Temporal Variation of Sedimentation on Paved and Unpaved Forest Roads in Belgrad Forest, Istanbul

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- Turkey has 57% mountainous terrain a rugged topography with high area covering a large section of forest in mountainous terrain.

- Being conducted in the forest sector, transportation, silviculture, forestation, fire fighting, insect and disease control, and revenues measured increments, continuous monitoring of forest health and other activities that are required for transport through the forest road is done.

- However, the importance of the environmental impacts of forest roads increases, the forest habitat of roads, landslide and erosion, and adverse effects on river hydrology are research priorities.

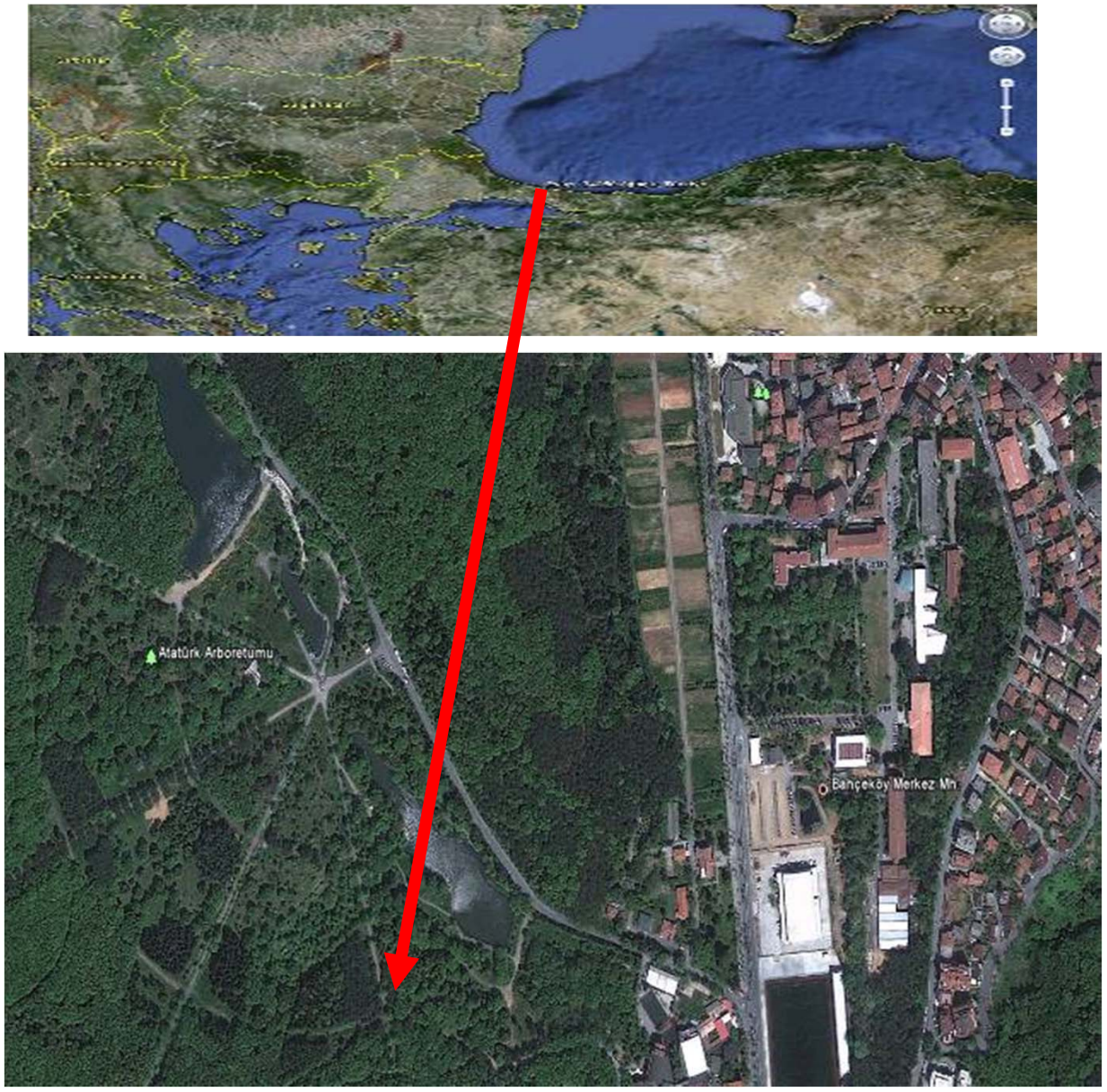
- In this context, the reason of forest roads construction, protective vegetation and organic layers were removed from large areas of surface erosion, to become open to the large amounts of soil and rock were dug to be exposed to mass movement and often corrupt bias of the remaining balance is made.
- As a result, sediment transport in streams after road construction, road construction compared to prior art is hundreds of times.
- Forest roads cut slopes both surface flow and interrupted the flow of shallow groundwater to collect in the ditch edge.
- Directly in the cut slopes and road surface downward slope rainfall, surface flow to the ground with not seep down the road to the ditch edge goes to the slopes.
- As a result, after the rain shower, then surface and groundwater flow is accelerating faster than in the stream is reached.
- Also, peak flows in streams to increase, river water temperature rises, road surface and edge of the ditch and excavation on the slope from erosion due to movement of material, the amount of sediment reaching the stream bed has been increased.

