The Impact of The Land Use Changes Through Batang Spatial Planning on The Ecosystem Services on Climate Management

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Abstract. The Indonesian government through Presidential Regulation Number 79 of 2019 and Presidential Regulation No. 109 of 2020, established an Integrated industrial zone in Batang (KIT Batang). At the local level, it is followed up by spatial planning revision of the Batang Regency. At that policy, many agricultural areas will convert into the industrial zone and their supporting facilities. It accommodates more than 3,000 Ha of the industrial zone increment including KIT Batang. On the other hand, the main issue in a coastal area such as Batang Regency is the increasing level of seawater resulting from climate change. Climate change is caused by global warming. Moreover, global warming is affected by increasing CO2 in the air. That phenomenon occurred by several factors such as increasing carbon emission by vehicles, decreasing the area of the green zone, increasing the high carbon emission activity, and so on. Most of the global warming factor is derived from industrial zone activity. By that fact, the researchers want to ensure the impact of Batang Integrated Industrial zone establishment on the ecosystem services, especially the Climate Management Service. The research is conducted by the deductive–qualitative–rationalistic paradigm. The deductive starts from resuming the theory regarding ecosystem services on climate management and then synthesis of the variable and factor. It will be compared to the empirical fact and analyzed quantitatively through scoring and spatial analysis, By using the 2019 (start years of new spatial planning of Batang) and 2039 (end years of Batang spatial planning) data, this research aims to identify the land convert phenomena to measure the ecosystem services changes.

Keywords: climate management, ecosystem services, land-use

1. Introduction
The Indonesian government encourages industrial development as the main focus in improving economic performance. The strategic step in developing industrial development is to establish new industrial zones in several areas including Batang. Industrial development, especially the Batang integrated industrial area is regulated through presidential regulation Number 79 of 2019 and Presidential Regulation No. 109 of 2020. Explicitly, these two regulations contain the development of integrated industrial estates and their complementary infrastructure. At the Regency level, this presidential regulation is accommodated through the changes to the Batang Regency spatial plan for 2011 – 2031 into a Batang Regency spatial plan for 2019 – 2039. This change was ratified through
Batang Regency regional regulation Number 13 of 2019 concerning the RTRW of Batang Regency 2019 – 2039.

In the Batang Regency spatial plan 2019 – 2039, the total industrial area has increased significantly to 3,762.95 hectares. This area is much increased compared to the existing condition in 2019, which was only 122.08 Ha. Industrial development has several good and bad impacts. The good impact of the industry can be an increase in the number of workers. Negative impacts can be in the form of environmental pollution.

On the other hand, Batang Regency has a protected forest area which is one of the cornerstones in maintaining regional and regional climate stability. In 2019, the wet forest area reached 3,028.57 Ha and the area of dry land forest reached 15,119.15 Ha. This makes Batang one of the regencies that has a major role in climate stability, especially on the north coast of the island of Java. This is important considering that most of the coastal areas of the island of Java have developed into built-up areas with the dominance of settlement, trade, and industrial activities. Furthermore, the existence of the north coast road makes the propagation of regional development more rapid.

Based on these two phenomena, Batang's integrated industrial development plan can affect the condition of ecosystem services, especially climate management. This assessment is carried out to ascertain the impact of industrial development on the condition of environmental services in climate regulation. The study findings will identify which areas have experienced a decline in quality related to climate management ecosystem services (ESCM). Based on this information, stakeholders can conclude and formulate environmental conservation policies.

2. Method

The research regarding “The Impact of The Land Use Changes in Batang Integrated Industrial Zone on The Ecosystem Services on Climate Management” is conducted by Deductive – Qualitative – Rationalistic. The deductive is implemented by structuring theory regarding ecosystem services and then comparing them to empirical facts. Qualitative is conducted by using spatial data and the scoring method. To ensure the study makes sense and is logical, the rationalistic approach is made by synthesizing the rational relation between land-use change, ecosystem services, and ecoregion.

The spatial approach is conducted by identifying the land-use change of Batang Regency in tears 2019 and 2039. The land use will be analyzed through scoring and weighing. The weighing and scoring involve other criteria such ad ecoregion, land use, and vegetation. The scoring and weighting are structured by an expert choice method. The experts are academicians from several top universities in Indonesia who has an environment and geographic science background.

| No | Variable          | Climate Control Services | Weight (%) | Score |
|----|-------------------|--------------------------|------------|-------|
|    | Landscape        |                          |            |       |
| 1  | Lake              |                          | 30         | 4     |
| 2  | Fluvial           |                          |            |       |
| 3  | Vulcanic          |                          |            |       |
| 4  | Volcanic Fluvial  |                          |            |       |
| 5  | Structural        |                          |            |       |
| 6  | Solusional Karst  |                          |            |       |
|    | Land Use          |                          |            |       |
| 1  | Urban Settlement  |                          | 50         | 1     |
| 2  | Rural Settlement  |                          |            | 3     |
| 3  | Waterbody         |                          |            | 4     |
| 4  | Open land         |                          |            | 3     |
| 5  | Irrigated Paddy Field |                    |            | 3     |
3. Results and Discussion

