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Biodiversity of ligneous species in semi-arid to arid zones of southwestern Niger according to anthropogenic and natural factors

Larwanou Mahamane [a,*], Saadou Mahamane [b]

[a] *Département de Gestion des Ressources Naturelles (DGRN), Institut National de Recherches Agronomiques du Niger (INRAN), BP 429 Niamey, Niger*

[b] *Département de Biologie végétale, Université Abdou Moumouni de Niamey, BP 10662 Niamey, Niger*

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Abstract

Floristic diversity, abundance and disappearance of woody species were investigated at four sites of southwestern Niger, two in the semi-arid, two in the arid zone. The woody vegetation was assessed on transects from villages to bush, the measured parameters being number of individuals, height, diameter and number of stems. Questionnaires were used in the field to record information provided by the population for the disappeared species.

Sites in the semi-arid zone were species richer than those in the arid zone. In terms of land-use there was a significant difference among and within sites and the number of trees increased with the distance from the village to the bush.

A total of 23 species had completely disappeared from the study sites, i.e. five from the semi-arid and 18 from the arid zone. Thirteen different causes of tree species loss were recorded, six of them being of anthropic and seven of natural origin. Four disappeared species were consumed as leaves, buds, flowers and fruits while others were used as firewood and timber. All disappeared species were part of the traditional pharmacopeia. The plantation of useful species is suggested to improve re-introduction.

Keywords: Diversity; Disappeared species; Semi-arid zone; Arid zone; Niger

1. Introduction

In the Sahelian countries and particularly in Niger, the woody species occupy a significant place in the dynamics of the ecosystems and in the socio-economic life of the human population (Saadou, 1990; Gerard et al., 1997). The current Sahelian landscape is a result of natural and cultural factors, the biological diversity of woody species being linked to physio-geographical and climatic alterations. An estimated 2.124 plant species occur in Niger including 1.461 species of angiosperms (Saadou, 1998) while the flora of the southwestern part of the country is poorly known.

The degradation of the terrestrial ecosystems became apparent during the drought years 1973 and 1984 as a loss of woody and herbaceous perennial species, along the valleys and on the plains (Grouzis, 1988). The natural regeneration of the woody species is threatened by the scarcity of rain, their abnormal distribution in time and space, along a south–north gradient in particular (Ozer and Erpicum, 1995).

Like many Sahelian countries, Niger shows signs of a reduction in the biological diversity of tree

* Corresponding author. Tel.: +227-973442; fax.: +227-722252.
E-mail addresses: larwanou@caramail.com, m.larwanou@coraf.org (L. Mahamane).

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species (Larwanou, 1998). This regression is due to a number of factors including drought (Wijkman and Timberlake, 1990), high demographic pressure and overexploitation of the environment (Grouzis and Albergel, 1986; Mainguet, 1990). A study was undertaken in four villages of southwestern Niger to better understand the diversity, abundance, and distribution of woody species with a view to propose possible solutions.

2. Materials and methods

The sites selected in southwestern Niger were under semi-arid (sites I and II) and arid (sites III and IV) climate, between 200 and 300 m a.s.l. Annual average rainfall ranged between 500 and 700 mm in the semi-arid, 300–400 mm in the arid zone. The soils were in general sandy with various signs of degradation.

Two sites were mainly used for agriculture, another two for pastoralism. In the agricultural sites, land preparation for farming played a major role in the degradation of woody species diversity, whereas animal pressure mainly affected woody species in the pastoral sites (Sinclair and Fryxell, 1985; Stiles, 1995; Ganaba and Guinko, 1998).

Three types of land-use were identified in the sites, i.e. (1) natural undisturbed formations, (2) fallows and (3) parklands with scattered trees.

Investigations were carried out during the rainy season (August), during which all species can be identified. The inventory occurred on transects from the villages to the bush as described by Yamba (1994). The transects were chosen to cover all land-use types and the various physiographical units.

On each transect, plots 50 m × 50 m were defined, the first 300 m from the village, the following at 500 m distance. All woody species were recorded in each plot. Adult trees and regenerations (plants < 0.5 m) were listed separately for each species. The following parameters were measured: (1) height of the largest stem; (2) diameter at 0.2 m for trees < 1.30 m high; (3) diameter at 1.30 m for trees > 1.30 m high; (4) number of stems.

The Sympson index (I) was determined at each plot, and extrapolated by site or type of land-use as

$$I = \frac{N(N-1)}{\sum_{i=1}^{q} n_i(n_i - 1)}$$

where N is the total number of individual trees inventoried, q the number of species inventoried, and n_i the total number of individual trees for species i. The reciprocal of the index was used to appreciate diversity. Differences were analyzed by ANOVA general linear model (GLM).

For disappearing species, data were collected in a survey of the same transects to record information provided by the population. In each village, an assembly was convened around the head of the village and questions were asked using a questionnaire prepared for the circumstance. Old, average-aged and young people were asked to list species disappeared, threatened, the uses of each species, the past situation, the causes of disappearance and possible solutions. The number of people involved varied between villages from 123 to 210.

Transects were followed up to the limit of the village to confirm information. The model by Guarino (1997) based on the distribution of a taxon, a score being allotted to each factor was used, a rare species having a score of 10, an abundant one a score of 0. A score of 15 was allotted to species which had disappeared from the area.

Data were analyzed using SPSS software. A cross-tabulation was made to determine the percentage of answers given to each parameter, Pearson's coefficient of correlation being used to determine any correlation.

3. Results

There was a significant difference ($P < 0.01$) for the average number of species per plot (L.S.D. $= 1.24$). Sites located in the semi-arid zone were floristically richer (5.36 and 6.20 species) than those of the arid region (3.90 and 4.10 species). Sympson index of diversity for sites I–IV was 0.29, 0.19, 0.12 and 0.44.

The number of species varied significantly ($P < 0.001$) between land-uses (L.S.D. $= 0.94$). Parklands had more tree species per unit area than the other land-uses. The smallest number of species was recorded on site III. Fallow were a transition between parklands and natural formations with species num-