Natural Resource Conservation with Peoples' Participation in the Uplands of the Maribios Volcanic Ranges of Nicaragua. I. Appropriate Land Use and Rural Social Diversity[1]

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ABSTRACT

Biophysical and socioeconomic problems related to natural resource conservation of the uplands of the Maribios volcanic ranges of Nicaragua are discussed. Since the USDA method for land classification was found to be unsatisfactory, the FAO method, as adapted to the conditions of the Maribios, was used to develop appropriate land use maps of two (Nos. 3 and 4) of the eight upland watersheds of the Western Maribios. Almost all these uplands need appropriate soil, water and forest conservation measures to remain sustainable under present use or in use according to land capability. For watershed No. 3, 5466 ha (11%) and in No. 4, 10 342 ha (3.3%) are in a critical state. These critical areas need to be converted to forestry or otherwise protected. Almost 95% of the rural-based families are either small farmers (50%) owning 1.4-7 ha or landless share croppers/farm laborers (45%). Since both these groups are subsistence farmers and represent a majority in the rural-based society, special efforts are needed to adapt appropriate conservation technology to their needs, limitations and traditional practices, if present land use or use according to land capability is to remain sustainable in the Maribios uplands.

Key words: Land suitability classification, rapid rural appraisal, land use systems, land distribution.

COMPENDIO

Se discuten en este trabajo los problemas biofísicos y socioeconómicos relacionados con la conservación de los recursos naturales de la cordillera volcánica de los Maribios en Nicaragua. Para elaborar los mapas de uso general apropiado de la tierra, en dos de las ocho cuencas hidrográficas altas (nos. 3 y 4) de la parte oeste de los Maribios, se utilizó la metodología desarrollada por la Organización de las Naciones Unidas para la Alimentación y la Agricultura (FAO), y adaptada por el autor de este artículo a las condiciones de la región. El método del Departamento de Agricultura de los Estados Unidos de América (USDA) resultó inapropiado. Casi todas las tierras de las cuencas altas necesitan medidas de conservación de suelos, agua y bosques, para lograr sostenibilidad bajo los actuales usos o por capacidad de la tierra. Sólo alrededor del 11% de la tierra de la cuenca no. 3 y el 3.3% de la cuenca no. 4, con áreas totales de 5366 ha y 10 342 ha respectivamente, se encuentran en condiciones de uso conflictivo y consecuentemente crítico. Por lo tanto, si fueran usadas medidas de conservación, sería necesario convertirlas para uso forestal o en áreas protegidas. Del 95% de las familias rurales, 50% lo forman pequeños productores con fincas de 1.4 ha a 7 ha, y el 45% es una combinación de arrendatarios y trabajadores rurales. Dado que ambos grupos son productores de subsistencia y representan a la mayoría de la población rural, se requiere invertir esfuerzos especiales para adaptar tecnologías de conservación a sus necesidades, limitaciones y prácticas tradicionales, y para lograr la sostenibilidad en el uso actual o por capacidad de la tierra de los Maribios.

INTRODUCTION

The Maribios volcanic ranges of Region II of Nicaragua are densely populated (190 inhabitants/km^2), with a total population of about 376 000, of which about 45% live in rural areas. Approximately 11 000 families are dependent for their living on the uplands of the Western Maribios alone (50 000 ha, Fig. 1). The uplands of the Maribios are considered to be all those lands over 200 masl, since all lands below this elevation are practically flat. Almost 95% of these upland families are either landless (share cropping and casual labor) or are small marginal farmers (Sharma 1990). In general, these families are subsistence farmers who survive by rainfed agriculture, fuelwood collection and/or as casual laborers. The agricultural productivity of their lands has recently been going down due to serious erosion, estimated to be 30-40 t/ha annually in the region (Lutz *et al.* 1993). Most

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of the community forests in the region have also been disappearing progressively over the last 30 years, making fuelwood scarce. Thus, the majority of the population in the uplands is living in poverty, forcing these marginal farmers to over-exploit the lands and scarce forests, exacerbating poverty. Conservation of natural resources (soil, water, forest) for sustained crop and fuelwood production is an urgent task if the standard of living in the region is to be improved.

