



Apothem of Bagelen land in the 18th-21st centuries: Agriculture, plantations, and forestry

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ABSTRACT

Background: Bagelen is a region located in Purworejo, Central Java, Indonesia. In the past, Bagelen had a very long history, from becoming an independent region, to becoming a residency, and then joining the Kedu residency. The landscape or land in the Bagelen region (Purworejo, Kebumen, Wonosobo, Banyumas, and Kedu) has undergone a long history of transformation. This study will examine the changes in the landscape or land use in the Bagelen region from the end of the 18th century to the 21st century, based on an environmental history perspective. **Methods:** The methods used in this study include a historical approach and other scientific approaches such as botany, linguistics, archaeology, and anthropology to strengthen the evidence related to the transformation in this region. **Findings:** This study found changes in land use over various periods of time. This study found that the landscape of the Bagelen region had changed; initially, the Bagelen region consisted of agricultural land, which later transformed into plantations. Furthermore, due to high demand for timber, the Dutch East Indies government implemented a reforestation project from 1875 to 1925, with the aim of profiting from the sale of timber and other agricultural products. **Conclusion:** However, while these landscape changes had occurred regularly over the centuries—or in accordance with soil science principles—at the beginning of the 20th century, further changes took place due to a growing population in need of land. This led to the conversion of forests—which had been reforested during the colonial era—into plantations and settlements. However, these changes were not based on sound soil science principles, resulting in natural disasters such as landslides. **Novelty/ Originality of this article:** The research presents an innovative environmental history of Bagelen, combining historical methodology with insights from botany and pedology.

KEYWORDS: Bagelen; environmental history; landscape change; reforestation.

1. Introduction

Humans and the environment are inseparable entities. In addition to being a place to live, the environment is also a means for humans to obtain and fulfill all aspects of their needs, in this case natural resources. However, records or writings related to the history of the relationship between the environment and humans rarely receive much attention. In this case, what is meant is environmental history. The context of environmental history is not well understood in Indonesia. This is because, for the most part, the understanding of history is often concentrated on the study of political, cultural, religious, or economic history. Environmental history is the study of the causal relationship and influence between humans and the environment in the past (Boomgaard, 2005). The term “past” needs to be emphasized in this study because it highlights the main difference between environmental history and other disciplines, especially ecology, which does not explicitly place the study

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in a temporal perspective. History always views and places the issues under study in the context of time and region.

On the other hand, environmental history can be defined as a historically documented account of the life and death of various living creatures, such as humans and other species, in relation to their environment (Grove, 1998). Basically, environmental history has three areas of study, including the physical environment, economic modes of production, and ideology or socio-cultural values and attitudes towards the environment in the past and its transformations, such as forests, mountains, rivers, and beaches (Worster 1988). In this context, the relationship between humans and the environment can be interpreted as changes in the natural environment or the conversion of land use by humans, thereby altering the natural landscape. Essentially, environmental history has two core tasks: revealing the strengths and limitations of hybrid transitions. The first task is to incorporate environmental causality into historical narratives. Environmental historians have long argued that nature plays a very important role in human affairs; in fact, some refer to nature as an agency (Sutter, 2013).

In this study, the Bagelen region (during the Dutch East Indies period) was chosen as the object of research because, first, no one has specifically studied this region in terms of natural changes in the context of environmental history. Furthermore, the time frame of this study begins at the end of the 18th century as the initial stage of explaining the landscape of Bagelen. Then, after the Java War in 1830, there began a stage of land use change. The study will end in the 21st century in 2024, because in that year there is the latest data related to forest area as part of the research object.

In reports from Dutch East Indies archives, Bagelen is geographically located on the southern coast of Central Java. It lies between 109° 12' and 110° 11' east longitude and between 7° and 7° 57' south latitude. This residency borders the Kedu Residency and the Sultanate of Yogyakarta to the east, while to the north it borders the Pekalongan and Semarang Residencies. To the west lies the Banyumas Residency, and to the south it is bordered by the Indian Ocean and Tegal. The Bagelen region covers an area of approximately 3,831 km².

Before Bagelen came under colonial rule, and also before Mataram split into two; the Sultanate of Yogyakarta and the Sunanate of Surakarta, Bagelen was part of the grand state (*negaragung*) of the Mataram Sultanate, which was centered in Yogyakarta. However, after the signing of the Giyanti Agreement on February 13, 1755, between the Dutch *Vereenigde Oostindische Compagnie* (VOC) on one side and Prince Mangkubumi on the other, Mataram was divided into two powers: the Sultanate of Yogyakarta and the Sunanate of Surakarta, so that the geopolitical structure of the division of power at that time was quite complicated. There were several districts in Bagelen that were under the authority of the Sultanate of Yogyakarta, and there were some districts in Bagelen that were part of the Sunanate of Surakarta. Then, after the political contract of September 27, 1830, as a result of the Java War, there was a transfer of *nagari*, namely the separation of coastal areas from Mataram's rule. Including foreign territories, in this case Bagelen was also part of that territory, as a consequence of the defeat in the Java War. The Bagelen Residency at that time consisted of the districts of Purworejo, Kebumen, and Wonosobo. Bagelen remained a residency only until August 1, 1901, because from that date onwards, the Bagelen residency was merged with the Kedu residency.

During Dutch colonial rule, there was a reforestation program. This area was managed regularly in 1875 with the establishment of the Kedu Bagelen Banyumas forest district. In 1893, this district was divided into two, namely East Kedu Bagelen (with the Purworejo and Wonosobo divisions) and West Bagelen Banyumas. Starting in 1898, the Bagelen forest formed a separate forest district until 1920. Since then, this district has been merged with the Banyumas forest district. This study will examine changes in the landscape or land use, from agriculture to plantations, then to forests, and finally to mixed use.

