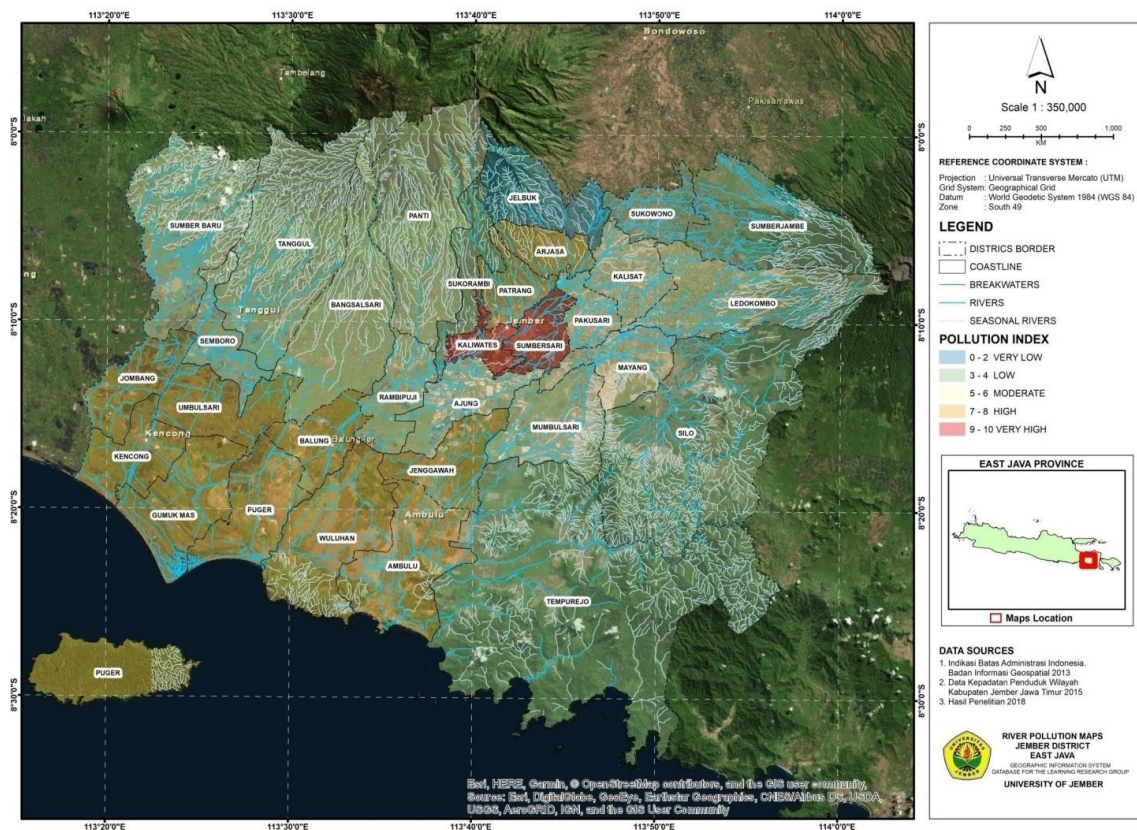


Figure 1. Pollution Index of the rivers in Jember Regency based on topography

Activities in the center of Jember consist of education centers, service centers, government centers, and trade centers. This will have a sharp influence on the area built in this region. The height of the zones that are built will affect the flows that can erode the masses in the region. The magnitude of the eroded coral will increase the level of river turbidity. Sub-districts that built many activity centers were Summersari District and Kaliwates District. This happened in these 2 Subdistricts.

The data also shows, the wider the settlement, the more polluted the river will be. This is caused by. The house is still low. Sheet erosion and many occur in settlements the ability of the soil to absorb air will be reduced. As a result, the Activity Center, Summersari District and Kaliwates District also have the most densely populated settlements. River pollution with river water that is no longer clear, but the pollution of the river in Jember Regency is more by households. This shows that erosion in the upstream area is not high. Pollution is very much due to the speed of households in the central and downstream areas of the watershed.

