Overview on Vetiver Technology Applications in Indonesia
(Case Studies: West Java, East Java, East Kalimantan and Papua)

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ABSTRACT

In line with the phenomenon on global warming and climate changes, construction of public work infrastructure and housing are faced with the challenge of erosion and landslide disasters. One of erosion and landslide countermeasure technologies has been developed is the Vetiver Grass Technology. The technology uses Vetiver Grass, which has a distinctive technical characteristics (rooting more than 3m), cheap, easy and fulfilling the concept of green construction. Institute of Road Engineering, Ministry of Public Works in Indonesia in Bandung is one of government agencies that has managed to develop and applied the Vetiver Grass Technology. Since 2008 till now, some product related research with Vetiver Grass Technology has been produced, either in the form of research reports, books, scientific manuscripts, prototype of full-scale testing, and standard books or guidelines. The product of development and research is expected to be useful for planner and implementers in the areas of road and bridge construction.

Since 2008 the Institute of Road Engineering has conducted extensive trials on various scales of the Vetiver Technology at several locations in Indonesia. This paper present the case studies in West Java, East Kalimantan and Papua.

Keyword: erosion, landslide, green construction, vetiver grass

1. INTRODUCTION

In line with the phenomenon of global warming and climate change, development of public works infrastructure and housing are faced with the challenge of erosion and landslide disasters. This challenge, in the future will increasingly threaten the quality of the environment. Therefore, future development policies must be able to push forward the environmental quality including development of public works infrastructure and settlement, in the planning process, implementation, operation and maintenance . Environmental and sustainable public works infrastructure must meet the characteristics of balance and equity, long-term view, and systemic. The policy of green construction, green building and green infrastructure is an effort to maintain and encourage the increase of the percentage of Green Open Space (RTH) in farming areas, maintaining conservation areas, especially in urban areas, realizing ecocity, as well as improving environmental supervision and control of the implementation aspect of public works infrastructure construction and settlement.

The most important benefit from the application of green construction is not just to protect natural resources, but also in order to realize the efficiency of energy use and minimize

environmental damage. Other benefits are considered the most important thing namely the lives and health of the community will be better, including the increasing environmental awareness of communities in supporting local economic growth and development of aesthetic values of the environment. One of the green construction technologies in the stability of slopes or roadside is vetiver grass technology. This technology uses vetiver grass which has a typical characteristic to prevent or reduce the occurrence of erosion or landslide. Vetiver System (VS) is a simple low-cost technology that utilizes living plant vetiver for soil and water conservation and environmental protection. VS is very practical, inexpensive, easily maintained, and very effective in controlling soil erosion and sedimentation, water conservation and land stabilization and rehabilitation. Vetiver, in Indonesia known as vetiver "akarwangi" (Vetiveria zizanioides) or a usar (Vetiver nigritana), is a kind of large grass that has many advantages. As an ecological plant , vetiver has a unique system of roots. This plant has massive roots that go very deep into the ground (the current record for longest vetiver roots is 5.2 meters found in Doi Tung, Thailand).Vetiver is also easy to control because they do not produce flowers and seeds that can quickly spread like wild weeds and other grass.

The use of vetiver grass technology to control erosion or slope protection already widely applied in other countries such as
Thailand, Malaysia, India, China, South Africa, Vietnam, Congo, Australia and so on. In Indonesia, the use of vetiver grass technology for the control of erosion / landslides problem , especially on the shallow slope began to be known since 2007, and one of the institutions that have developed and implemented this technology is The Institute of Road Engineering

2. RESEARCH CONDUCTED AT INSTITUTE OF ROAD ENGINEERING FROM 2008 TO 2011

2.1 The influence of Vetiver Planting Pattern on Soil Erosion Reduction

In 2008, the research focused on the capability of individual vetiver grass combined with Bahia grass in reducing the rate of soil erosion. The research was carried out on the slope of Nagreg Road in Km 43, with the inclination of slope close to 80º. Table 1 showed that planting pattern by combining vetiver grass and bahia grass (V2B1 or V1B2) is the best grass planting pattern in reducing the rate of soil erosion (99%) compared with individual vetiver grass or Bahia grass planting patterns . This erosion rate reduction was compared when soil covered by grass reached 70%.