In this research, the title "Apothem of Bagelen Land in the 17th-21st Centuries: Agriculture, Plantations, and Forestry" was chosen because the term apothem was considered suitable to describe the changes in land use in the Bagelen region from the 17th

century to the present. Apothem is a term from mathematics that means a line segment connecting the center point to the midpoint of one side of a plane or the center point to the chord of a circle at a right angle. In this case, the center point can mean the land in Bagelen, while the other point or side is the change itself from agriculture to plantation, then forestry, and back again to plantation or agriculture. The circle that forms the space for the apothem is Bagelen itself, a circle that has no beginning or end, but as long as the circle keeps turning, change will always occur.

1.1 Literature Review

The first literature review in this study is *First Along the River: A Brief History of the United States Environmental Movement* by Benjamin Kline. This important book traces the development of environmental awareness in the United States from the colonial era to the modern age. Kline describes the dramatic shift from the colonists' initial view of nature as a commodity to be conquered to the emergence of the conservation movement in the 19th century. The book highlights the roles of early figures such as John Muir (preservation) and Gifford Pinchot (utilitarian conservation) in shaping public policy regarding national lands. These books highlight the 1960s and 1970s as a crucial turning point. The publication of Rachel Carson's *Silent Spring* and the celebration of the first Earth Day in 1970 sparked mass awareness that led to the establishment of strict government regulations, such as the creation of the Environmental Protection Agency (EPA). Kline critically examines how environmental issues have consistently clashed with partisan political interests and corporate economic growth. He demonstrates that every green regulation almost always faces significant resistance from the industrial sector, which prioritizes short-term profits. Overall, this book is highly recommended as an introductory text because it successfully presents the complex history of the environment in a chronological, concise, and easy-to-understand manner.

Next is *A Green History of the World* by Clive Ponting. This work is one of the pioneering works in environmental history. The book analyzes the history of human civilization from an ecological perspective, showing how societies throughout history have tended to exploit their environments to the point of exceeding the carrying capacity of ecosystems. Ponting challenges the conventional historical narrative that views human history as a path of unending progress. Instead, he argues that the material success of civilization often comes at the cost of long-term ecological damage. The Easter Island Metaphor: Ponting opens his book with the story of Easter Island as a microcosm of the entire planet Earth. He explains how the island's society collapsed socially and demographically after it deforested the island to make way for agriculture and the transportation of giant statues (Moai).

Ponting divides human history into two major turning points: the Agricultural Transition, the shift from hunting and gathering to farming, which triggered a population explosion but also led to early soil degradation and the Industrial Transition the shift to the use of fossil fuels, which multiplied humanity's ability to exploit nature while simultaneously creating a global pollution crisis. In the field of historiography, Ponting's book is considered to have several key strengths, including an interdisciplinary approach: Ponting successfully integrates history, ecology, archaeology, and economics to construct a coherent narrative. Another strength is a paradigm shift, as the book shifts the focus of history from political figures or military power to the material relationships between humans and energy/natural resources. Furthermore, there is its accessibility: Ponting writes in a straightforward style supported by strong empirical data (such as figures on energy consumption and deforestation), making it understandable to both professional historians and general readers.

A Green History of the World remains a crucial foundational text. Ponting's greatest contribution is debunking the myth that the environmental crisis is a modern phenomenon that only emerged after the Industrial Revolution. This book demonstrates that the roots of

today's ecological crisis are deeply embedded in the history of human civilization's thought and way of life.

The next work reviewed is Oliver Rackham's *The History of the Countryside*, one of the most influential works in the field of environmental history. This book has transformed the way we view the rural landscape, particularly in England, by treating it as a living, ever-changing historical document. Rackham argues that the countryside is not an untouched wilderness, but rather the result of thousands of years of interaction between human activity and natural processes. The modern landscape preserves a physical archive of past agricultural, forestry, and land-management practices. He divides the English landscape into two broad categories: the Ancient Countryside and the Planned Countryside.

Ancient Countryside: Characterized by winding roads, ancient forests, and irregular field boundaries, reflecting organic growth dating back to prehistoric times. Planned Countryside: Characterized by straight lines, uniform hedgerows, and geometric layouts resulting from the Enclosure Acts of the 18th and 19th centuries. Rackham's greatest contribution lies in the interdisciplinary approach he pioneered. He combined various disciplines to reconstruct the history of the landscape. First was Botany and Ecology; he used the presence of specific indicator species (such as certain herbaceous plants) to identify whether a forest was ancient or recent. Next was field archaeology, in which he examined physical features on the ground such as earthworks, ancient ditches, and remnants of ancient boundaries, as well as historical documents; he combined physical field evidence with ancient maps, Anglo-Saxon charters, the Domesday Book, and manorial records. *The History of the Countryside* remains an essential reference for historians, ecologists, and landscape planners. This book teaches us not merely to see the rural landscape, but to read the long history inscribed upon its land.

Finally, the book *Discovering the Vernacular Landscape* (1984) by John Brinckerhoff (J.B.) Jackson is one of the seminal works in the study of cultural geography, architecture, and regional planning. Jackson, who was also the founder of *Landscape* magazine, challenged conventional perspectives that tended to glorify monumental landscapes (such as historical monuments or city parks designed by famous architects) and shifted the focus to vernacular landscapes, everyday spaces shaped by the activities of ordinary people.