- In this study, sediment amounts determined based on the forest road ditch with land through sediment fences.

- This study was to examine sediment production differences among unpaved (UPFR), paved (PFR) forest roads and undisturbed area (UA) in the dominant sessile oak (*Quercus petreae* L.) stand of Istanbul Belgrad Forest in Turkey.

Study site

The study area was located within the boundaries of Ataturk Arboretum in Istanbul. The mean annual precipitation is 1074.4 mm, while the mean annual temperature is 12.8°C, The research areas was comprised of a dominant sessile oak (*Quercus petraea* L.), canopy cover of 0.8, average tree diameter of 15.4 cm, an average tree height of 16.14 m, and a stand density of 3200 trees ha^{-1}. The average altitude of the research area was 140 m and the slope was 4-7% with a north-northeast aspect.



FOREST ROAD PROPERTIES IN RESEARCH AREA

- This study was conducted between November 2009 to October 2010 (12 months) and the unpaved and paved forest roads were selected 100 m long.
- The unpaved (UPFR) and paved forest roads (PFR) width is 4.0 m, longitudinal slope is %4-7 and transverse slope is 2-5%.
- Pavement material on paved road is crushed stone and thickness is 25 cm and one time graded after constructed.
- The forest roads passes through the stand in a north-south direction and has been used to logging and transporting in forest area.
- Traffic density is 1-5 vehicles per day and vehicle types are 2x4, 4x4, truck, tractor and tractor-treyler.
- UPFR and PFR's cut slope has been vegetated, 0.5-1.0 m high, 1:3 slope, no recently graded. Estimated age of roads is 35.

PROPERTIES OF SEDIMENT TRAPS

- The establishment of sediment trap, ribbed iron sticks in 1.2 cm diameter and 1.3 meters high and plastic geotextile materials are used in research.
- A synthetic geotextile fabric that is woven to provide structural integrity with small openings (smaller than 0.001 mm) that pass water but not sediment.
- Sediment traps located on forest road ditch at 10 m intervals and located randomly on undisturbed area (UA) where were at least 30 m away from the forest road where there was no direct road impact (at least one tree length away from the forest road edge).
- Total of 24 sediment traps, 4 on undisturbed area, 10 on unpaved forest road ditch and 10 on paved forest road ditch has been established.
- Each sediment trap collected sediment from 20 m^2 areas on forest roads (total 200 m^2). Each sediment traps on undisturbed area collect sediment from 50 m^2 areas