Figure 1:
Small Scale Trial of Vetiver Grass Technology At Nagreg Road Link KM 43 – Bandung Regency
Source: IRE, 2008

Table1:
The decrease of Erosion Rate for each Treatment
Location: Nagreg KM 43 – Bandung regency

Planting pattern	Erosion reduction (%)
Vetiver Grass(V)	77,4
Bahia Grass (B)	91,8
Combination of Vetiver : Bahia grass(V1B2)	99,2
Combination of Vetiver : Bahia grass(V2B1)	99,3

Sumber: IRE, 2008

2.2 The influence of vetiver grass covering and rainfall on erosion reduction

In 2009, IRE has conducted further research with more focused on the efforts to determine the relationship between soil covering by vetiver grass, rainfall and the decrease of soil erosion. The study was conducted on the slopes of Cipularang toll road KM 95 and KM100 +200 +200. The results of correlation analysis and multiple linear regression model between the independent variables (the intensity of rainfall and the soil covering by the grass) with the dependent variable (erosion reduction) at both locations generally showed good correlation (R 2 »90%) with significant values of less than 0, 05. It indicated that there is influential relationships between rainfall intensity and soil covering on the rate of soil erosion reduction. The correlation between the intensity of rainfall and the rate of erosion reduction is negative . This negative correlation can be defined as the greater the intensity of the rainfall, the smaller the rate of erosion reduction. On the other hand, the correlation between the soil covering by the grass with a reduced rate of erosion is positive . This means that the greater soil covering by grass, the greater the rate of erosion reduction as shown in Table 2 and Table 3.

Table 2:
The correlation of rainfall and soil covering by vetiver grass Versus The Rate of Slope Erosion Reduction At Cipularang Km 95+200

No.	Model	Equation	R^2	Sig
1	PE30 - L3	107,310 – 4,071(I) + 0,170(P)	0,941	0,015
2.	PE30 - L6	107,389 – 4,293(I) + 0,194(P)	0,907	0,028
3.	PE30 - L9	105,916 – 3,830(I) + 0,679(P)	0,899	0,032
4.	PE45 - L3	100,158 – 5,139(I) + 0,458(P)	0,888	0,033
5.	PE45 - L6	97,547 – 5,080(I) + 0,539(P)	0,892	0,035
6.	PE45 - L9	96,814 – 5,172(I) + 0,572(P)	0,894	0,034

7.	PE60 - L3	89,906 – 6,561(I) + 1,012(P)	0,902	0,031
8.	PE60 - L6	89,805 – 6,441(I) + 0,946(P)	0,890	0,031
9.	PE60 - L9	89,450 – 6,379(I) + 0,952(P)	0,905	0,029

Source: IRE, 2009

Table 3:
The Correlation of Rainfall and Soil covering By Vetiver Grass Versus The rate of Erosion Reduction At Km 100+200

No.	Model	Persamaan	R^2	Sig
1	PE30 - L3	82,71 – 4,108(I) + 0,667(P)	0,875	0,016
2.	PE30 - L6	81,71 – 4,061(I) + 0,687(P)	0,868	0,017
3.	PE30 - L9	84,12 – 4,528(I) + 0,665(P)	0,871	0,017
4.	PE45 - L3	76,55 – 5,112(I) + 0,837(P)	0,902	0,010
5.	PE45 - L6	76,24 – 51,28(I) + 0,839(P)	0,905	0,009
6.	PE45 - L9	75,74 – 5,130(I) + 0,851(P)	0,904	0,009

Source: IRE, 2008

Keterangan:
PE = The rate of Erosion Reduction after grass planting, (%)
L = Slope length, (m)
I = Rainfall intensity , (mm/hr)
P = Soil Covering by grass, (%)

