NUTRIENT CYCLING IN DEGRADED ECOSYSTEMS (GRASSLANDS) OF MEGHALAYA

(ABSTRACT)

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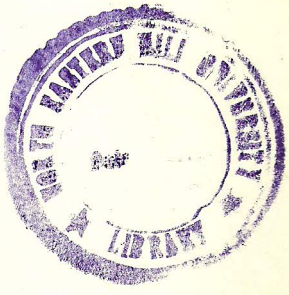

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ABSTRACT

This study deals with the community composition, storage of N, P and K in different vegetation compartments and soil and their cycling between plant-soil system of the degraded plant communities represented by grasslands in Meghalaya. The study emphasizes the effects of altitude, climate, soil and protection against mild cattle grazing and annual burning on the various aspects mentioned above.

The experimental sites are located at Burnihat, Cherrapunji and Upper Shillong having an altitude of 100, 1300 and 1900 m, respectively in the East Khasi Hills district of Meghalaya. The data were collected during August 1988 to August 1989. The mean values of climatic variables were: maximum and minimum temperatures 26.0 and 22.4^{o}C, respectively and annual rainfall 2871 mm at Burnihat; maximum and minimum temperatures 19.7 and 16.6^{o}C, respectively and annual rainfall 16247 mm at Cherrapunji; and maximum and minimum temperatures 18.5 and 17.0^{o}C, respectively and annual rainfall 3268 mm at Upper Shillong.

The soil at Burnihat and Upper Shillong is sandy loam whereas at Cherrapunji it is highly stony; three-fourth of the total substratum being gravel or stone. Water holding capacity, pH, cation exchange capacity and total exchangeable bases are considerably low at Cherrapunji compared to the other sites. Organic carbon content increased significantly with altitude and ranges between 1.72 % at Burnihat and 3.5 % at Upper Shillong (protected stand). The mean values of total nitrogen content are

7488, 8847, 16679 and 11661 Kg ha-1 at Burnihat, Cherrapunji, and in the protected and unprotected stands at Upper Shillong, respectively. The extractable phosphorus is very low at all the sites and does not exceed 7.5 Kg ha-1. Exchangeable potassium ranges between 170 Kg ha-1 at Cherrapunji and 483 Kg ha-1 in the protected stand Upper Shillong.

Species content varied from 15 at Cherrapunji to 32 in the protected stand at Upper Shillong. The community at Burnihat was dominated by *Setaria glauca* whereas *Arundinella khaseana* and *Arundinella nepalensis* were dominants at Cherrapunji and Upper Shillong, respectively. Proportion of perennial species and chamaephytes in the community increased significantly with elevation. Legumes were poorly represented in all the grassland communities. forbs were most prominent at Upper Shillong, whereas the Cherrapunji grassland community was composed almost entirely of grasses. At Cherrapunji, species diversity was low and dominance was high compared to those at Burnihat and Upper Shillong. The grassland communities at various elevations were quite dissimilar. However, at Upper Shillong, there was about 80% similarity between the protected and unprotected stands.

Protection of community at Upper Shillong against annual winter burning and mild cattle grazing increased species content, density, cover and diversity. Dominance of *Osbeckia crinita* and *Arundinella nepalensis* declined following protection while that of *Imperata cylindrica* increased.

Nitrogen reserve in soil at Upper Shillong was approximately twice that of Burnihat and Cherrapunji. Of the total nitrogen in the soil-plant system, more than 98 % was present in

soil and only 1 to 1.5 % participated in biological circulation. Difference in the standing state of nitrogen in vegetation was insignificant among the four communities and the mean value ranged between 10.2 g m-2 at Burnihat and 12.2 g m-2 at Upper Shillong (protected stand). In all the communities, belowground parts accumulated more N than aerial parts. Annual uptake was maximum (232 Kg ha-1) in the Cherrapunji community. At Burnihat and in the unprotected stand at Upper Shillong, annual uptake was about 40 % less than the uptake at Cherrapunji. In the protected stand at Upper Shillong, uptake (206 Kg ha-1) was less than Cherrapunji but more than other sites. About two-third of the total uptake was diverted to belowground parts at Burnihat and Upper Shillong, whereas at Cherrapunji, it was much higher (ca. 88 %). The annual release through litter and belowground detritus was more than the uptake at Burnihat and in the unprotected stand at Upper Shillong. At Cherrapunji and in the protected stand at Upper Shillong, release was less than the uptake. The annual budget showed a net loss of about 13 % of the total uptake at Burnihat and 6 % in the unprotected stand at Upper Shillong. On the other hand, there was a net retention of about 5 % at Cherrapunji and 21 % in the protected stand at Upper Shillong. In all the communities, turnover rate was near unity indicating almost complete recycling within a year.