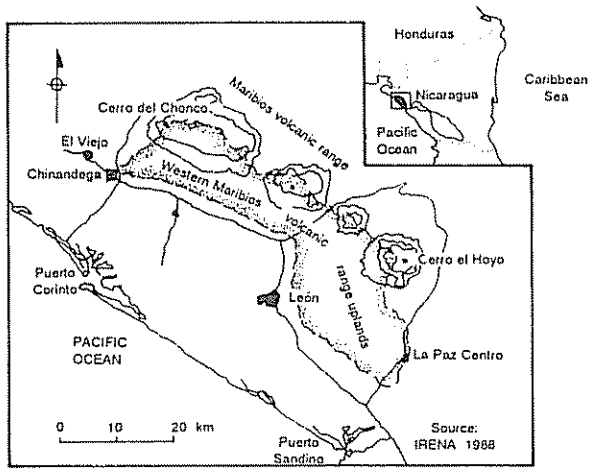


Fig. 1. Map of the Western Maribios volcanic ranges of Nicaragua.

This study, presented in three parts, aims at: (1) establishing appropriate land use based on land capability; (2) establishing appropriate natural resource conservation technology, as adapted to the farmers' traditional practices, needs and limitations, such that farmers can easily adopt it and conserve their natural resources through sustained crop and fuelwood production; and (3) developing a conceptual framework to determine incentives for farmers/land holders to carry out various conservation activities.

Part I of this study is a result of an analysis of eight upland watersheds of the Western Maribios. The study was conducted in 1989 to determine appropriate land use of the watersheds so that farmers can make rational use of their lands and meet their needs within their limitations and land potential.

SOILS AND RAINFALL

Soils

The soils of Western Maribios uplands are of volcanic origin and vary in soil taxonomical order from Entisols to Inceptisols (Nic. MAG 1969). They are mostly sandy or sandy loam in texture (Nic. MIDINRA 1979), varying in depth from very shallow (<20 cm) to very deep (>90 cm) (Nic. MAG 1971). The organic content of these soils varies from moderate to moderately high (3-6%), but, due to their volcanic origin, the soils have low levels of phosphorus and only moderate levels of potassium. All these characteristics make the soils moderately erodible (erodibility factor K = 0.1-0.25) (Nic. MIDINRA 1983). The risk of erosion for these soils without any surface cover becomes even higher as slope and rainfall increase. However, they can safely be used for sustained agricultural and forestry production even on slopes if they are properly protected by a suitable surface cover.

Rainfall distribution

The climate of the Maribios is sub-humid tropical. The average annual rainfall received in the uplands varies from about 1300 mm to 2000 mm, increasing from west to east (Nic. MIDINRA 1983).

Recent studies by Rapidel and Rodriguez (1990) show that the most probable date of rainy season commencement in the Leon and Chinandega areas (Fig. 1) is between 10-15 May. The areas north and west of Leon generally receive very irregular rains in the first humid period (*primera*) from May to August. The areas north and east of Chinandega regularly receive over 600 mm in the same period. There may be a relatively dry period (*canícula*) of two or more weeks during August. The potential for a dry period is high in areas to the north and west of Leon, but very low in areas around Chinandega. The second half of the rainy season (*postrera*) runs from August to November. Most areas around and to the north of Leon and Chinandega receive an average rainfall of over 700 mm during this period. The summer season (*apente*), from November to April, is usually a dry period receiving <20 mm of rainfall.

Winter rainfall is often received in the form of high-intensity storms which create even more erosion on unprotected sloping lands. But with proper

land protection, this rainfall is good for at least two crops annually. Thus, the Western Maribios have potential for sustained production if appropriate land management is used.