Jackson's greatest contribution in this book is his deconstruction and redefinition of the term landscape. He divides it into two historical and conceptual prototypes that are contradictory yet coexist. The author explains that this type of landscape is characterized by a formal, permanent division of space with clear legal boundaries. This type of landscape is typically initiated by authorities or the state for the purposes of social, political, and economic control. Examples include geometric urban planning, national highway networks, and public monuments. Then there is the landscape that emerges organically from the bottom up. This landscape is adaptive, temporary, and rooted in practical daily functions and local culture. Their main characteristic is the absence of a rigid adherence to formal territorial boundaries; spaces change function as community needs evolve (for example: dirt roads, adaptive informal settlements, or pop-up markets).

The writer rejects the notion that only landscapes that endure are valuable. He defends temporary architecture (such as wooden stilt houses, mobile homes, or roadside convenience stores) as a reflection of America's dynamic and mobile culture. In this regard, the vernacular landscape possesses its own sacredness, which does not stem from formal religious rituals but rather from a sense of community (sense of place) and the social spaces where people interact. Jackson views the road not merely as infrastructure connecting point A to point B, but as a vibrant vernacular public space, complete with billboards, gas stations, and motels that shape the identity of American modernity. *Discovering the Vernacular Landscape* remains a must-read because it offers a new lens through which to view the world around us. This book teaches us that even the most ordinary built environments, which we often pass by without a second thought, are actually full of messages about who we are, what we value, and how we interact as social beings.

2. Methods

The methods used in this study are historical approaches and natural science approaches related to ecology, such as botany. Basically, historical studies or research cannot be separated from historical sources. Leopold von Ranke's adage, "no document, no history," explains that without documents or written materials from the past, it is impossible or difficult to reconstruct history. The historical method approach in this study included a literature study covering data related to the landscape, types of plants grown, soil construction, and rice fields or plantations in the Bagelen area, followed by morphological analysis.

First, a literature study was conducted to search for data in the form of archives, newspapers, and visual data related to changes in the landscape of the Bagelen region. Data related to the research object can be found at the National Library of Indonesia, the National Archives of Indonesia, or websites that provide data information such as Delpher, Royal Netherlands Institute of Southeast Asian and Caribbean Studies/*Koninklijk Instituut voor Taal-, Land- en Volkenkunde* (KITLV), and others. Next, morphological analysis is used to observe natural changes in Bagelen from one period to the next. In addition, other disciplines such as archaeology, linguistics and anthropology were also used in reconstructing all sources in this study.

The methodology used in this study is often referred to as the Holistic-Ecological Historical Methodology or the Biocultural-Historical Approach. This approach is highly effective for reconstructing ancient history, the origins of civilization, human migration, and environmental history. This methodology works by dividing the research process into four pillars of complementary disciplines, with History serving as the common thread that weaves all findings into a single, coherent chronological narrative.

Several scientific disciplines are employed: first, archaeology, which identifies physical remains of human activity (in this study, statues). Archaeology provides absolute evidence of when (through carbon dating) and where an event or culture once existed. Next is botany/archaeobotany (environmental & subsistence dimensions), which analyzes phytoliths (plant silica), fossil pollen, and wood charcoal remains. This helps answer questions about past climate conditions, which plants were domesticated, what people ate, and how they altered the natural landscape. Next, anthropology/ethnography (social & behavioral dimensions) to understand social structures, belief systems, and work organizations. Through ethnoarchaeology, we can compare the behaviors of contemporary traditional societies to understand the functions of archaeological tools from the past. Then, linguistics / historical linguistics (cognitive & migration dimensions) analyzes language genealogy and reconstructs proto-languages. If a group of people shares the same proto-word for "rice" or "boat," linguistics can trace migration routes and kinship ties among ethnic groups.

3. Results and Discussion

3.1 Bagelen as an agricultural and plantation area

The name of the Bagelen region is related to the indigenous people of the area who worshipped the god Shiva. There are clear traces of this in the caves of the *Koetå Ardja* temple, particularly the lingga pillars. The part of the body represented by the lingga is called *Pagelèn* in the Kawi language. The local people at that time referred to their place of residence as *Pagelèn*, but sometimes as *Bagelèn*.



Fig. 1. Godenbeeld: Shiva - Siwa Mahadewa (800-900)
(Wereld Museum, n.d.)

Figure 1 It is a statue of Shiva that was found in the Bagelen region in 1903. Anthropologically, there is also a folk tale or legend that explains the origin of the name of this region. The legend explains that in the past there was a nobleman named *Awoe-awoe Langit* who settled in the Kelir mountains. As a farmer, he married a woman named *Njai Roro Renganis*, better known as *Njai Bagelèn*. and they were blessed with two children. However, due to a mistake made by the father, one of their children died, causing a quarrel between *Awoe-awoe* and *Njai Roro Renganis*, which ended with *Awoe-awoe* leaving with their surviving child. *Njai Roro* was very disappointed with this situation, and her disappointment never improved until the end of her life. *Roro Renganis* died in the area where the lingga was located, so the local community named the place *Pègèl*. Meanwhile, *Pagelèn* or *Bagelèn* is a form of the word *Pègèl* in ancient Javanese (Veth, 1882).