The amount of extractable phosphorus in soil ranged between 4.2 Kg ha-1 at Upper Shillong and 7.5 Kg ha-1 at Cherrapunji. Its mean accumulation in vegetation was maximum in the protected stand at Upper Shillong (2.48 g m-2) and minimum at Cherrapunji (0.96 g m-2). The grassland communities at Burnihat

and Cherrapunji exhibited more or less equal value but the unprotected stand had lower value than the protected stand. In all the communities, accumulation was 2-3 times more in the belowground parts than in the aboveground parts. Of the total available phosphorus content in soil and that stored in plant system, about 56 % was in vegetation at Cherrapunji, 86 % in the protected stand, *ca.* 25 % at Burnihat and in the unprotected stand at Upper Shillong. The accumulation in belowground parts was relatively less (36 %) at Cherrapunji than the other sites (51-56 %). In all the communities, the annual uptake was more than the amount of extractable phosphorus in soil. The annual uptake was maximum (34 Kg ha-1) in the protected stand at Upper Shillong, and it is nearly two times that of Burnihat and Cherrapunji. In the unprotected stand, it was 26 Kg ha-1. About two-third of the total uptake was transferred to the belowground parts at Burnihat and in the unprotected stand. In the protected stand, it was more than the unprotected stand. At Cherrapunji, the proportion of belowground uptake was 75 %. The release was more than the uptake at Burnihat, Cherrapunji and in the protected stand. In the unprotected stand, however, it was slightly less than the uptake. The annual budget showed a net loss of about 26 and 6 % of the total phosphorus uptake at Burnihat and Cherrapunji. Interestingly, the unprotected stand retained 6 % in belowground vegetation. In all the communities, turnover rate was quite fast and the value ranged between 0.8 and 1.2; the minimum being at Burnihat and maximum in the unprotected stand.

The exchangeable potassium in the soil was related to

the percentage of fine particles (clay + silt) and its amount was maximum in the protected stand (483 Kg ha-1) and minimum at Cherrapunji (170 Kg ha-1). At Burnihat, the reserve of exchangeable potassium in soil was about 50 % of that present in the protected stand at Upper Shillong, whereas in the unprotected community this was about twice that at Cherrapunji. Potassium content in the vegetation was maximum in the protected stand (8.37 g m-2) and minimum at cherrapunji (4.13 g m-2). It was 7.15 g m-2 in the unprotected stand and 5.56 g m-2 at Burnihat. Except at Burnihat, accumulation was more in the belowground than in the aboveground parts. The reverse was true at Burnihat. About 15-19% of the total labile potassium in soil and that stored in plant system participated in biological circulation. The annual uptake was maximum in the protected stand (139 Kg ha-1). A higher proportion of uptake was channelized to the belowground parts in all the communities except Burnihat where aboveground compartment was more prominent. The annual release through dead plant parts was less than uptake at all the sites except in the unprotected stand at Upper Shillong where the output and input were more or less equal. The annual budget showed a net gain of 20 % at Burnihat, 8 % at Cherrapunji and 13 % in the protected stand. Potassium turnover rate ranged between 0.95 and 1.16.

Protection of the community at Upper Shillong for about 7 months increased the accumulation of N, P and K in soil and vegetation compartments of the community. The uptake and release and daily flux rates between the compartments also increased. There was a build up of nitrogen and potassium mainly in the belowground phytomass of the community after protection.

A comparison of nutrient cycling in these grassland communities with those from other ecoclimatic zones of the country shows that in humid grasslands of Meghalaya, belowground parts play more important role in accumulation and cycling of nutrients than the aerial parts which have been reported to be of greater significance in other ecoclimatic regions of the country. The turnover of N, P and K is much faster in these grasslands compared to the subhumid, semiarid and Himalayan grasslands. The high turnover rate also depict the recycling of almost all the uptake of these elements annually in the grasslands of Meghalaya.