METHODOLOGY

There are many different methods used to classify land capability. In Latin America alone, over 35 methods are used in different countries (Tosi 1985). In Nicaragua, the USDA method (Klingebiel and Montgomery 1961) has been used in the past, and land capability classification maps have been prepared for many parts of the country (Nic. MAG 1969). The USDA method is usually an interpretation of the soil maps. Since most soils in the Maribios are good for any use, the only criterion used to differentiate land classes according to the USDA method in 1969 is soil depth; thus, this method gives soil capability rather than land capability. Additionally, under the tropical conditions of a developing country, this method suffers from various other limiting assumptions (Klingebiel and Montgomery 1961): a temperate climate, agriculture use only on the best soils, high inputs and mechanization, all of which are not valid in the Maribios case. The method also requires highly trained personnel for implementation. In Nicaragua, most extensionists are semi-trained and most farmers are semi-literate. For these reasons, although the USDA methodology has been available in the country since 1969, practically no transfer of the 1969 USDA land capability maps has been made to farmers' fields.

In addition to not considering the socio-economic conditions and needs of the farmers who use the lands, the USDA methodology specifies only

Table 1. Summary of land use planning criteria for Entisols/Inceptisols as adapted to the conditions of the Maribios, Nic. (Sharma 1990a).

FAO land suitability class	No. of land class	Slope (%)	Soil depth (cm)	General appropriate land use	General soil, water and forest conservation measures*
Suitable					
S_1	I	0-8			
S_1(a)	Ia	0-1.5	> 40	all	Nil
S_1(b)	Ib	1.5-8	> 40	all	Alley cropping with base knitting
S_2	II	8-15	> 40	all	Hedge rows with base knitting
S_3	III	15-25	> 20	Fruit trees or pasture or forest	Hedge rows or leguminous bushes and trees mixed
		all<15	20-40	-do-	-do-
Marginally suitable					
NS_1	IV	25-35	> 20	Community forestry	Cover crop or pasture cover on ground
		all<25	20-40	Community forestry or pasture with cover crops	Cover crop or pasture cover on ground
Not suitable					
NS_2	V	> 35	all	Integrally protected natural forest	No disturbance of any kind, completely protected area. no fire at all

* Biological soil fertility improvement methods are an integral part of all soil conservation measures on all lands except class V

mechanical methods of erosion control, not suited to the unstable nature of sandy soils on the uplands. The USDA maps do not constitute appropriate land use maps, as neither slope nor actual land use have been considered, making these maps difficult to use even for general land use planning.

An appropriate land use plan is not only an interpretation of soil data, but also includes topography, climatic conditions, socio-economic needs and limitations, socio-cultural limitations in implementing the plans, resource limitations of the land users, ease of transfer of the land use methodology under farmers' conditions (semi-literate), as well as actual land use. The USDA method does not take all these factors into consideration. Therefore, the FAO method as adopted by Sheng (1989), was further adapted by Sharma (1990a) to the bio-physical and socio-economic conditions of the Maribios uplands for sustained production, based on a rapid rural appraisal of socio-economic and cultural conditions, and was used to develop land use maps of some of the important watersheds (nos. 3 and 4) of Region II. This revised method is given in Table 1. The soil, water and forest conservation measures in Table 1 are a general guide, and have been developed in more detail as adapted to farmers' traditional practices, needs and limitations in Part II of this study.

The author's method uses the soil maps/data available in Nicaragua (Nic. MAG 1969) and determines the slope ranges for different climatic and soil conditions, superimposing soil depth and actual land use maps on them to arrive at general land use maps. These land use maps are good for general planning purposes only, due to their scale (1:50 000). However, a barely trained extensionist or even a semi-literate farmer can easily use this method to determine whether a farmer's piece of land is suitable for his preferred use or not. This is done by matching various land qualities (reflecting soil characteristics, climatic and topographic conditions) to the requirements of the use a farmer wants to make. As the only soil limitation in the Western Maribios is soil depth and the climate is suitable for most uses, the farmer need to only dig a hole in his farm to find soil depth and determine land slope with an A-frame. Using Table 1, the farmer can decide if his land is suitable for his preferred use or not.