The results of this study are in accordance with the results of the study that the high pH may be due to the presence of other pollutants introduced into the water, as most of the study sites are located near waste dumpsites in the metropolis [3]. Billion's of liter industrial waste water, raw sewage and agricultural wastes are dumped into the river. Human activities have the most influence on river water quality. Especially if the river water is polluted by industrial waste. Industrial waste

will make water contain heavy metals which are harmful to health. This will get worse if industrial placement is not in accordance with environmental regulations. Industrial placement that is too close to the river will cause various environmental risks. Especially if the industrial waste is disposed of without processing first.

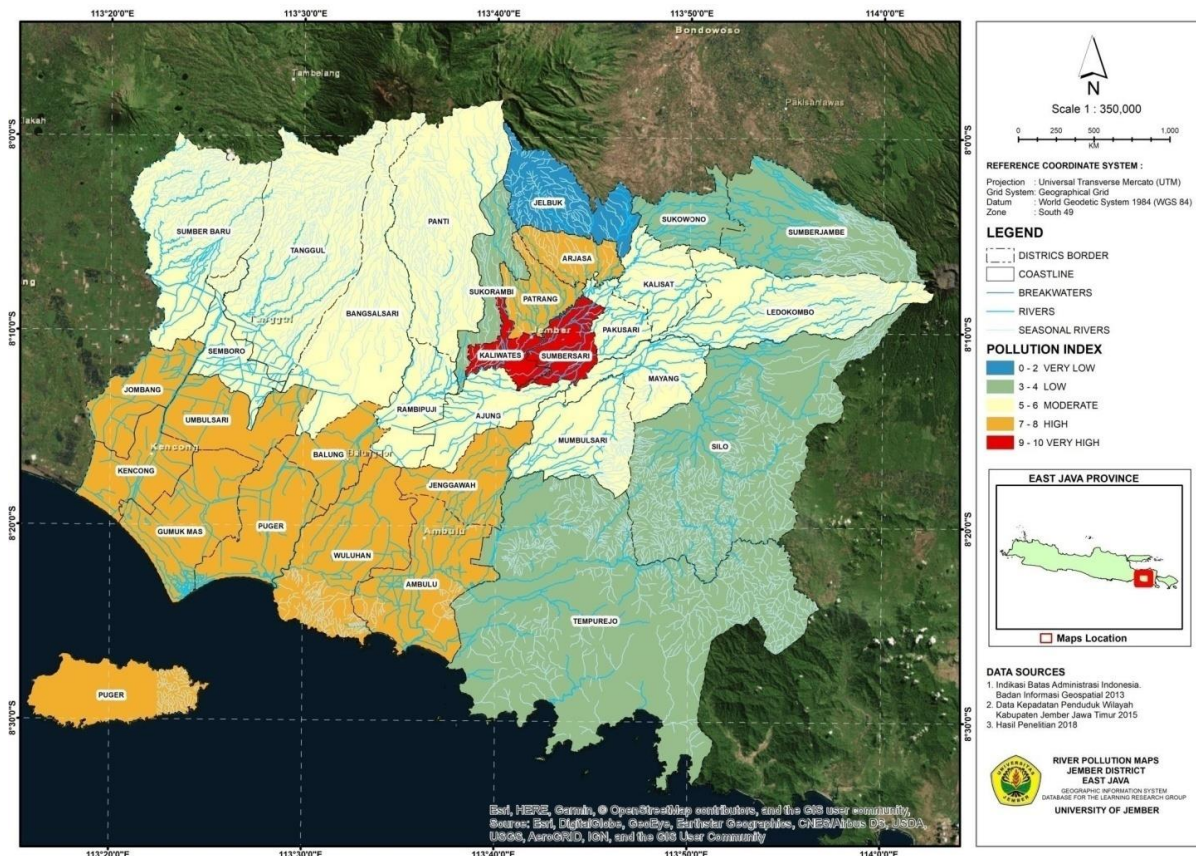


Figure 2. Pollution index of the rivers in Jember Regency based on type of river

Sediment thickness factors used as indicators in this study because it influence to another factor. The purification of common pollutants by riverbed media of three sediment thicknesses, as well as the river water infiltration as supplied by reclaimed water [4]. Water quality degradation are from soil erosion, sedimentation, and nutrient inputs from municipal stormwater discharges. Sediment thickness will affect the turbidity of river water. The turbid river water will make biota in the river difficult to develop. In addition, sediment thickness will also affect the silting process of the river which will result in a high risk of flooding.