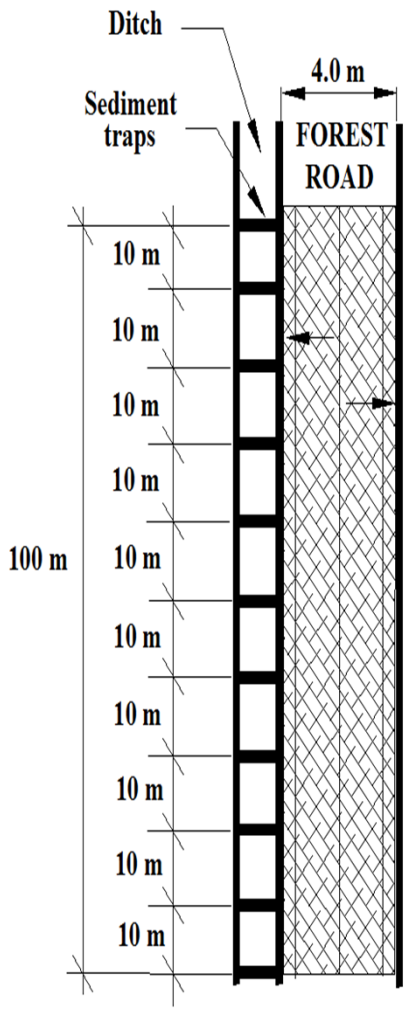
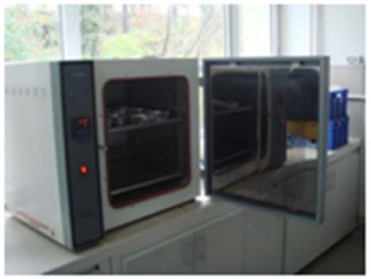


Figure 1: Sediment traps on (a) paved forest road and (b) unpaved forest road (c) undisturbed area.

MONTHLY PRECIPITATION, SEDIMENT AND SOIL SAMPLING AND ANALYSIS

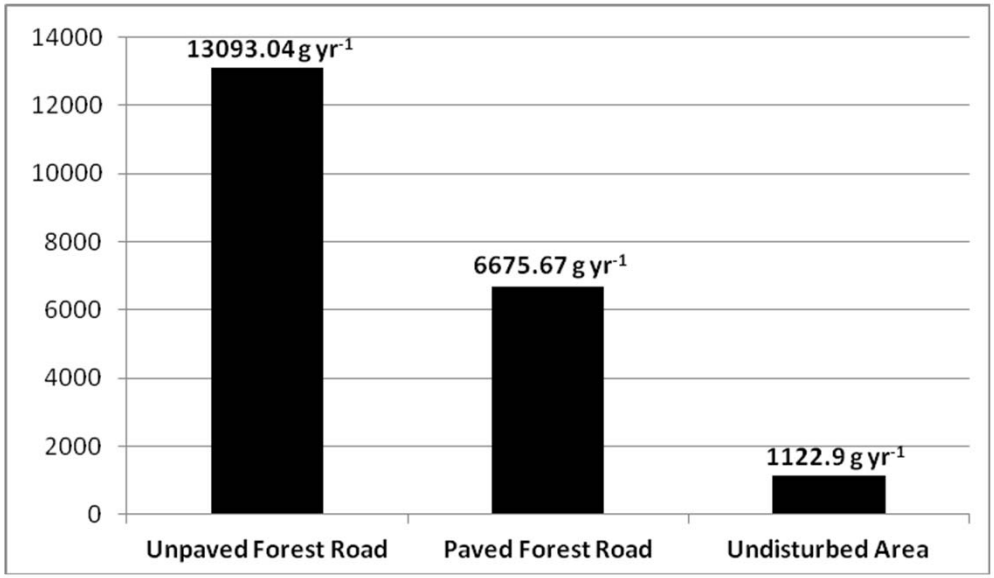
- To determine the monthly precipitation, total of 10 precipitation collectors established and their average was calculated as mean monthly precipitation.
- Sediment samples collected from the sediment traps after every precipitation.
- All collected sediments were put in polyethylene bags, labeled and brought to the laboratory, were promptly weighed (within 1 hour) in 0.01 g sensitivity.
- Sediment samples were dried at 105^{o}C for 24 h. To determine general soil properties of experiment site, we quantified sand, silt and clay rates, dispersion ratio and permeability in soil samples taken from each sediment traps.
- Soil samples have been taken with steel rings from 0–5 cm soil depths. Sand, silt and clay ratio of soil samples in the laboratory were found by Bouyocus hydrometer method.
- C and N contents of grounded sediment subsamples with three replicates were determined with Leco CN (Truspec 2000) analyser.