Gradient 30°

Gradient 45°

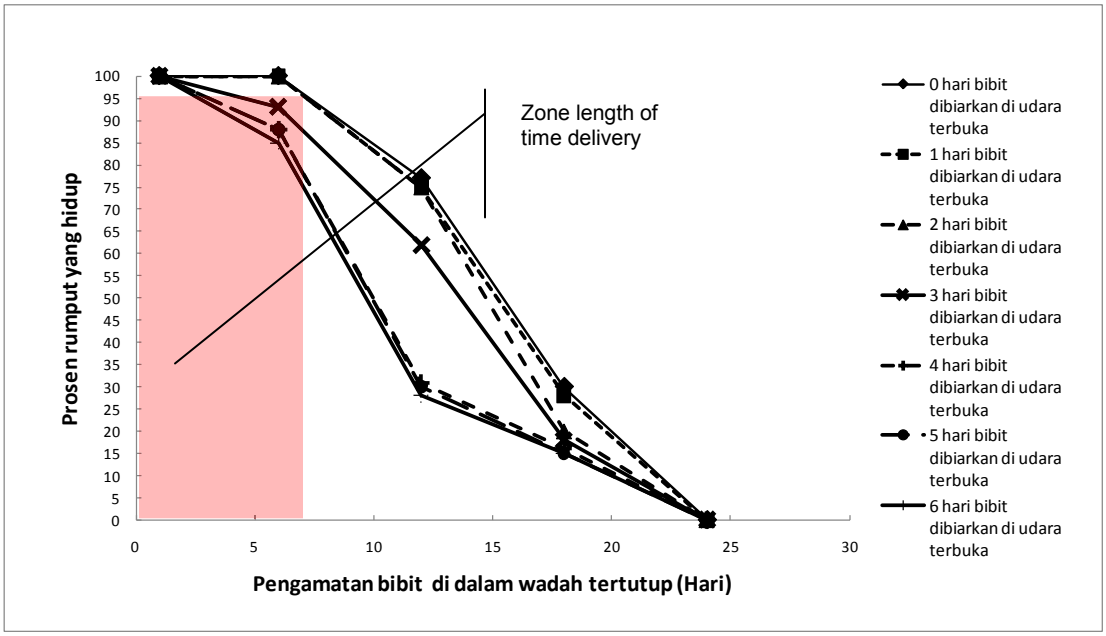
Gradient 60°

Figure 2:
Small-scale Trial of Vetiver Grass technology
At Cipularang Toll KM 95+200 and Km 100+200 –Bandung Regency
Source: IRE, 2009

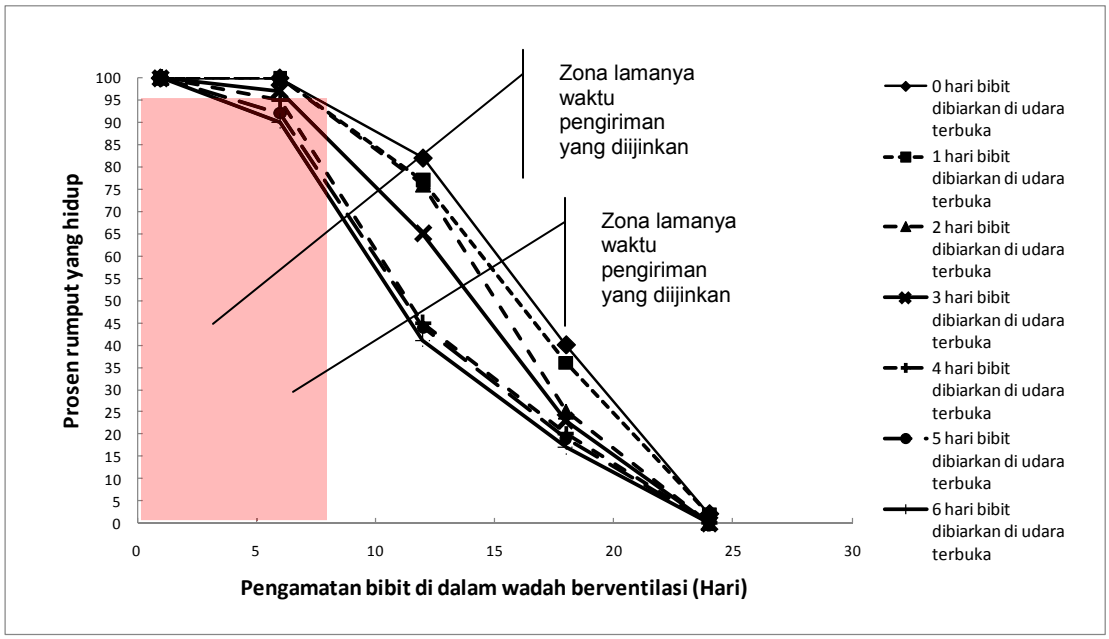
2.3 The Influence of Packaging System on the quality of vetiver grass seedling

To determine the quality of vetiver slips during shipment, especially sea transport delivery (where the time delivery required is relatively long that over 5 days), In the research, the packing simulation was conducted both in polybag or slips stored in holed containers and sealed containers to find out how long vetiver can survive in container and the percentage of died vetiver.