Fig. 2. Map of Bagelen on the island of Java during the Islamic Mataram period
(Veth, 1882)

The name Bagelen first appeared during the Islamic Mataram Kingdom, around the 16th century. At that time, Bagelen was an agricultural area. The majority of the indigenous population on the island of Java in the past made their living from agriculture, while a small

number lived from small-scale trade and fishing, or worked in industry. Those who worked in agriculture were called *ahli*, *djeroe*, *wong* or *djelma tani*, while Javanese people who ran *tatanen* businesses were also called *tani* (De Bie, 1901). Rice fields were most commonly found in lowland areas. Agriculture in the Java region often forms a continuous whole, only occasionally interrupted by local settlements. Then in the mountainous region, at an altitude of 1,200 to 1,250 meters above sea level, there is a piece of land that, considered profitable, has been converted into rice fields for regular irrigation. Due to the uneven terrain, the rice fields often consist of small, narrow, irregular, and high terraced plots. In Central Java, such as in the Bagelen area, these rice fields are called *pangempangan*, which are rice fields with depressions in the ground so that water can easily flow from the surrounding higher areas and be dammed without much difficulty. Then there are *balong* rice fields that have dams or *tambakan*, which function to store water, while the water is used as a pond. In terms of land ownership, it is often passed down based on inheritance rights (Niermiej, 1918).

The majority of Java's soil consists of reddish soil, as evidenced by most of the reclamation projects built on hillsides. Water flowing from highlands to lowlands carries various types of fertilizer and mud deposits, which settle here and there. Water also accelerates the weathering of plants and plant parts that are already on the land. Over time, these dark substances mix with the original soil, gradually making it appear darker and also helping to increase its fertility. Therefore, the Dutch East Indies government was interested in the land in Java because it could be used as a testing ground for planting. In the eyes of native Javanese farmers, the general rule is that dark-colored soil is of better quality than lighter-colored soil. The majority of commodities grown by farmers in Java, such as in the Bagelen area, are rice, banger, corn palms, corn, and bamboo.

After the Java War, in 1830, there was a political contract called the Klaten Agreement, which was signed after the end of the Java War. The agreement aimed to reaffirm the boundaries and territories between the Sultanate of Yogyakarta and the Sunanate of Surakarta. Under the treaty, the Kedu and Bagelen residencies became the property of the Dutch East Indies government. After acquiring the territory, various crop cultivation experiments were conducted (Krooneman, 1860), including tea, which was quite popular.



Fig. 3. Map of Bagelen during the Dutch East Indies period (Veth, 1882)

In 1833, Jacobson (a botanist working for the Dutch East Indies government) obtained a number of new tea seeds from China to test planting in Bandung. Jacobson then served as the Government Tea Culture Inspector and continued his experiments in fourteen provinces in Java, one of which was the Bagelen region. Most of these experiments were unsuccessful, except in the Bagelen region, although there were still several areas that were suitable for

agriculture. Due to the many failures and losses in various regions related to tea cultivation by the Dutch East Indies government, the government tea plantation was canceled in all regions in 1842, except for a few areas, one of which was Bagelen, which was leased to the private sector. The tea cultivated in the Bagelen region has a high reputation and is used for good blends.



Fig. 4. *Het huis van de Secretaris in Purworejo in de Residentie Bagelen op Java* (1845) (Wereld Museum, n.d.)

Figure 4 is a painting by R.R. Toelaer, depicting the secretary's house in the Bagelen residency in 1845. Although tea prices rose in the 1840s, tea cultivation continued to be unprofitable for the Dutch East Indies government. The quantity produced remained too small. After deducting import duties and all sales costs in 1852, tea auctioned in Amsterdam yielded an average of 83/100 per half kilogram in 1861. As supply increased, the quality generally fell short of expectations; only a few leading companies in Preanger Regency (Bandung) and in the Bagelen region produced products suitable for the best blends. Tea from these few companies had a luxury reputation in the market for a long time (two companies maintained that reputation for years), but most of the typical Javanese tea lagged behind the higher quality Chinese tea (Indologische Studien aan de Rijks Universiteit te Utrecht, 1924).

3.2 Exploitation of timber commodities during the dutch east indies era

Forest logging contracts had actually been in place since before the 17th century. The Dutch East India Company entrusted all forest exploitation activities, particularly teak, to the private sector. Europeans, especially private entrepreneurs, were able to see the economic benefits of forest exploitation, particularly teak, because it was considered to be of higher quality than oak. In this case, teak forests were successfully controlled by the VOC in the 17th century in the Rembang Residency (Warto, 2001). It began with an agreement between the VOC and the Javanese rulers who often fought for power. The VOC provided assistance to the Javanese king in exchange for part of the territory on the island of Java. This then led to the exploitation of timber, particularly teak, as evidenced by the use of teak wood for the shipbuilding industry in the Tuban region (Simon, 2010).

After the VOC went bankrupt, all teak forest ownership, especially in parts of Java, was transferred to the Dutch East Indies government. In addition to teak, various types of wood were exported to various European countries. One of the reasons why wood from the archipelago was a valuable commodity was because it was strong and resistant to teredo

navalis or shipworms in areas close to water, such as the coast (Sturler, 1866). In this case, teak and walikukun were the most sought-after types of wood. The durability of wood from the Dutch East Indies for decades without major repairs made this commodity highly sought after by foreign countries. There were various types of native Javanese wood that were in high demand and exported to Europe during the colonial period.