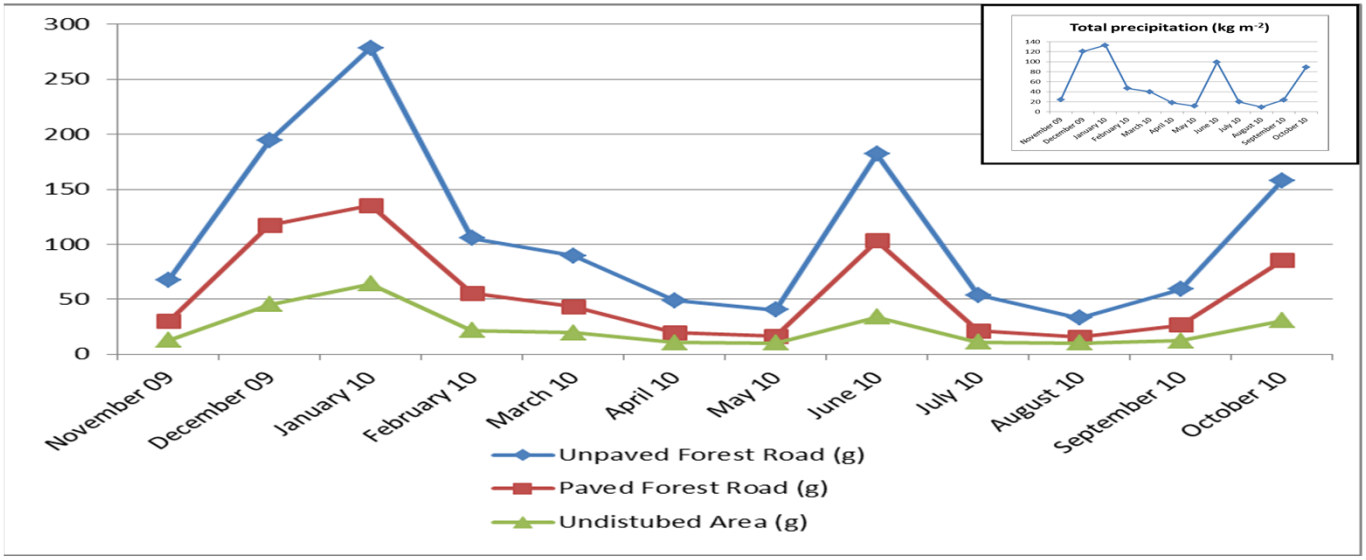
RESULTS

- Significantly differences were found on sediment productions among experiment sites.
- Annual sediment production was 0.654 t/ha/yr on UPFR, 0.334 t/ha/yr on PFR and 0.056 t/ha/yr on UA.
- Total sediment production of UPFR was 1.96 times higher than to PFR and 11.68 times higher than UA.



Total sediment production of experiment sites.

RESULTS



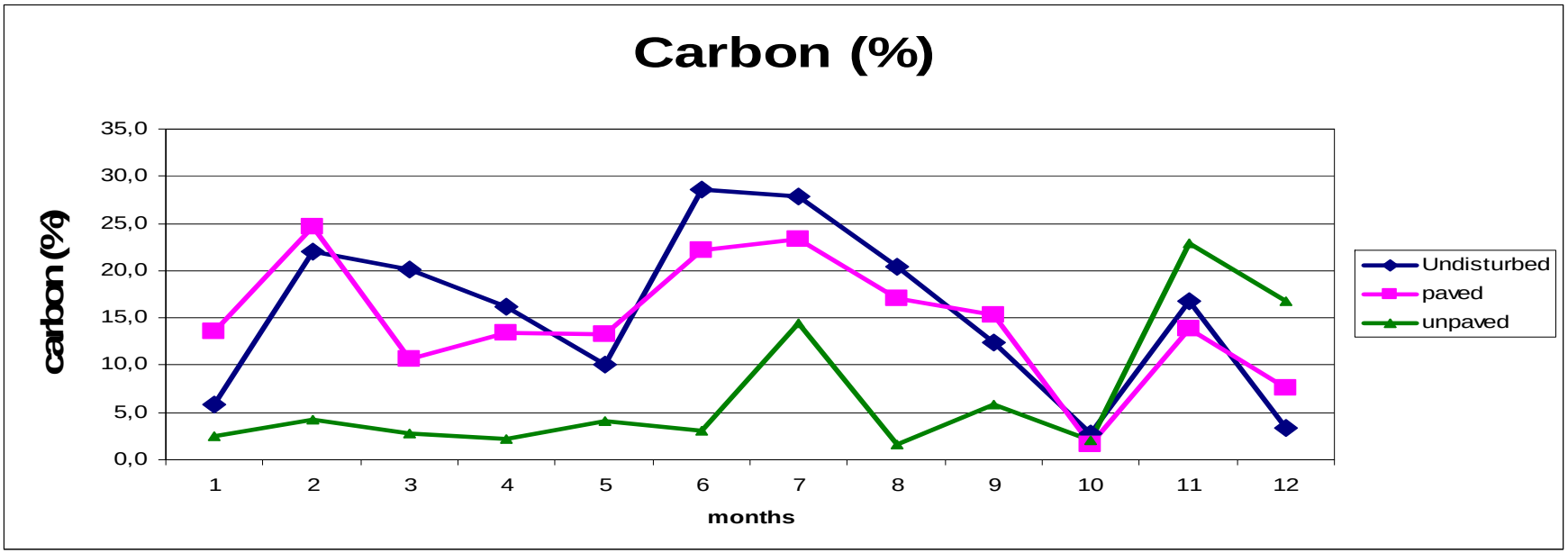
Mean monthly sediment productions (g)