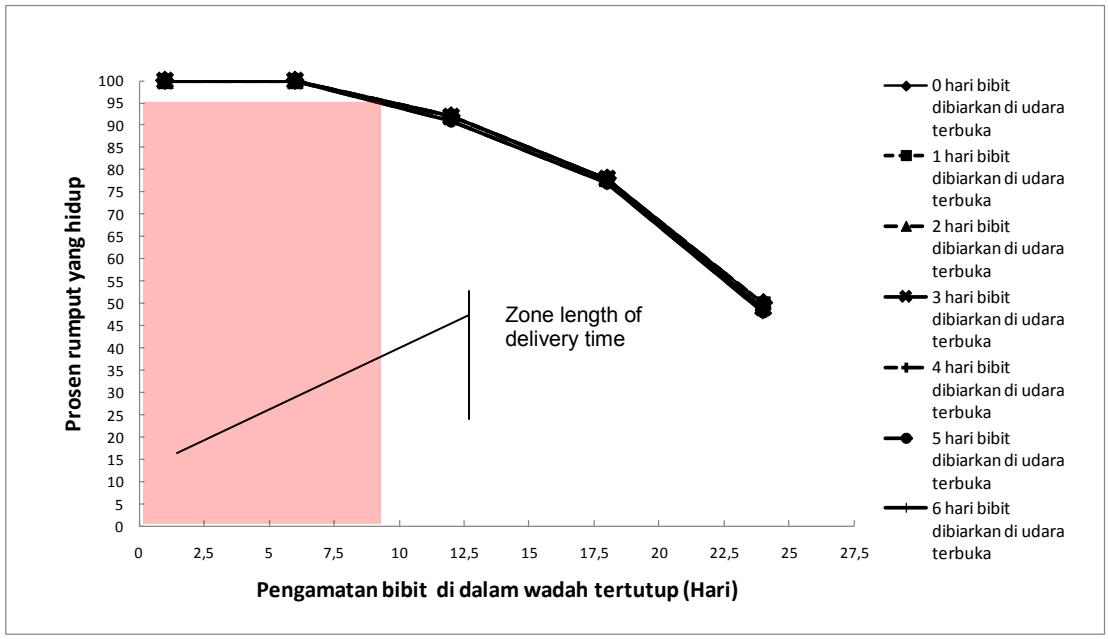
From the simulation results shows that there is the difference in the number of slips that survive between slips in sealed containers and holed containers or slips in polybags packed both in sealed containers and holed containers. Seedling slips in holed containers showed good condition compared with slips in sealed containers. Similarly, slips in polybag shows better condition. The success criteria is shown by the small % of died vetiver slips . If the slips are compared with slips in polybags, the slips in polybags showed better results where % of died vetiver is smaller than the slips without polybags. The simulation results are presented in Figure 3 until Figure 6.



Gambar 3:
Percentage survival of Vetiver (slips) in sealed container
Source: IRE. 2010



Gambar 4:
Percentage survival of vetiver (slips)
In Holed Containers
Source: IRE, 2010



Gambar 5:
Percentage survival of vetiver in polybags in sealed containers
Source: IRE, 2010

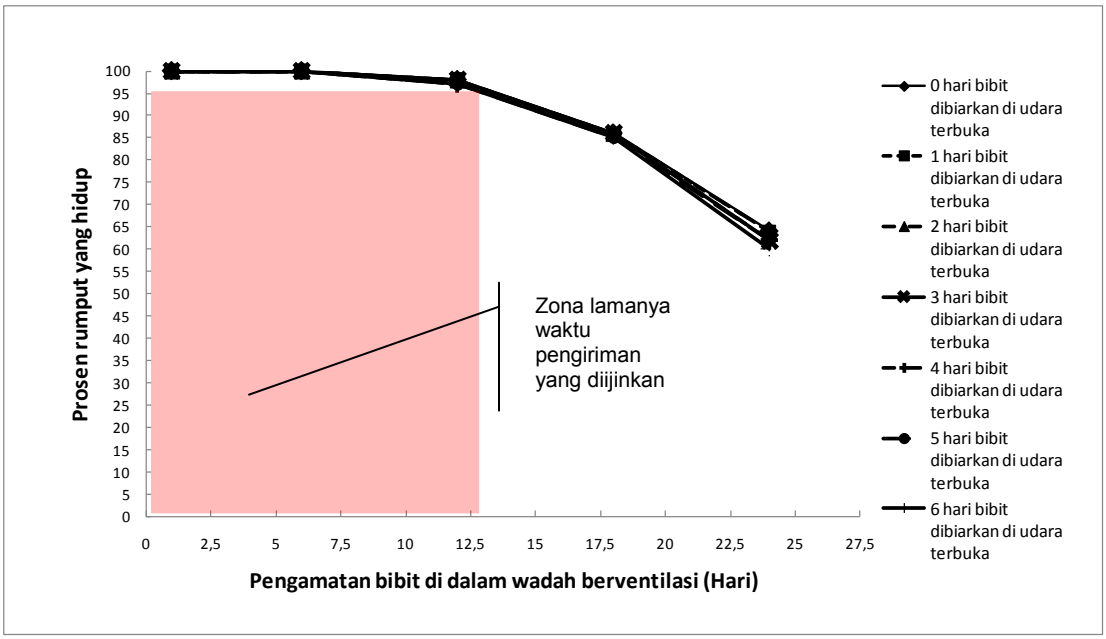


Figure 6:
Percentage survival of vetiver in polybags in holed containers
Source: IRE, 2010

The above figure shows that if the tolerable percentage is 5%, delivery time is maximum 7-8 days and 9 to 12 days for vetiver (slips) and vetiver in polybags respectively. It is proven by delivering 50.000 vetiver to Jayapura and Samarinda, where 99% of vetiver was in good condition. Vetiver was packed in ventilated container made of bamboo.