People interested in stream pollution frequently make a distinction between point-source and non-point-source pollution. The results of the study show that not all high-potential sites cause pollution to the river. Sources of pollution caused by waste household activities and household industries which discharge directly into the river [5]. Places that have a lot of human activity for aspects of settlements and industries will be more vulnerable than places used for agriculture or forestry. This is due to the fact that settlements and industries will cause new power in the deformation of land forms such as surface runoff water, household waste, and industrial waste.

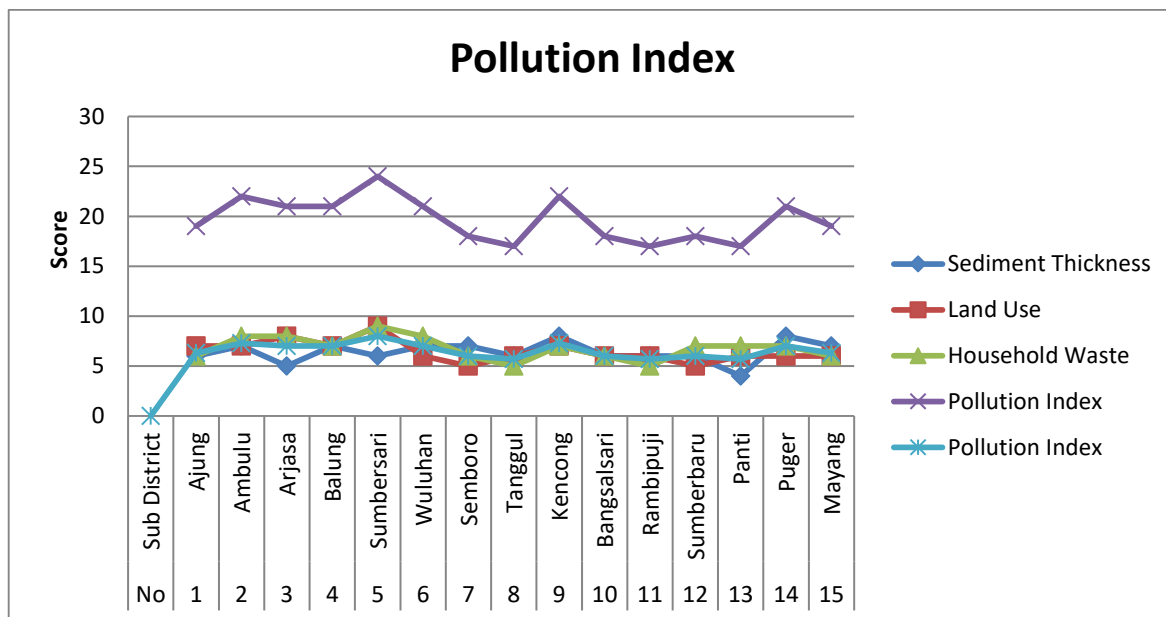


Figure 3. Pollution Index with the indicators in Sub District 1-15

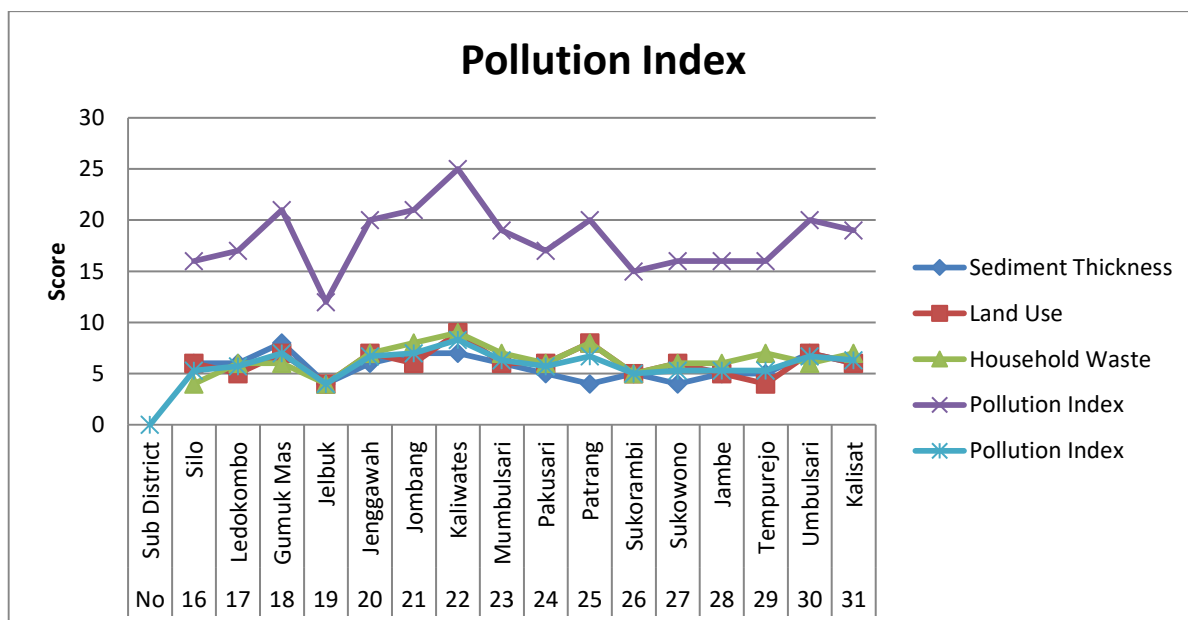


Figure 4. Pollution Index with the indicators in Sub District 16-15

Jember's high rainfall causes pollution to also occur in the downstream area. The decrease in annual runoff and sediment discharge by increasing evapotranspiration and alleviating soil erosion [6]. the simulation shows that with the increasing of vegetation coverage annual runoff increases and evapotranspiration decreases in the basin. High rainfall will cause the river discharge to increase and the spread of sediment and waste will also expand. Sediments that spread if balanced with land use that is still under control, then the negative impacts associated with river pollution will not occur. But if household waste quickly spreads, then this will become difficult because household waste is material that cannot be decomposed by water erosion.

Household waste containing bacteria is closely related to the existence of settlements. The high value of bacteria which are majorly pathogens in the residential area can be attributed to its nearness to the dumpsite as well as the various and diverse human activities [7]. Therefore, holistic counter measure for microorganism pollution control is necessary for both point and non-point sources. Some communities around the river are still many who use river water for bathing. This will lead to diseases caused by domestic waste bacteria. There needs to be an effort so that the existence of this household waste does not meet the river body evenly.