- Monthly sediment production on UPFR significantly higher than the PFR an UA for each month.
- It clearly shows that stabilizing cover on forest road led to less sediment production and more soil protection.
- Significantly differences on monthly sediment production were determined among experiment sites in all observation period.
- Monthly sediment production showed a parallel relationship to monthly precipitation.

RESULTS

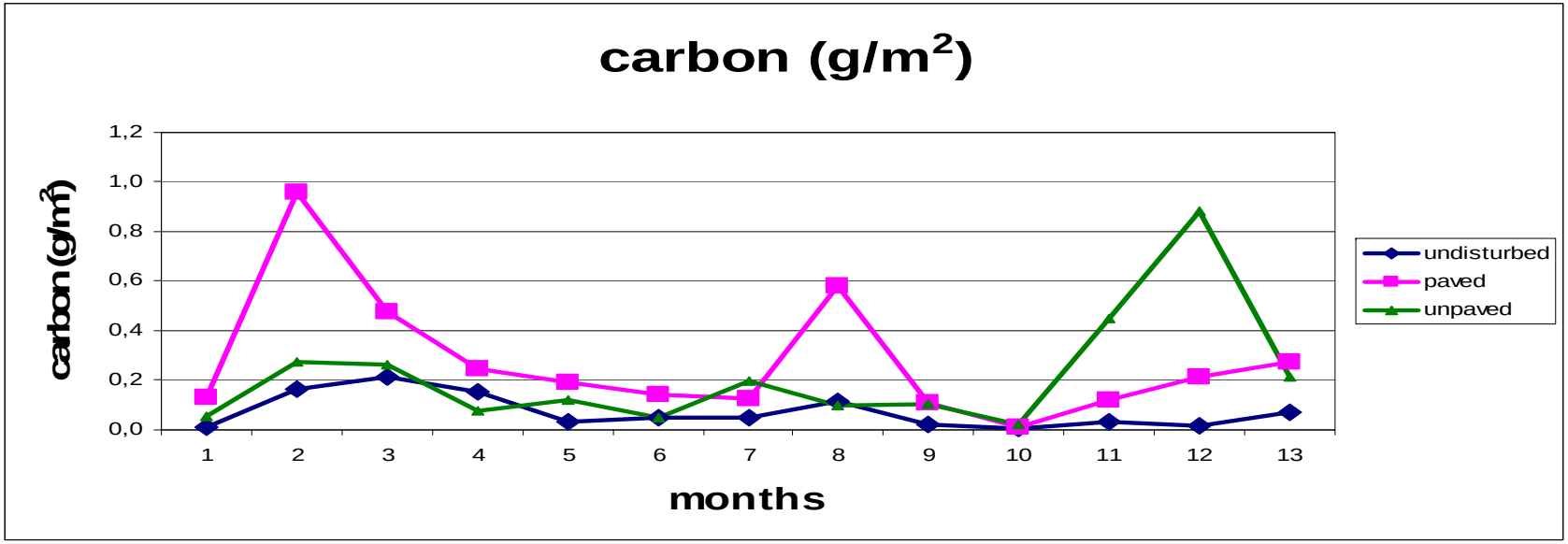
- Our results more less than the results of former studies.
- Less traffic density (1-5 vehicles per day), lower logging and harvesting activities, lower road longitudinal slope (4-7%) and more protection effect by plant cover should be possible causes to less sediment production in experiment site.