Figure 7:
Condition of vetiver (Slips) after placed in sealed container
Source: IRE, 2010

Polybag – 1 day in ventilated container

Polybag – 11 days in ventilated container

Polybag – 24 days in ventilated container

Figure8:
The condition of vetiver (polybags) placed in sealed container
Source: IRE, 2010

3. VETIVER NURSERY

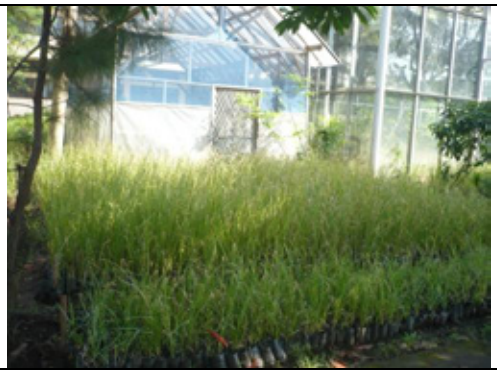
3.1 Vetiver Nursery Technique

The increasing utilization of vetiver grass for slope conservation, IRE has made vetiver grass nurseries in some locations such as East Java;East Kalimantan; Papua and IRE.
The Research Team of IRE focused on the nursery method in polybags. This method is considered the most effective and low risk of death. Vetiver grass nurseries successfully performed with a total of 50,000 slips in the region of East Java, East Kalimantan, and Papua, and 100.000 slips at IRE. Vetiver nurseries aims to support research activities and also prepared for full-scale in East Java, East Kalimantan, and Papua. Monitoring result of the four locations is presented in Figure 9.

BBPJN - Surabaya

Samarinda

InKoya - Papua



IRE, Bandung

Figure 9:
Vetiver Nursery in Surabaya, Samarinda, Papua, and IRE.

From the result of monitoring indicated that the percentage of failure during the nursery process varied between 2% to 5%. If the failure rate is investigated further (based on the cause of failure), so that the source of failure are as follows:

- The quality of slips are uneven
- Delayed treatment
- Decay.

By looking at the causes of these failures, careful attention should be paid in the following factors: ie.:
• Selection of vetiver grass slips in producer level;
• Handling of vetiver grass slips during shipment Handling of vetiver grass slips when arrive on site

3.2 The Price of vetiver slips

Unit price of vetiver slips which are ready for planting (aged 2 to 3 months) is calculated based on several components of the major jobs such as: (i) preparation of slips , (ii) filling the soil into polybags, (iii) the planting of vetiver slips in polybags , and (iv) maintenance. Material is calculated based on the market. Materias which calculated, are: (i)plant, (ii) polybag , (iii) soil, (iv) fertilizer. Overall, the price is Rp.3000/polybag and Rp. 1500/slip.

4. THE APPLICATION OF VETIVER GRASS TECHNOLOGY

In 2010, vetiver grass technology was applied in three locations as shown in Figure 10 to 15, for East Java region the application took place in new road link (Sta. 1 +195 sd Sta. 1 +495) that is the longest access to Suramadu Bridge. In East Kalimantan region, application of vetiver grass technology was applied on Loa Janan -Church Road link (Km. km 17 +400 sd. 17 +502). As for the territory of Papua, vetiver grass technology was applied on Yetti -Arso road (km 106 +750 +000 Km.107 +000). In general, conditions of application of vetiver grass technology in three locations showed the following results:

- Vetiver grass technology showed good performance as expected.
- There was a significant change in slope conditions before and after the vetiver grass technology applied. The Slopes were previously unstable and covered with weeds. At present the site turned into green slopes by vetiver grass.
- Less surface erosion
- Another condition that can be found is a change in color of the soil surface that was originally yellowish brown to dark brown .It is predicted that with the presence of vetiver , soil moisture and organic content increased
- From ± 3000 m2 slope area that planted with vetiver grass, nearly 100% was growing. However, when observed more closely, 10% of plants did not develop healthy growth.