3.1 Land Use Changes
Batang Regency is an area located on the northern coast of Central Java. This district is located between Semarang City and Pekalongan City. Morphologically, Batang Regency has hills that lead from the mountains to the coast or coastal. Based on land use, it is known that in 2019, land use is still dominated by dryland agriculture, which is 33,340.35 Ha. In the second place is dryland agriculture with an area of 17,483.57 Ha and in the third position is a dry land forest with an area of 15,119.15 Ha. Even though it is located on the northern coast of Central Java, which has a fairly high activity load, Batang Regency still has wetlands covering an area of 3,028.57 Ha.

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![Figure 1](image_url)

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rice fields with an area of 17,853.46 Ha. The second-largest position is a dry forest with an area of 15,336.33 Ha. In the third position is the use of dryland agricultural land with an area of 12,137.95 Ha. On this side, the existence of wet forests is still maintained with an area of 3,043.08 Ha.

### Table 2. The land use changes in Batang Regency.

| Land Use                  | 2019 (Ha) | 2039 (Ha) | Difference |
|---------------------------|-----------|-----------|------------|
| Wet Forest                | 3,028.57  | 3,043.08  | 14.51      |
| Dry Forest                | 15,119.15 | 15,336.33 | 217.18     |
| Industry                  | 122.08    | 3,762.95  | 3,640.87   |
| Dry Agriculture Land      | 33,340.35 | 12,137.95 | -21,202.41 |
| Mangrove                  | 0.00      | 121.33    | 121.33     |
| Harbour                   | 1.56      | 0.00      | -1.56      |
| Waterbody                 | 1,550.81  | 1,550.81  | 0.00       |
| Production Plants         | 5,377.52  | 4,566.73  | -810.79    |
| Rural Settlement          | 9,691.12  | 9,015.93  | -675.19    |
| Urban Settlement          | 0.00      | 8,379.28  | 8,379.28   |
| Irrigation Paddy Field    | 17,483.57 | 17,853.46 | 369.89     |
| Non-Irrigation Paddy Field| 0.00      | 5,275.74  | 5,275.74   |
| Open Land                 | 29.52     | 340.88    | 311.36     |
| Mix Plants Area           | 0.00      | 4,359.79  | 4,359.79   |
| **Total**                 | 85,744.26 | 85,744.26 | 0.00       |

Based on this comparison, the use of dryland agricultural land is reduced by 21,202.41 Ha. This number is very large compared to the area of origin. It explains that 70% of dry agricultural land is converted to other land, both agricultural and non-agricultural. On the other side, the development of the built-up area particularly the residential area has grown to more than 8 thousand ha with the urban settlement characteristic. Besides that, industrial land is planned to increase to the area of 3,640.87 hectares with the main industrial center located in the Batang Integrated Industrial Estate. Figure 2 is an illustration of the Integrated Industrial Zone development in Batang Regency.

![Figure 2. The integrated industrial zone of Batang.](image)

### 3.2 Landscape

In general, the landscape in Batang Regency consists of four main types, namely fluvial plains, volcanic plains, and denominational and structural folds. The fluvial plain consists of wavy fluvials and fluvimarinis. The wavy fluvial was in the central area of Batang Regency, while the fluvimarin was in the coastal area of Batang Regency. On the other side, there are volcanic plains and structural hills in
the southern area of Batang Regency. The volcanic plain itself is divided into volcanic hills and volcanic cone mountains. Based on these characteristics, Batang Regency has the support of undulating hilly land spans that are suitable for forest and plantation land use. This area is suitable for cultivation in the middle to the north, with a characteristic fluvial landscape. The following is the distribution of the Batang Regency landscape. Figure 3 is the map of the landscape of the Batang Regency.

3.3 Ecosystem services of Climate Management (ESCM)
Based on the scoring method on spatial data related to landscapes, land use, and natural vegetation, the result was in 2019, environmental services for climate management in Batang Regency are dominated by low conditions, moderate and high conditions. Low conditions have an area of 34,198.39 Ha. At the same time, the moderate and high conditions have an area of 28,843.32 Ha and 20,248.52 Ha. Aggregately, Batang Regency has a relatively good ability to close to moderate in terms of contribution to climate management in the northern part of Central Java.

At the end of the Batang Regency RTRW planning, the ecosystem services for climate management are as follows.
1. Low conditions are still dominant with a larger area, namely 39,292.91 Ha;
2. Moderate conditions are in second place with an area of 25,971.59 Ha;
3. The condition of different heights is in the third place with an area of 14,884.77 Ha;
4. Very low conditions experienced a drastic increase to 3,128.73 Ha.