RESULTS



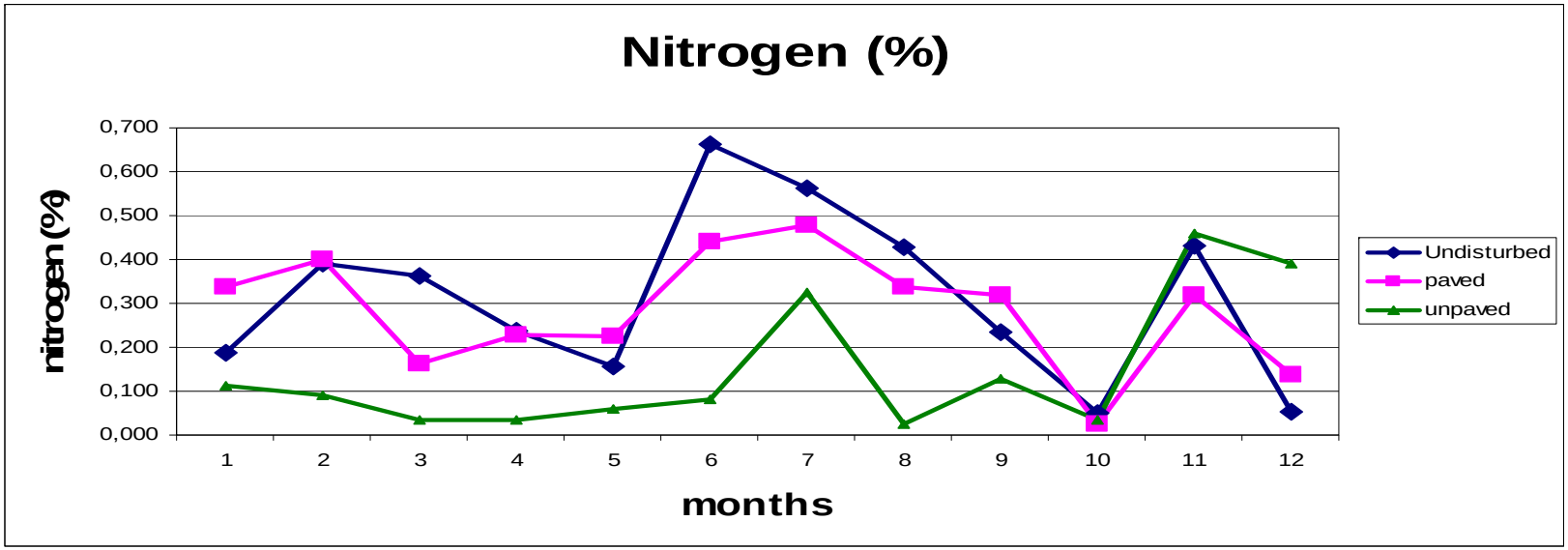
- The monthly sediment carbon contents differ significantly (P=0.000) among months on all experiment sites. The lowest carbon content (%) in sediments of undisturbed (UA) and paved forest road (PFR) was determined in august 2010 while was on june in unpaved forest roads. The highest sediment carbon contents (%) were in april 2010 on undisturbed area, in december 2009 on paved forest road and in September 2010 on unpaved forest road. The highest annual mean sediment carbon content was determined on undisturbed area as 15.53 % followed by paved forest road (14.68 %) and unpaved forest road (% 6.86).

