Infiltration characteristics under selective logged and intensive line planted in a tropical Indonesian rainforest

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1. Introduction

Activities that compact or alter the soil surface, soil porosity, or the vegetation cover can reduce the infiltration capacity. Timber extraction using heavy machines destroys the soil structure that plays an important role in water and nutrient cycling, accelerating the soil erosion rate. Heavy machines in timber collection areas and on skidder roads increase soil compaction by up to 40% [1], and 10-30% of the soil surface may be laid bare in the form of logging roads, skidder tracks and log landings [2]. Exposing a soil to direct raindrop impact also will diminish the openness of the surface soil and reduce infiltration capacities.

Many studies have considered infiltration capacity under forested area, but information on the selective logging and intensive line planting in tropical rainforests remains limited. Therefore, in this study, we quantified and compared the infiltration among virgin forest and selective logged forest with intensive line planted in different ages.

2. Methods

2.1 Study site

This study was conducted in tropical rainforest at the Sari Bumi Kusuma company concession area, a private forest in Central Kalimantan, Indonesia. This location is part of the high-biodiversity area known as the "Heart of Borneo". The study site was located in the headwater region of the Katingan watershed, one of largest watersheds in Central Kalimantan.

According to the forest climate classification system of Schmidt and Ferguson, the area is a type A (very wet) tropical rainforest (monthly average rainfall > 100 mm). The mean annual precipitation for the period 2001–2009 was 3,601 mm, with the highest average monthly precipitation (367 mm) occurring in November and the lowest average monthly precipitation (183 mm) occurring in August. The mean temperature is 30ºC–33ºC at noon and 22ºC–28ºC at night.

2.2 Intensive forest management system

Intensive forest management system is a technique for timber harvesting and maintains the potency of forest standing stock. The main activities are selective logging for trees with diameters up to 40 cm and intensive line planting to enrich the standing stock in the future shown in Fig. 1.

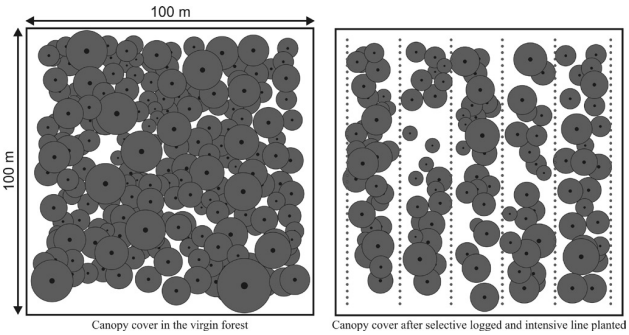

Fig. 1: Forest canopy changes after intensive forest management

The implementation of intensive forest management system decreased the number of trees per hectare. In the virgin forest, the percentage of canopy trees cover was 80.1%. After selective logging and intensive line planting, it decreased to 49.3%. The implementation of TPTII decreased the canopy trees cover by 38.5%.

2.3 Research sites and observation

This research was conducted in the 11 test sites located in the forest that had been selective logged and intensive line planted from in 1999 (11 years ago) until in 2008 (2 years ago) and in the undisturbed forest (virgin forest). Field measurements of infiltration were made using a portable double-ring infiltrometer. The 120 infiltrometer tests were performed in the 11 test sites. At each test site, the infiltrometer test was performed in four locations: line planted, cleared area, logged area and skidder (tractor) track (Fig. 2) with three repetitions based on differences of topography. The spot-points for infiltrometer test were selected by random sampling method.