Figure 5 shows the extent of environmental services distribution for the Batang Regency climate regulation in 2019 and 2039.
Referring to the analysis results, very low climatic conditions experienced an increase of 3,099.52 Ha. Meanwhile, the low condition experienced a total of 5,094.51 Ha. This condition indicates that there is a decline in the quality of ecosystem or environmental functions in terms of service providers for climate stability and management. It illustrates that the condition of good regulation decreased significantly by 5,363.75 Ha. Table 2 is the change in the condition of the ecosystem services of climate management in the Batang Regency.

Table 3. The ESCM changes of Batang Regency.

| Category    | JEPI 2019 (Ha) | JEPI 2039 (Ha) | Difference | Description   |
|-------------|----------------|----------------|------------|---------------|
| Very Low    | 29,21          | 31,28,73       | 3,099,52   | Increasing    |
| Low         | 34,198,39      | 39,292,91      | 5,094,51   | Increasing    |
| Moderate    | 28,843,32      | 25,971,59      | -2,871,73  | Decreasing    |
| High        | 20,248,52      | 14,884,77      | -5,363,75  | Decreasing    |
| Very High   | 2,424,81       | 2,466,26       | 41,45      | Increasing    |

|               | 85,744,25 | 85,744,25 | 0,00       |               |

3.4 Discussion
The decline in the level of environmental services in climate management of Batang Regency is influenced by shifts or changes in land use from agricultural land, especially dryland agriculture such as horticulture, people's forests, and the like to built-up land including industry and settlements. The pattern of distribution of environmental services and the distribution of industry has several relationships as follows:

1. The existence of industry in coastal areas such as the mainland for the Batang Integrated Industrial Estate changes the condition of environmental services from good/high to low;
2. In industries located in the Batang urban area, namely in the middle, slightly to the east, the condition of ecosystem services changes from moderate to low;
3. In industries located in the Batang urban area, namely in the middle, slightly to the west, the condition of ecosystem services changes from low to very low. In the urban area, the carbon emission which the main influencing factor of ESCM is affected by the people income, knowledge and education regarding energy using in transportation and activity [1].
4. In the southern area where there is no industrial presence, ecosystem services climate regulation is fixed. In order to keep the ESCM condition and improve the economic activity at the same time, the government can develop the ecotourism or forest-based tourism [2].

Figure 5 is an illustration of the distribution of industry and the condition of environmental services in Batang Regency's climate regulation in 2019 and 2039.

![Figure 5](image)

**Figure 5.** The Location Association of Industrial Zone and ESCM condition 2019 (left) 2039 (right).

Related to the land-use change, this industrial area is the result of conversions from agricultural land, especially dryland agriculture such as fields, fields, or community forests. This is similar to the phenomenon in Bogor that reduced mixed gardens have implications for a decrease in climate regulatory environmental services [3]. This is because, in the City and District of Bogor, the existence of mixed gardens is the dominant vegetation cover compared to other vegetation cover such as forests and community forests. In areas with converted forests, environmental services will change drastically [4][5].

Meanwhile, the industrial designation plan for rice fields, especially irrigated rice fields, is planned to be replaced with a Sustainable Food Agricultural Land scheme, especially for reserve land. On this side, the existence of built-up land has a significant contribution to the decline in environmental services [6][7]. Meanwhile, the existence of forests, specially protected forests, has a good role in maintaining the stability of environmental services in climate management. This also happened in Batang Regency where the existence of wet and dry forests which experienced a slight increase in the area had implications for improving environmental services which were very good in climate management.
In developed areas, the existence of industry and settlements as supporting activities that reduce the level of environmental services can be suppressed by the application of waste treatment [8]. This waste treatment can be done by sorting waste through 3 R, composting, and converting waste into energy [9]. In the Batang Regency area, the prevention of this decline in ecosystem services can be done through the construction of integrated waste installations of good quality, the application of green buffers in industrial areas, and air quality management in industrial areas. Regulation regarding environmental management is needed to avoid the gradual decrease of ecosystem services on climate management [10].

4. Conclusion
Industrial development is a strategic step launched by the government to improve the regional economy. One of the government's strategic projects is the development of an Integrated Industry in the Batang Regency. Batang is an area on the north coast of Java Island that still has the use of protected forest land and production forest. On this side, Batang Regency has good environmental service conditions and is in climate regulation. However, with the planning of the Batang KIT coupled with changes to the Batang Regency's RTRW, environmental services for climate regulation are predicted to decline. A significant decrease is in the area directly adjacent to the planned industrial land use. In the KIT Batang integrated industrial area in Gringsing District, the ecosystem services for climate regulation changed from good to low. Meanwhile, in industrial areas in the Batang urban area, environmental services have changed from low to very low. So it is necessary to mitigate the decline in environmental services climate regulation by seeking several things such as the development of urban forests, industrial barriers, and waste management in industrial areas.

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