RESULTS



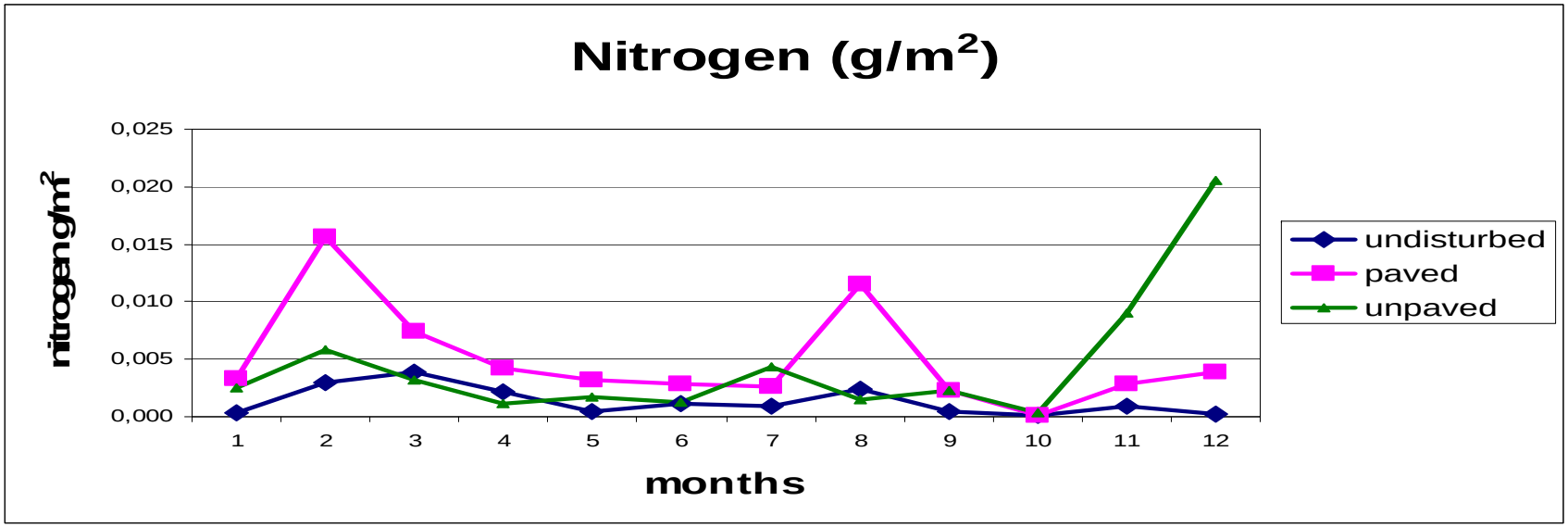
The lowest carbon mass (g/m^2) values of all three experiment sites were found in august 2010 when the lowest sediment and precipitation were determined. The highest carbon mass values; 0.21 g/m^2 on undisturbed area in January 2010, 0.96 g/m^2 on paved forest road in December 2009 and 0.88 g/m^2 on unpaved forest road in October 2010. Monthly changes of carbon mass on each experiment site show significant difference in a year. Undisturbed area show the lowest mean annual carbon mass (0.07 g/m^2) despite the highest carbon contents in sediments among experiment sites. Difference on annual mean carbon mass between PFR and UPFR experiment sites is not statistically significant. Thus it can be interpreted that paved and unpaved forest road produce similar mean annual carbon mass losses in sediments.

RESULTS



In general, nitrogen content of sediments on experiment sites shows a parallel change with carbon. This can be explained by nitrogen content is highly related to organic matter including more carbon in sediments under forest cover. However, the highest carbon value of PFR was determined in December 2009 despite the highest nitrogen content was determined in may 2010. Other monthly changes on all experiment sites show similar tendency with changes on carbon contents in sediments.

RESULTS



Changes on nitrogen mass (g/m^2) have similar tendency to carbon mass, and only one exception was that the highest carbon mass value of PFR was determined in December 2009. Monthly changes of nitrogen content and nitrogen mass in sediments on all experiment sites show statistically significant differences (P=0.000). Mean annual nitrogen content of UA and PFR have similar values and they are significantly (P=0.000) different from UPFR. Mean annual nitrogen masses of PFR (0.0049 g/m^2) and UPFR (0.0044 g/m^2) have similar values and they significantly (P=0.000) higher than UA (0.0013 g/m^2).

THANK YOU FOR YOUR INTEREST

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