Appropriate on-farm land use depends not only on land capability, but also on the farmers' needs, limitations and an appropriate conservation technology within their reach. Since this varies from farmer to farmer, land holding was used as a criterion for classifying different types of farmers to draw generalized conclusions. The method of rapid rural appraisal (Chambers 1987; Grandstaff and Grandstaff 1987) was used to determine various types of farmers and to establish their needs and limitations in nine rural areas of upland watersheds nos. 3 and 4 (Figs. 2, 3) during October-November, 1989. This method (RRA) permits a quick estimation of generalized, but not specific, conditions. But very specific, information is not needed, as each farmer should himself adjust his land use to his own special needs and limitations. Contour maps, soil maps, slope maps, land capability maps, actual land use maps (1987), interviews with various different type of farmers and field visits were used for compilation of the data.

RESULTS AND DISCUSSIONS

Appropriate land use

The soils (Entisols/Inceptisols) and the climate of the Maribios are suitable for almost any use that a farmer wants to make of his lands, except for certain important limiting factors that govern land capability. The most important factors determining land capability are land slope and soil depth, as shown in

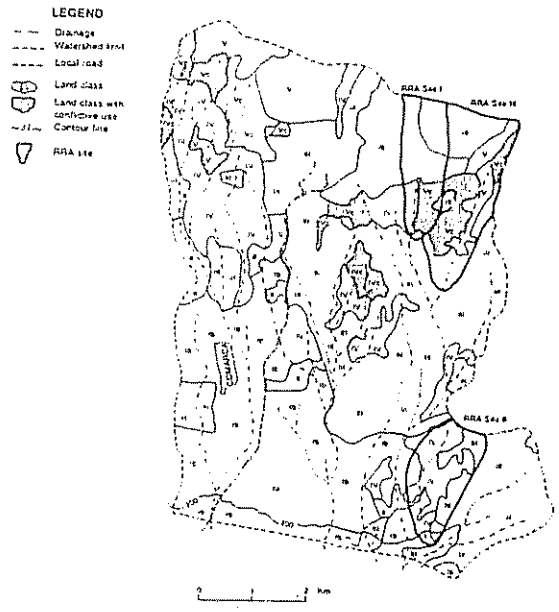


Fig. 2. **Indicative appropriate land use map of upland watershed no. 3 in the Western Maribios.**