The first is *Behlo-itam* (*Cargilia maritima* Hasskl.), which belongs to the Ebenaceae family and is found in Borneo, Manado, Ambon, Sapaoea, on the small island of Kangiang east of Madura, and in Java. This tree grows very densely in Maluku, with a trunk one meter thick. Another name for *Behlo* is *Kesambi* (*Stadmannia sideroxylon* DC.). This tree species is commonly mistaken for Ebony (*Maba ebenus* R. Br.), which is actually related to it. The wood is hard and strong, dark brown in color with brown flames and fairly straight grain. The indigenous people use it to build houses and make furniture. This wood is easy to work with, despite its hardness, and is very suitable in Europe for making table tops and cabinets. Its specific gravity is 1.258. Next is *Koelit-bawang*, *Ki-bawang-bodas* in Sundanese (*Trichilia*), which belongs to the Meliaceae family. This tree is found in Maluku and also in Java. It is rather heavy and its bark smells like garlic, as its name suggests. The wood, although not very dense in texture, is excellent for house construction and is easy to work with. Its specific gravity is 0.493.

Then there are Bintangur, Nyamplung, Pěnaga or Kapoor ratjang (*Calophyllum inophyllum* Linn.), which belong to the Clusiaceae family. These trees are very heavy and grow along the coast and in lowlands. Ship masts in the 19th century were made from this material and although it is very stiff and knotty when worked, this wood can still be processed well with good equipment into furniture. In addition, there are still many types of wood found in Java, including *Ki putri* (*Podocarpus* spp.), *Sono Kembang* (*Pterocarpus indicus*), *Jati* (*Tectona grandis*), *Walikukun* (*Schoutenia ovata*), *Ki Hiang* (*Albizia procera*) and others. Basically, there were around 120 types of wood from the archipelago that were exported by the Dutch East Indies government (Sturler, 1866). Due to the high demand for wood commodities, and the Dutch East Indies government feeling that it was more profitable to trade in wood and several other plants, plans for the reforestation of Bagelen were finally made.

The Bagelen reforestation was carried out in four stages. The first stage took place from 1875 to 1889, where the main focus was on planting seeds and maintenance. The second period involved hydrological improvements from 1890 to 1900. The third period, from 1900 to 1918, saw the replanting of old, damaged plantations and the clearing of some areas for the cultivation of wild timber. Finally, from 1918 to 1925, the planting carried out in 1875-1900 was changed to large-scale planting that promised more direct timber or forest product yields.

3.3 Bagelen reforestation 1875-1925

Reforestation in the Bagelen area began with the planting of *Myrica javanica* and Eucalyptus trees on Mount Sumbing and Mount Sindoro. Only ordinary soil types were deliberately chosen, and by the end of August 1876, around 2.5 hectares had been planted with 1,709 Eucalyptus trees. However, the planting on Mount Sumbing failed, while reforestation on Mount Sindoro was successful because it was considered more profitable. The Dutch East Indies government reported a shortage of wood, especially good quality wood, from Bagelen in various service and industrial sectors. Therefore, the government brought in a forestry expert named Seubert, A.K.L.M., who helped create extensive planting for the future.

In mountainous areas, these trees grow within 20 years, while teak trees are cultivated in lowlands. This planting was done for the sake of ease of transportation. In 1877, Seubert began building a teak plantation in South Bagelen (Karanganyar Regency above Gombong). This location was specifically chosen for the cultivation of sungu teak, as this type of teak was found there. It is likely that sungu teak was imported. The teak plantation was planned to be built in Bagelen, with seeds supplied from the Semarang and Rembang areas. He then

expanded the teak plantation area to other regencies in South Bagelen (Purworejo, Kutoarjo, and Kebumen).

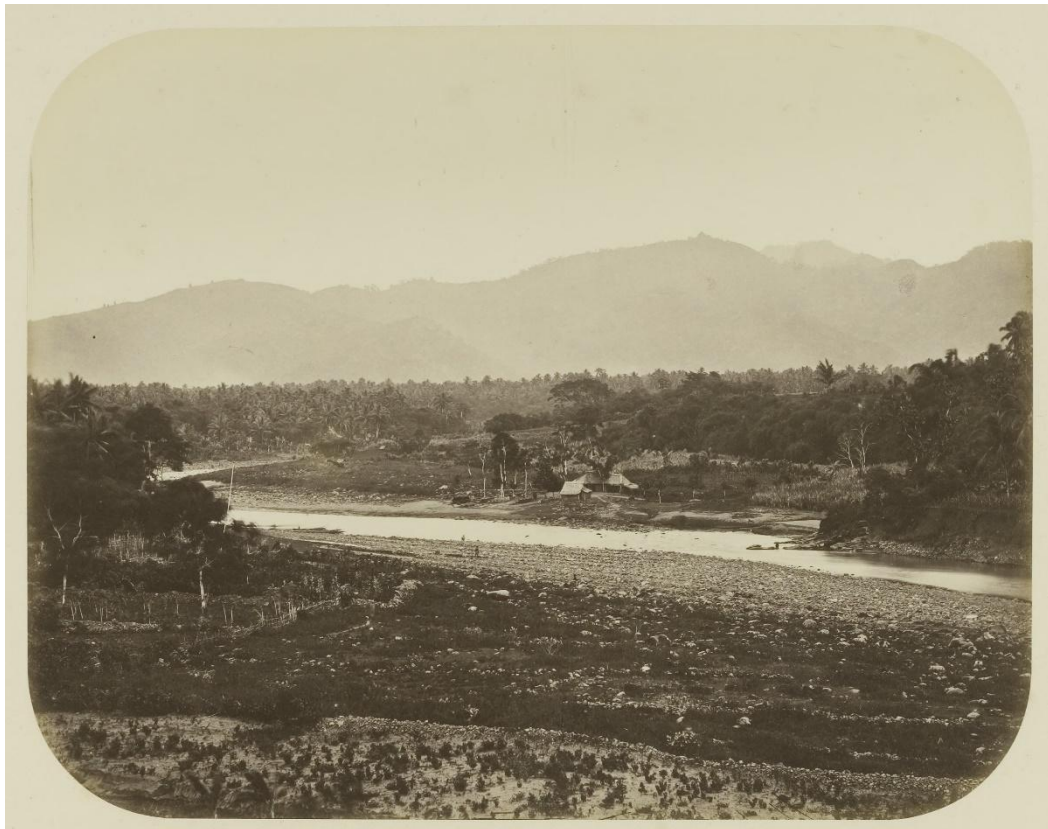


Fig. 5. Rivierlandschap te Bagelen in de buurt van Poerworedjo (before 1880)
(Woodbury & Page, n.d.)