 Before	 2 weeks after planting
 3 months after planting	 7 months after planting

Gambar 10:
The growth of vetiver grass on Slope of
Surabaya – Madura road link Sta. 1+195 s.d Sta. 1+495

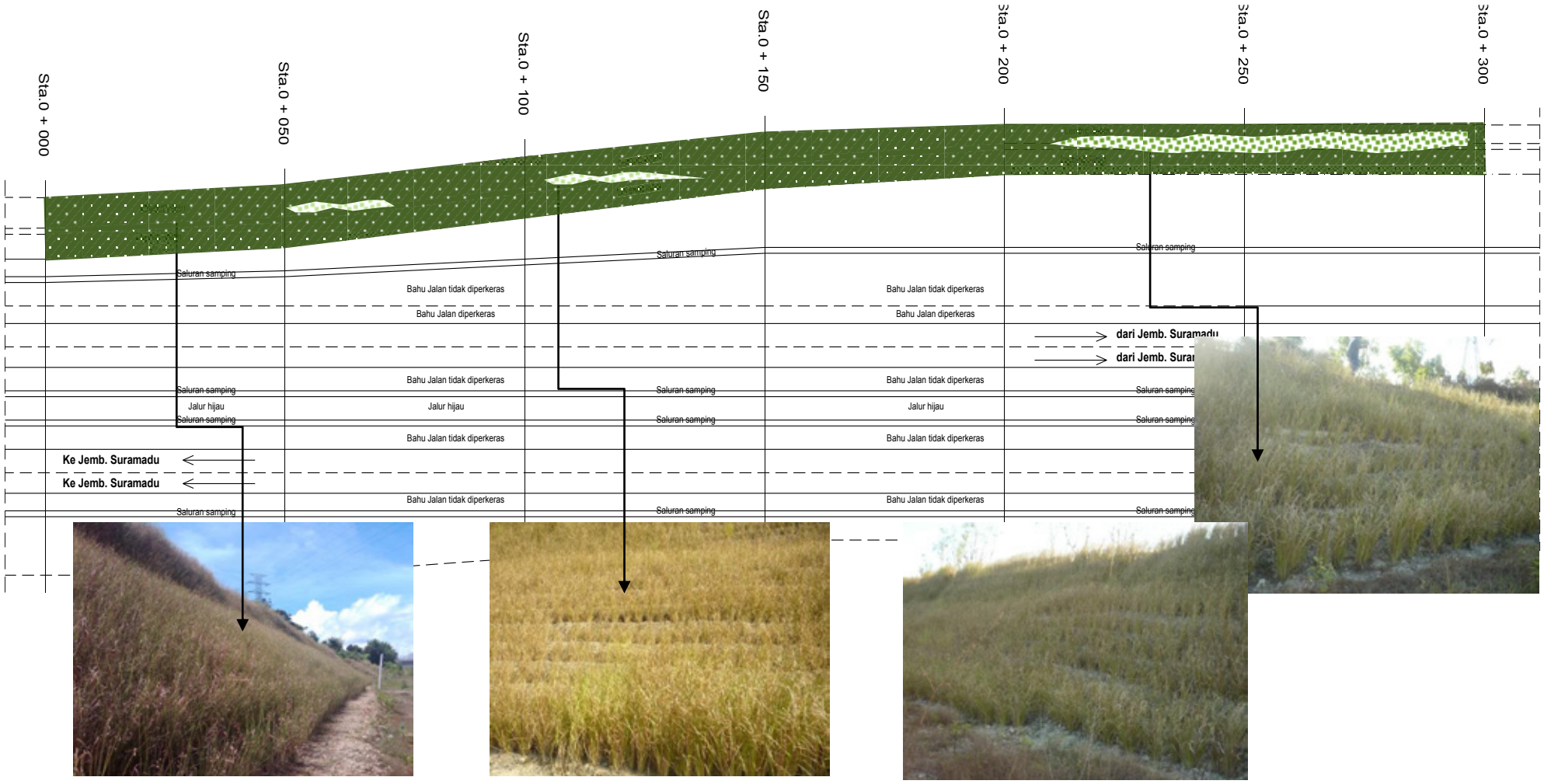


Figure 11:
The Sketch of Growth Rate of vetiver grass
On Slope 0f Surabaya – Madura Road Link Sta. 1+195 s.d Sta. 1+495

Before

1 month after planting

3 months after planting

7 months after planting

Gambar 12:
The Growth of Vetiver Grass on Slope of
Loa Janan – Gereja Road Link KM. 17+400 s.d 17+502, East Kalimantan