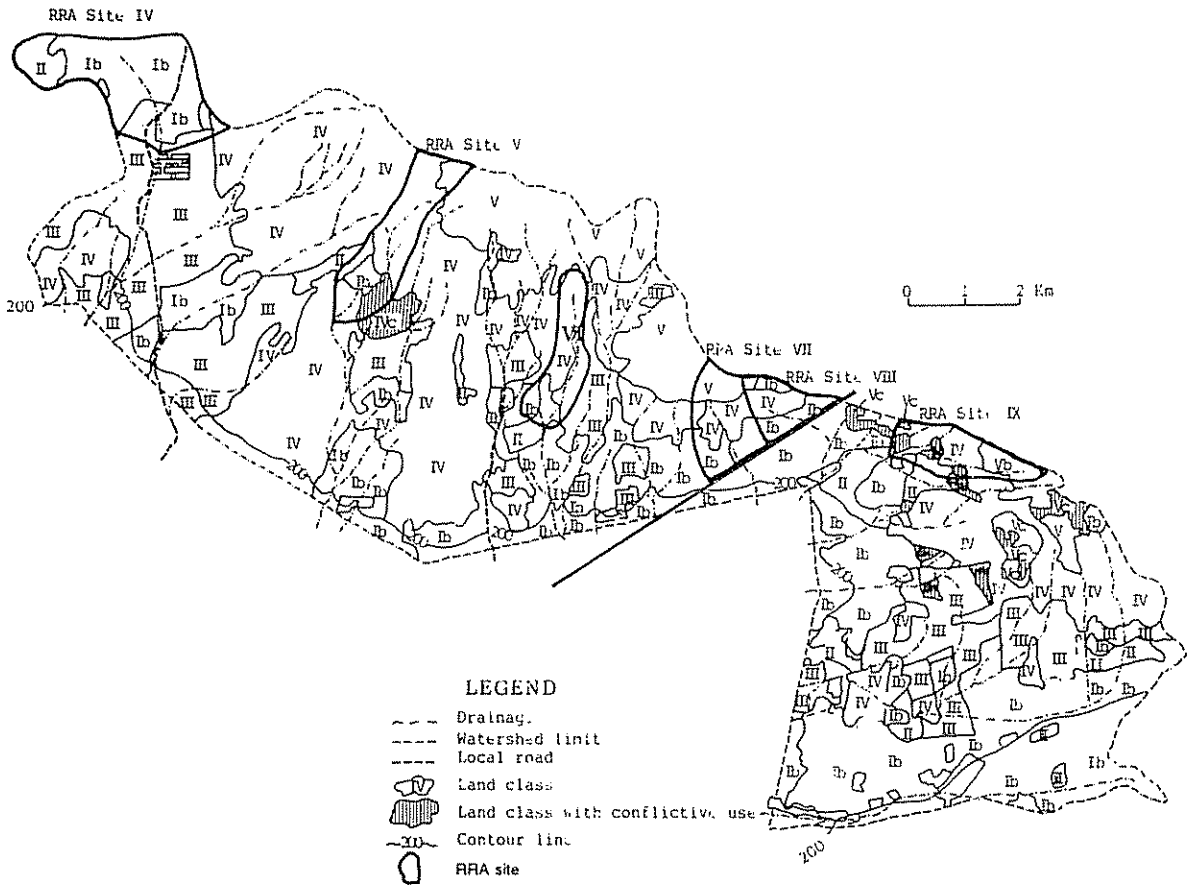


Fig. 3. Indicative appropriate land use map of upland watershed no. 4 in the Western Maribios.

Table 1, for the given climate and soils of the Maribios. Conditions such as stoniness and lava deposits should also be factored in before deciding on land use. Using the adapted land suitability classification criteria given in Table 1 (Sharma 1990a), soil maps, slope maps derived from contour maps by the circle method (1:50 000) and actual land use maps based on the most recent available aerial photographs (1987) were manually superimposed (manual GIS) to arrive at the indicative appropriate general land use maps of upland watersheds nos. 3 and 4. The superimposition is done such that a better or the same land use as recommended in Table 1 is maintained, and any use beyond the land capability is considered conflictive and classified as critical. The general appropriate land use as shown in Table 1 for different land suitability classes assumes appropriate natural resource, conservation technology.

Based on this analysis, Fig. 2 is a map of indicative general appropriate land use with land suitability classes for upland watershed No. 3. Out of a total area of 5466 ha of the watershed (Table 2), only 1.8% is flat (Class Ia). All the rest (98.2%) of the watershed needs conservation measures, as shown in a general way in Table 1, to remain sustainable under present use or use according to land capability. However, if appropriate conservation techniques are used, almost 89% of the area can continue to be sustainable under present use. A total of 10.7% of this watershed is under conflictive use, hence critical (lower case "c" shows critical land class in Table 2 and Fig. 2). All the critical area under conflictive use is in land classes IV and V, which exceed 25% land slope.

Fig. 3 shows the indicative appropriate land use and land suitability classes of upland watershed no. 4. There are no flat lands in this watershed, hence all of it (total 10 342 ha) needs appropriate conservation measures to remain sustainable under present land use or use according to land capability (Table 2).