Figure 5 is a portrait of the Purworejo region landscape before 1880. In the photo, there are many trees and land to be planted. Then in 1880, above Kutoarjo (Gunung Krikil complex), the *Albizia moluccana* plantation that had failed was taken over, saved, and expanded with teak. During the implementation of the first phase of reforestation in the Bagelen region, a considerable number of seeds were planted in the lowlands and mountains of the region. The following is a table of the seeds planted in the first phase.

Table 1. Number of plant and tree species cultivated in the first phase

Year	Number of seeds
1876	16 type
1877	5 type
1878	9 type
1879	58 type
1880	25 type
1884	40 type

(Zwart, 1927)

During the reforestation process, the period from 1878 to 1879 saw the most tree planting, namely *Eucalyptus globulus* Labill. (14,310 trees), Surian (*Toona sureni*) (29,000 trees), Weru (*Albizia procera*) (36,000 trees), Mlandingan gunung (*Paraserianthes lophantha*) (72,000 trees), Sapen (*Artocarpus elasticus*) (72,790 trees), Kina (*Cinchona* spp.) (4,550 trees) and other plants, totaling 233,420 trees (Zwart, 1927), which were planted in various areas depending on the soil and terrain, such as on the Dieng plateau near Lake Wema, where there were about 11 hectares of *Eucalyptus globulus* plantations mixed with Mlandingan gunung (*Paraserianthes lophantha*). In 1881, many teak (*Tectona grandis*) and Johor (*Senna siamea*) trees were planted in the lowlands, but in the following season, the

teak trees died. Initially, reforestation was only carried out on the eastern slopes of Sindoro, then in 1886-1887 it was planned to carry out reforestation on the western side by empowering the people of Bagelen if they wanted to cultivate wood among their crops. Seubert cultivated teak forests on a daily basis, employing 300 to 400 laborers (residents) for the planting. In addition to teak, cinchona was also cultivated. Then, during planting in the Dieng region (1878), a pattern of 720 holes, each measuring 2 square feet and 0.6 meters deep, was made to plant eucalyptus, and another 720 holes, each measuring 2 square feet and 0.6 meters deep, were made for mountain mlandingan plants. Meanwhile, *Myrica javanica* plants were planted 4 feet apart.

In the 1888-1889 planting year, De Graaf, a government forestry expert, began reforestation in other areas solely for hydrological purposes (the function of forests as water regulators, such as absorbing, storing, and releasing water regularly). This was done in Loano District (2,000 hectares) and in Cangkep (1,000 hectares). Planting was then carried out in Ngadipolo (east of the Bogowonto River), Kaligepoek, and in the Cangkep mountains on the Bagelen-Yogyakarta border. In 1889, these areas were expanded, and work began in Sipetoeng (on the western slopes of the Sindoro River), as well as in the subdistricts of Sapuran and Kaliwiro. In 1890, reforestation work in North Bagelen in terms of expanding teak cultivation was halted for economic reasons. Only in the Soka district (Kebumen) was it permitted to continue expanding. Based on statements in the archives, teak cultivation was still being expanded on 114.50 hectares of land in 1890-1891, while the rest, until 1894, only replanted dead trees.

Table 2. Area of several reforestation areas in Bagelen from 1875 to 1894

Name of region	Areas in hectares reforestation
Sindoro	261
Dieng	11
Praoe	-
Sumbing	2
Ngadipolo	70
Kaligepoek	35
Cangkep	163
Sipetoeng	36

(Zwart, 1927)

Then, for the successful planting of teak trees throughout the Bagelen region until 1891, there were 1,537 hectares of teak land. In addition to planting crops, hydrology was also carried out during the second period of reforestation. The hydrological function of forests clearly shows that the greatest role is played by humus (dark-colored, nutrient-rich organic matter formed in the soil from the decomposition or breakdown of dead plant and animal matter by microorganisms). In addition, tree roots also allow water to penetrate deep into the soil, into the nutrient reservoir of springs. Dutch East Indies botanists attached great importance to high humus content and the humus layer on the soil. In order to address long-term water issues in the soil, *Albizia* trees were planted. These trees can act as soil conditioners. When planted on a large scale, *Albizia* can be harvested after 20-25 years for renewal. This plant species has the ability to penetrate dense soil layers with its long roots. It is suitable for supplying firewood and timber quickly, and in mixed plantations, this wood can last for about 10-15 years, during which time other types of wood will be available.

Next, in the third period, the Dutch East Indies government planted cinchona, rubber, and other crops in several locations that had not yet been reforested. Such as the planting in the Kaliwiro area, where no less than 246 hectares of pure rubber land were built in 1904, 205 hectares in 1905, and another 97 hectares in 1906. The reason for establishing these rubber plantations was the disruption experienced by residents due to the wild forest reforestation project in the second period. In the Kaliwiro district, several small reforestation plots ranging from 8 to 30 hectares were located in the middle of residents' land.