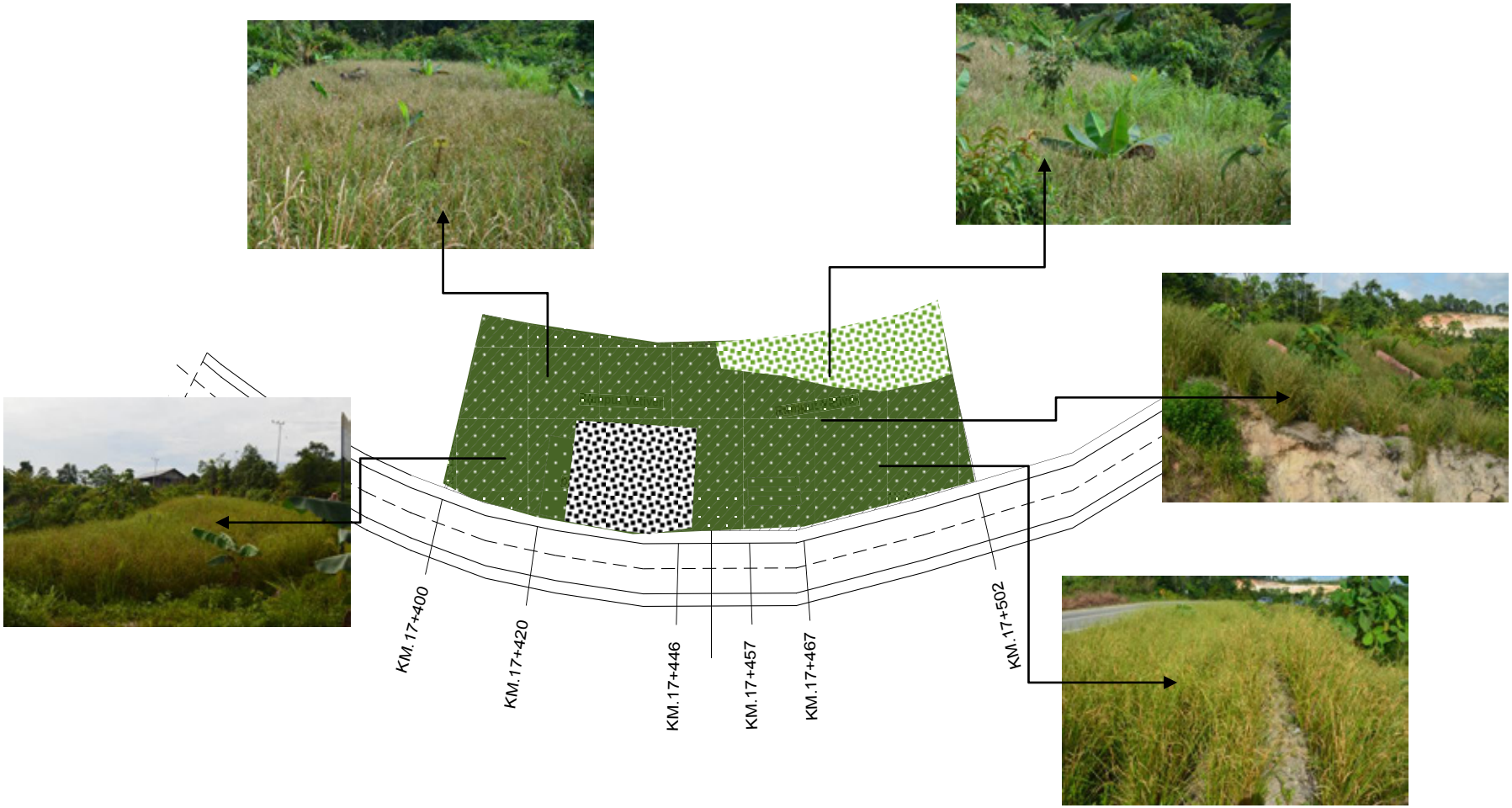


Figure 13:
The Sketch of Growth Rate of Vetiver Grass
On Slope of Loa Janan – Gereja Road Link KM. 17+400 s.d 17+502, East Kalimantan

Before

1 month after planting

3 months after planting

7 months after planting

Figure 14:
The Growth of Vetiver Grass on Slope of
Yetti – Arso Road Link KM 106+750 s.d KM 107+100