Table 2. Areas of various general land use classes in upland watersheds 3 and 4 in the Western Maribios volcanic ranges of Nicaragua.

Land class	Watershed no. 3		Watershed no. 4	
	Area (ha)	(%)	Area (ha)	(%)
Ia	102	1.8	0	0
Ib	1 630	30.4	3 185	30.8
II	155	2.9	350	3.4
III	1 970	36.7	1 690	16.3
IIIc	-	-	70	0.6
IV	755	14.1	3 740	36.2
IVc*	65	1.2	110	1.0
V	510	9.5	1 024	10.0
Vc*	249	4.66	173	1.7
Total	5 436	100	10 342	100

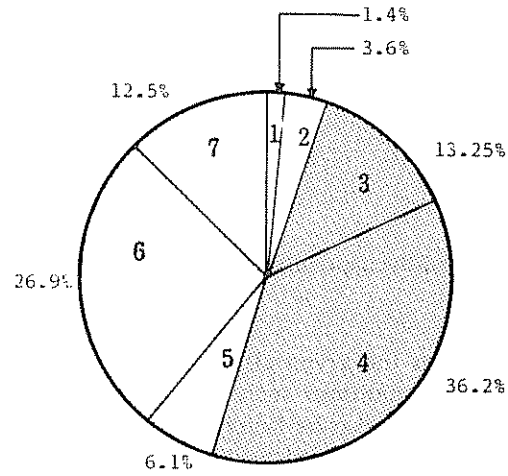
* Lower case "c" shows conflictive (critical) current land use

However, very little area (only 3.3%) is under critical/conflictive use (over 15% land slope), if appropriate conservation measures are used.

Thus, appropriate natural resource conservation technology is needed for farmers. In areas where present land use is in conflict with land capability, change of land use with appropriate conservation measures is needed (Table 1), measures which must continue if changed uses are to be sustained.

Socio-economic diversity of rural areas

When the results of the RRA of the nine rural areas in watersheds 3 and 4 of the Western Maribios (Table 3, Figs. 2, 3) are generalized, the rural areas show a great socio-economic diversity (Fig. 4). Using land holding as a criterion for farmers' socio-economic classification, only about 1.4% of the rural land holders can be classified as large farmers with over 50 ha of land. About 3.6% are medium-sized farmers holding between 7-50 ha of land. Most families (about 50%) are small farmers holding 1.4-7 ha only, of which about 14% are individual farmers, and the rest (36%) are associated with some type of cooperative. The remaining 45% of farmers are practically landless share croppers, except some 6% who own between 0.5-2 ha, as well as doing share cropping. Of this 45%, 27% of the total are share croppers who also work as part time laborers; the rest (12.5%) are purely casual laborers.



LEGEND

1= Big farmers holding > 70 maz of land
2= Medium farmers holding 10-70 maz of land
3= Small independent farmers holding 2-10 maz of land
4= Small farmers associated with cooperatives (2-10 maz)
5= Share croppers also owning 1-3 maz of land
6= Share croppers and casual workers
7= Casual workers only

Fig. 4. Different types of farmers based on land holdings in the Western Maribios.

The share croppers generally rented an average of 0.7-3.5 ha of land for about one year, paying rent of some 10% of their produce or an equivalent payment

Table 3. Types of farm families based on the RRA of land holdings in upland watersheds 3 an 4 of the Western Maribios, Nic.