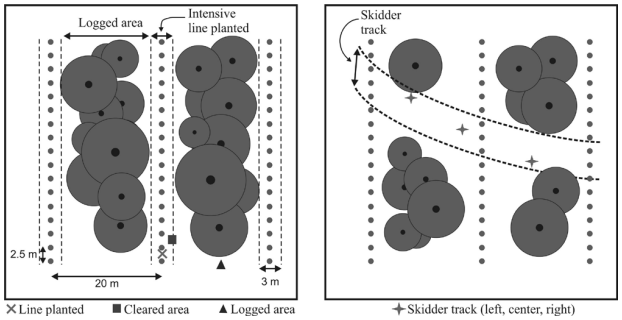

Fig. 2: Infiltration spot-point test

3. Result and discussion

3.1 Infiltration rates

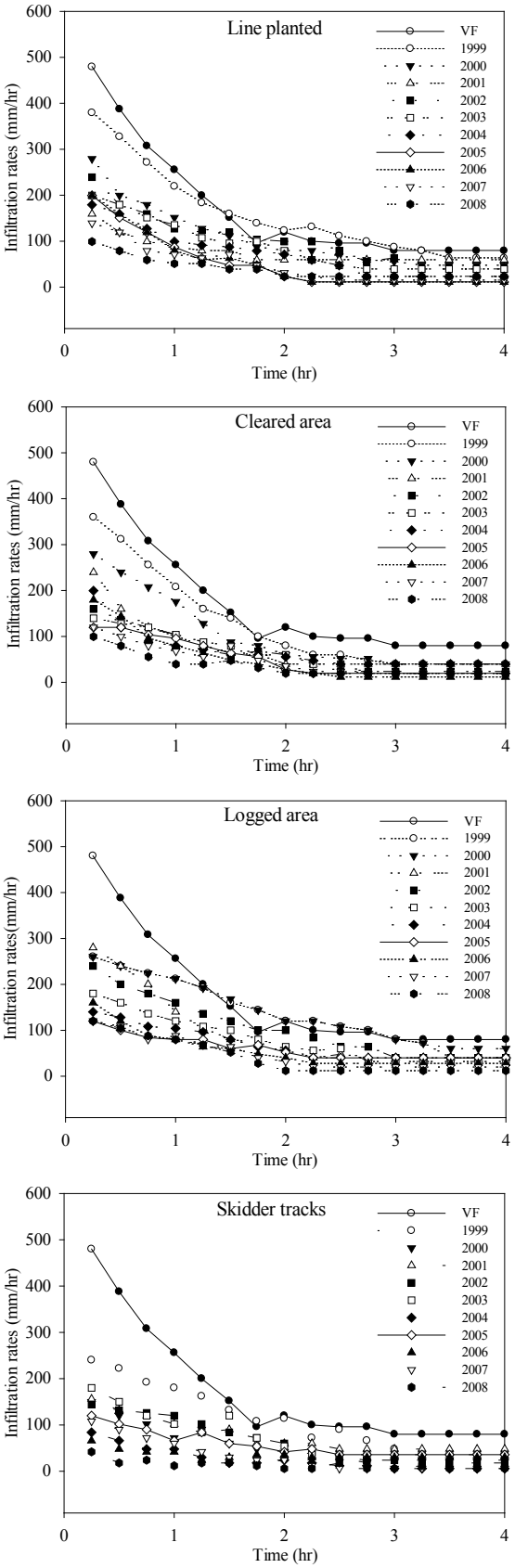

Fig. 3: Infiltration rate against time in line planted, cleared line, logged area and skidder tracks

Fig. 3 shows the results of the measured infiltration rates (IRs) against time in four type of location. Selective logging and intensive line planting have decreased the IRs. It is also noticeable that the steady state rate occurred between 2.5-3.5 hrs. The IRs at virgin forest was highest both in at the beginning of the test and the steady state rate. The IRs of line planted and cleared area in the intensive line planted area in the beginning of test were higher than those of logged area and skidder tracks.

3.2 Changes of infiltration capacity

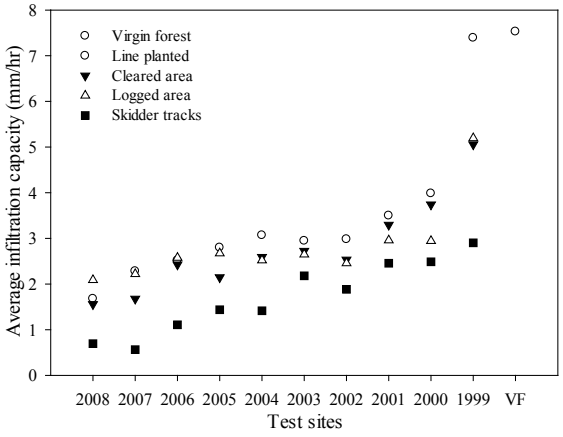

Fig. 4: Average infiltration capacity in 11 test sites

Fig. 4 shows the average infiltration capacity (IRc) in 11 test sites. The IRc at line planted, cleared area and logged area showed slightly difference. The IRc of skidder tracks was lowest and far from the IRc of virgin forest. IRc reduction from the virgin forest level in the intensive line planted, logged area and skidder tracks were 57%, 72% and 91%, respectively.

4. Conclusion

Intensive forest management system practices affect the infiltration capacity of the soils. Mechanized logging has the highest effect to the soil infiltration. The IRc with 11 years after logging in the intensive line planted area and logged area were closed to the IRc of virgin forest, but the IRc of the skidder tracks area was still far from the IRc of virgin forest. We recommended that controlling the tractor machine movement with reducing the track length and optimizing the winch cable could reduce the impact on soil infiltrability.

References

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