Watershed is a unitary area of ecosystem which is limited by topography and functions as a reservoir of water together with sedimentary elements in the river system. Sedimentation is a process of deposition of material transported by water media. Delta contained in river mouths is the result and process of deposition of materials transported by river water. Bedadung River is the largest river in Jember Regency. The composition in this area is clay, sand or mud. This river has a big influence on people who are around the flow. Sediment is the result of erosion processes in the form of surface erosion, trench erosion, or other types of soil erosion [8]. The temporary deposition process occurs on a wavy slope, which is a concave part of the slope. Erosion is the process of releasing soil grains from its parent in a place, and sedimentation is the transport of the material by movement of water or wind then followed by precipitation of material [9]. This concave slope section will temporarily accommodate particles of drift and in the next rain these deposits will be lifted back towards the lowlands or rivers.

Land and parts of land which is transported from an eroded place called sediment. Whereas sedimentation is the process of carrying sediment by runoff/ flow of water deposited in a place where the speed of the water slows or stops as in river channels, reservoirs, lakes and the edge of the sea area [10]. The grain motion starts because of the influence of water flow which gives rise to the flow force acting on the sediment material. The use of the basic principle of sediment transport is to determine the behavior of sediments under certain conditions whether there is a balanced state, erosion, or sedimentation as well as to predict the quantity of sediment transport in the process. This naturally occurring process is determined by the flow shear force and the diameter of the sediment grain.

4. Conclusion

The conclusion for the study is pollution of rivers in Jember district by activity centers located in the middle of the city, residential area anti-pollution of rivers, erosion material from upstream not have a big influence on river pollution. River pollution does not have to come from upstream, but the central and downstream areas of the watershed have a big influence. The slope of a sloping and flat slope causes the central and downstream areas to be vulnerable to being exploited by the surrounding community to build dense settlements and industries.

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