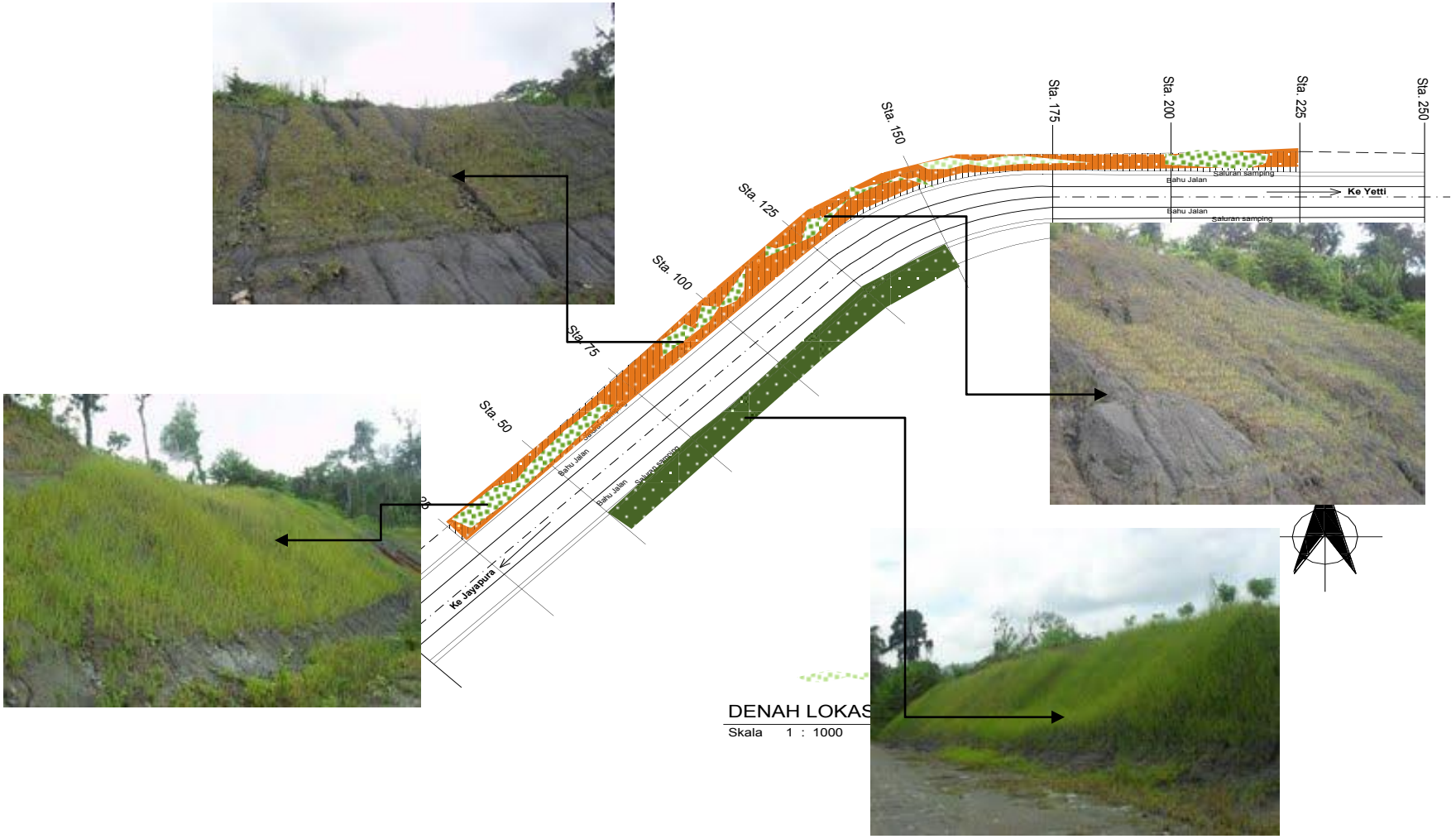


Figure 15:
The Sketch of the Spread of vetiver grass on The slope of Yetti – Arso road link KM 106+750 s.d KM 107+100

5. PROBLEMS AND ISSUES FACED

The following is the constraint or problem that can significantly impact the implementation of vetiver technology,i.e:

- Locations are quite far;
- The limitation of materials and equipment (even unavailable);
- The contour of steep slopes, uneven and ununiform;
- Texture or hard
- Water sources are far away;
- Limitation of human resources;
- Maintenance is lacking, in some cases this technology will fail without maintenance. Vetiver cannot compete with weeds that live around the site as shown in Figure 16.
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Gambar 16:
Vetiver grass competes with weeds

6. SOCIALIZATION AND DISSEMINATION

Trainings of Vetiver grass nurseries have been conducted in local Government Institutions (both in P2JJ and National Road Authority) in East Java Province, East Kalimantan and Papua. The training purpose is to train technical staff of P2JJ and BBPJN in order to have capabilities of vetiver grass nurseries and cultivation of vetiver grass . The training materials covered basic theory , the usage of vetier grass, propagation and planting method in the field. Besides theoretical material, practical skills of planting such as soil preparation, fertilizer were also given.

Learning theory of vetiver grass (BBPJN- Surabaya)

Learning theory of vetiver grass (BPJN - Samarinda)

	
Learning theory of vetiver grass (BBPJN- Papua)	Pembibitan Rumput Vetiver

6. CONCLUSION

- Vetiver grass technology is one of the alternative technologies to address the problems of erosion or surface erosion. The technology is relatively easy, inexpensive and environmentally friendly compared with others.
- The use of the technology must consider the factors of soil, contour and slope inclination, climate or weather, natural resources and people.
- The technology takes time to grow and develop in order to achieve optimal performance.
- Maintenance is the key factor to the success of vetiver grass system.

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