Wild pigs can easily hide in these gardens during the day and damage residents' plantations at night (Zwart, 1927). After 1906, there were organizational changes in the forestry department, so planting was halted and resumed in 1911. Aibizia plants were replanted in the Watoetoetoe complex. In 1912, there were plans to establish 10 hectares of Hevea cultivation on the site of a failed rubber plantation. A similar experiment was conducted in 1913 in the Sumbing complex (Potorono). However, the costs were so high that there were no further plantations of this type. In 1913, an additional 43 hectares of wildwood plantations were established, replacing the Hevea plantations that had originally been planned at locations where *Ficus elastica* had previously failed. The fall in rubber prices was the reason why wildwood was ultimately planted instead of Hevea.

Basically, most reforestation areas are located at an altitude of 300–500 meters, except for some cultivation in Sindoro-kembang (around 2,000 meters above sea level) and cultivation in Potorono (1,000 meters above sea level). The soil quality is generally better than in the second period, because the extensive eagle moth cultivation area was built on land that had been planted with Albizia for approximately 10 years. The silkworm cultivation area in Kedander was built on teak forests that had been completely cleared during the cultivation system period. Due to its location close to the village area, the forest was likely grazed by livestock at that time. The silkworm cultivation area in Ngadipolo was also built on land with abundant livestock grazing areas.

The 1904 wild timber plantation in Kaliwiro District was partly established on abandoned coffee land (Tlogomelum complex) and land burned during the second period (Beser complex). The Watoetoetoe plantation in 1911, Sumbing in 1913, and Sindoro in 1914 were also established on former plantation land. From 1913 to 1918, there was no further cultivation of wild timber in Bagelen. Then, in early 1918, around 600 plots of land, most of which had previously been reclaimed secretly, were reclaimed for planting, as the planting contract had to be completed by September or October 1918. From 1918 to 1920, it was evident that the allocation of scattered forest land was the only way to convert most of the forest land with sparse vegetation into timber-producing crops in a relatively short period of time.

Of all types of wood, teak grows most abundantly in the Bagelen region at an altitude of around 400 meters, and with good fire protection, wild shrubs in the rainy climate become so dense that their hydrological function is more than adequate. The 1921 annual report noted that reforestation of barren or low-vegetation areas was carried out for hydrological reasons. However, there was a secondary objective, namely the selection of these areas because deforested areas in regions that had already experienced a shortage of wood were a major consideration. This wood shortage was so severe in the mountains that almost all accessible forests had been plundered, so there was no need to look for areas for reforestation, but only to determine where cultivation was most urgent, so that with limited resources, the largest areas could be reforested first.

In 1921, the Binnenlandsoh Bestuur in Wonosobo began promoting the planting of firewood in tobacco plantation areas. Then, in 1922, the government in that department also promoted land allocation through planting contracts. No less than 1,100 plots of land were requested in the subdistricts of Kaliwiro, Wiadaslintang, Krasak, and Bruno. In 1924 and 1925, efforts were made to locate reforestation sites as close as possible to future sales centers, especially around Kebumen (South Lokoelo complex), Purworejo, and Wonosobo. The Benowo cultivation area in 1924 and 1925 was also established almost solely for the purpose of supplying wood in the future to the surrounding areas. During the implementation of reforestation by the Dutch East Indies government, this was carried out using two labor models, namely contracts with native coolies and contracts with private parties as field implementers.

Table 3. Total land area reforested in Bagelen

Region	Kuli bumiputra	Corporate	Total
East Bagelen	8,665 hektar	3,257 hektar	6,922
West Bagelen	570 hektar	3,596 hektar	4,166

(Zwart, 1927)

The total area reforested was 11,088 hectares. East and West Bagelen covered Kedu, Purworejo, Wonosobo and Banyumas, with various types of trees and plants. After reforestation, only maintenance and sales transactions were carried out by the Dutch East Indies government. After the reforestation process went according to plan, the landscape in Bagelen was divided into three types of land, namely agriculture, plantations, and forestry, which included residential areas. In this case, the Dutch East Indies government simply reaped the benefits of everything that had been done, both in the forestry, agricultural, and plantation sectors in the Bagelen area, however, treatment is not always easy.

In 1934 drought and uncertain rains had an impact on various kinds of crop cultivation, such as in the side region (Kemiri Purworejo), the number of affected trees remained around 130,000 trees, of which 60,000 could not produce at all due to peanut waste. Then in the Keduren (Djenar) region, the number increased from 12,000 to 12,500 trees, of which 8,000 trees could not produce at all, in both regions, there were many parasites.

The same is true in the Wirogaten (South Premboen) region, where the number of trees remains constant at 3,000-4,000. furthermore, in Sidoluhur (South Koetowinangoen), there are about 9,000 trees. In Buluspesantren (South Kebumen), diffuse infection remained constant at 4,500 trees. Then in the region of Asinan (South Premboen) also affected by the plague. In the outbreak of Balorejo (South Premboen), a detailed inspection was only in early September 1934 that showed that the situation had improved so much that re-pollination was no longer necessary. This also happened in the Wonodadi area (south Butoeh). Hide. Furthermore, in Pangenredjo (Purworejo) remained constant at 4500 trees, while in Grabag, rice beds were significantly affected by rat damage. Caterpillars caused considerable damage to cabbage in Grabag and Wonosobo. In addition, potato plantations in Rledoeng were severely affected by scab and caterpillars, while in Wonosobo, considerable damage was caused by shingles.