Site (no.)	Village or rural area	Approx. no. of families	Type of farm family						
			Large >50 ha	Medium 7-50 ha	Small		Share cropper and		Casual labor only
					Individual 1.4-7 ha	Cooperative 1.4-7 ha	Small 0.5-2 ha	Casual labor	
1,2	Mekeron/María	300	2	7	61	130	-	100	-
3	El Guanacastal	200	-	3	-	14	-	39	144
4	Cristo Rey	300	-	15	-	200	30	55	-
5	El Panal	80	1	-	54	-	-	25	1
6	Palo de Agua	43	1	7	11	4	-	20	-
7	Jicarito	123	-	-	15	58	20	30	-
8	Santa Clara	24	7	-	-	-	-	17	-
9	Ojochal	84	5	10	12	12	20	25	-
Total		1 154	16	42	153	418	70	311	145
Average		144	2	5.25	19.1	52.25	8.75	38.8	18
Range		24-300	1-7	3 15	12 61	12-200	20-30	17-100	1-144
Total (%)		100	1.4	3 6	13.25	36.2	6.1	26.9	12.5

in labor and cash. Most often, land is rented to relatives, friends or persons trusted by the land owner. Thus, the status of the share croppers is very fragile.

From the above discussion of the socio-economic conditions of the rural areas, it can be concluded that land use and the recommended technological package of natural resources conservation measures for sustaining that land use must be tailored to: (a) the landless and share croppers who represent some 45% of rural-based society, and (b) small farmers who represent about 50% of rural land-holding society. Both groups live at the subsistence level with very meager resources. In Part II of this paper, minimum technological packages, especially for these two groups, are adapted to traditional farming practices to meet basic needs.

LITERATURE CITED

CHAMBERS, R. 1987. Short-cut methods in social information gathering for rural development projects. **In** International Conference on Rapid Rural Appraisal (1985). Proceedings. Thailand Khon Khen University. p. 33-67.

GRANDSTAFF, T B ; GRANDSTAFF, S.W. 1987. A conceptual basis for methodological development in rapid rural appraisal. **In** International Conference on Rapid Rural Appraisal (1985). Proceedings. Thailand, Khon Khen University. p. 69-88.

KLINGEBIEL, A.A ; MONTGOMERY, P.H. 1961. Land capability classification. USDA/SCS. Agricultural Handbook no. 210. p. 1-21.

LUTZ, E ; PAGIOLA. S ; REICHE, C. 1993. Economic and institutional analysis of soil conservation projects in Central America and the Draft Document of The World Bank Caribbean. CATIE/World Bank Project. p. 14.

NIC. MINISTERIO DE AGRICULTURA. DEPARTAMENTO DE SUELOS Y DASONOMIA. 1969. Mapa de suelos y capacidad de suelos.

NIC. MINISTERIO DE AGRICULTURA. DEPARTAMENTO DE SUELOS Y DASONOMIA. 1971. Catastro e inventario de recursos naturales: Manual práctico para interpretación de los mapas de suelos. Managua DN. 7. p. 10-14.

NIC. MINISTERIO DE DESARROLLO Y REFORMA AGRARIA. DGTA. DIRECCIÓN DE SUELOS Y AGUAS. 1983. Identificación y delimitación de las

zonas de máxima protección contra la erosión en la planicie León-Chinandega. 43 p.

RAPIDEL, B.; RODRIGUEZ, J.R. 1990. Zonificación agrometeorológica de las lluvias en Nicaragua. DGTA/MAG, CATIE/CIRAD/ ORSTOM, Programa Nacional de Agrometeorología. 24 p.

SHARMA, P.N. 1990a. Report of consultancy in soil conservation and agro-forestry. FAO Project GCP/NIC/019/NET. 72 p.

SHARMA, P.N. 1990b. Manual on soil conservation by agro-forestry methods for the uplands of the Western Maribios Mountains of Nicaragua. Rome, FAO (UN), Project GCP/NIC/019/NET. 104 p.

SHENG, T.C. 1989. Soil conservation for small farmers in the humid tropics. FAO Soils Bulletin no. 60. p. 97-99.

TOSI, J.A. 1985. Sistema para la determinación de la capacidad de uso de las tierras de Costa Rica. San José, C.R., Centro Científico Tropical. p. 1-5.