Although some areas are affected by pests, for the agricultural sector quite good results are achieved. From the beginning of the month to August 1934, there were 205,399 paddy fields harvested. Rice krreteg also almost entirely harvested in Magelang, as well as rice paddies Temanggung. In Bagelen Utara, harvesting has begun, while in Wonosobo, the plant has just begun weeding. The harvest is satisfactory. In irrigated rice fields, tillage for paddy field crops has now begun everywhere, while the construction of seedbeds is not going well. In Bagelen, as a result of the drought, the construction of dry seedbeds took place on a much larger scale than usual. Then in the plantation sector the results obtained are not good, but also not bad. For example, young corn plantations, such as the Tegal region, among the almost exhausted tobacco plantations in the high mountain regions of Wonosobo and Temanggoeng, thrive thanks to little rain. The planting, which was about three months old in Geroet Sewoe, South Bagelen, in the high mountain region of Wonosobo, and in North Temanggung, went well. However, harvests in North Bagelen and South Wonosobo were disappointing due to severe drought, while young plantings in Grabag were also in fairly poor condition.

Furthermore, tobacco plantations, from early January to late August 1934, the Harvested Area reached 2,984 hectares. In the Tegal, Wonosobo, Temanggung, and Grabag regions, the harvest is underway, and yields are generally good. Harvesting in the rice fields is also underway, producing a good harvest in Temanggoeng, although most of the harvest in Bagelen is very disappointing due to drought. One year later the rice harvest in Bagelen was satisfactory, there is a report from January 1 to the end of May 1935 that the rice harvest in Bagelen reached 122,841 tons. Along with the development of the times and technology, this also had an influence on landscape changes due to the need for land for infrastructure development to support the economy.

3.4 Bagelen after reforestation to date

After independence, the landscape continued to transform, with land conversion from forest to plantation and agricultural land becoming inevitable. The surge in Indonesia's population has had an impact on land conversion, as was the case in Wonosobo at the beginning of the 21st century. In the village of Dieng, there is a protected forest area covering 359.6 hectares. Of this area, 205.8 hectares are used for yards and fields planted with potatoes, and 2 hectares are used for settlements. This means that 207.8 hectares, or 57.8% of the total protected area in the region, has been converted due to the increasing population and decreasing amount of land (Reni, 2007). With an increasing population, there is a growing demand for land (for housing and food). On the other hand, land area is limited and cannot be expanded, leaving rural communities with no choice but to clear new land in forest areas to meet their needs.

Land use change from forest to plantation or agricultural land with land management that does not follow soil and water conservation principles will result in reduced land cover vegetation, leading to soil degradation problems, especially in tropical and subtropical areas (Holthausen, 2018). The fading of land cover affects direct sunlight, especially during the dry season. This has a negative impact, namely the rapid decomposition of organic matter (on the surface and in the soil), which changes the soil's organic carbon stock and nutrient availability (Shaheen & Matien, 2016). All of these processes result in a decline in soil physical quality.

Then the rainwater that falls will fall directly onto the soil surface. This is due to the small amount of vegetation covering the soil surface. As a result, soil aggregates become dispersed, soil pores are covered with fine particles, so that the rate of water entry from the soil surface or infiltration decreases, causing surface water flow to increase. There are quite a number of studies on the impact of converting forest land to agricultural land, which causes a decline in the physical properties of the soil (Song & Liu 2017; Naharuddin 2018). The conversion of forest land to agricultural land involves many complex factors, which have a certain influence on soil properties (Assefa 2017 & Veldkamp 2020).

Soil degradation has dangerous impacts on humans, one of which is landslides. These disasters are exacerbated by land use changes. A combination of anthropogenic and natural factors often causes landslides that result in loss of life and material damage (Naryanto, 2017). In 2016, there were 35 fatalities, 25 missing persons, and 14 injuries due to floods and landslides in the Bagelen area (Central Java). Of the total number of fatalities, 19 were in Purworejo Regency, 25 were missing, and 11 were injured; in Banjarnegara, 6 were dead and 3 were injured; in Kebumen, 7 were dead; in Sukoharjo, 1 was dead; in Rembang, 1 was dead; and in Banyumas, 1 was dead.

Based on information from the Wonosobo District Disaster Management Agency (BPBD), from March 9 to March 17, 2022, there were a total of 103 landslide disaster sites spread across seven subdistricts, namely Kepil, Sapuran, Kalibawang, Kaliwiro, Wadaslintang, Mojotengah, and Garung. There has been a reduction in forestry land, which has been replaced by plantations and agriculture, or settlements. This can be seen from the data of the central statistics agency for each region that was formerly part of Bagelen. For example, the area of forestry in Kebumen based on 2021 data was 44,532 hectares, and in 2024 it will be 17,127 hectares. Banyumas had 25,789 hectares, Wonosobo had 13,918 hectares of forest in 2021 and only 9,746 hectares in 2024, and Purworejo had 8,545 hectares. This means that there has been a conversion of land use from forestry to other purposes.

4. Conclusions

This study found that the landscape transformation process in the Begalan region from the 18th to the 21st century describes how the land in this area of Central Java has been used. Starting with agriculture in the past, geopolitical issues then had an impact on land ownership by colonial powers, resulting in a change in function to plantations and forestry.

After independence, forests began to be cleared for economic needs, both state and private. Currently, the problems of overpopulation and decreasing land for housing and food have resulted in the conversion of forest land into settlements and plantations. However, the lack of proficiency in the transition process, which does not follow the principles of soil and water conservation, has resulted in soil degradation, which has become the main contributor to landslides after natural causes. Therefore, if we are forced to change the function of the land again, it is very important to know the rules or knowledge about land, water and environmental problems, besides that, other options or alternatives can be done as a form of handling the large population and lack of land.

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