COOPERATIVE AGREEMENT ON HUMAN SETTLEMENTS AND NATURAL RESOURCE SYSTEMS ANALYSIS

UPPER ARTIBONITE RIVER BASIN: IDENTIFICATION AND ASSESSMENT OF PLANNING UNITS

42

by

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1. INTRODUCTION

1.1 Scope and Purpose

In a previous document (Coffey, Lewis, and Hauge, 1984), the present authors proposed a set of specific interventions designed to improve the standard of living in the Cayes Plain Basin, while at the same time improving its land resource base. The conceptual-methodological approach which was developed in the course of this planning exercise and which served as the basis for that set of specific interventions was identified as a coordinated regional perspective.

A coordinated approach signifies one which considers various economic sectors (e.g., marketing, transportation, agriculture, industry), various components of the physical environment (e.g., rainfall, soil depth and quality, geomorphology, lithology) and various elements of the socio-cultural milieu (e.g., attitudes, values, and beliefs associated with farming practices and land tenure). Further, these three broad categories must themselves be regarded as functionally interacting systems. A regional approach signifies one in which the spatial dimensions of both human social-economic activity and the physical environment are incorporated into the planning process. The regional approach may be contrasted with the sectoral approach favored by classical economics, in which the location of phenomena plays no role. From a pragmatic viewpoint, the regional approach encourages the concentration of planning efforts within a well-defined area rather than allowing them to be spread too thinly over a wide area.

A region is an intellectual construct having no existence beyond the minds of the planners and policy-makers who establish it for a specific purpose using

various human and physical criteria that will best permit planning goals to be achieved. That is to say, regions do not exist naturally but are delineated as needed. There is, however, a logic to the delineation of a region, and this generally involves the consideration of both the homogeneity of attributes (e.g., per capita income, soil and crop types) and the flow patterns of people, products, information, money, energy and physical matter (e.g., soil particles, water). In the previously mentioned Cayes Plain Basin Study the river basin was utilized as the regional unit of analysis. There were two reasons for this decision. First, many of the variables and attributes upon which the coordinated rural planning methodology is based (e.g., pedological, biological, and hydrological factors) were clearly seen to function within the boundaries of major river basins. Second, field investigation by the study team demonstrated that many manifestations of human social and economic activity tended to function most strongly within river basin boundaries. That is to say, it was generally observed that a higher level of social and economic flows occurred within river basins than between basins.

The purpose of the present study is to lay the groundwork for a coordinated approach to rural regional development in the Upper Artibonite (Central Plateau). It seeks to accomplish this objective by the following sequence of steps. First, the vast area that comprises the Upper Artibonite will be disaggregated into more tractable planning units on the basis of both physical and social-economic criteria. Second, the characteristics of each planning unit will be reviewed and the units will then be ranked in terms of development potential. Finally, some general planning interventions will be suggested. As stated above, the goal of these interventions is to improve the standard of living of the population while improving the land resource base. It should be

noted that this study has been carried out without the extensive field investigation that characterized the Cayes Plain study. Thus, the information and recommendations contained in the present document must be viewed as suggestive rather than definitive.

1.2 Rationale for Upper Artibonite Boundary

No single criterion for determining the boundaries of the Central Plateau is widely accepted. Two recent reports, the National Transport Study and the Projet De Mise En Valeur Du Plateau Central delimit the area utilizing drainage patterns rather than topographic criteria as the term plateau implies. Nowhere is this more explicit than in the vicinity of Montagne Terrible (18° 55' N, 72° 25' W). According to these two studies, the Central Plateau is limited to the northern portion of the Montagne Terrible area since surface waters in this portion drain into the Artibonite; the southern portion, while morphologically identical, is excluded from the Central Plateau as streams in this section drain directly into the Canal de Saint Marc.

In practice, the Artibonite River Basin and Central Plateau are used almost interchangeably. According to the National Transport Study and Projet De Mise En Valeur Du Plateau Central, all lands upstream from the confluence of the River Capucins with the Artibonite comprise the Central Plateau (Figure 1.1). Within this area of approximately 5,300 square kilometers is found a diversity of topographic conditions including: rolling uplands of low relief; narrow river valley bottoms having no flood plains; rivers having well developed flood plains; rugged dissected mountain ranges; and individual mountain peaks overlooking broad areas of low relief. Given the mixture of landscapes found throughout the lands designated as the Central Plateau, the best single

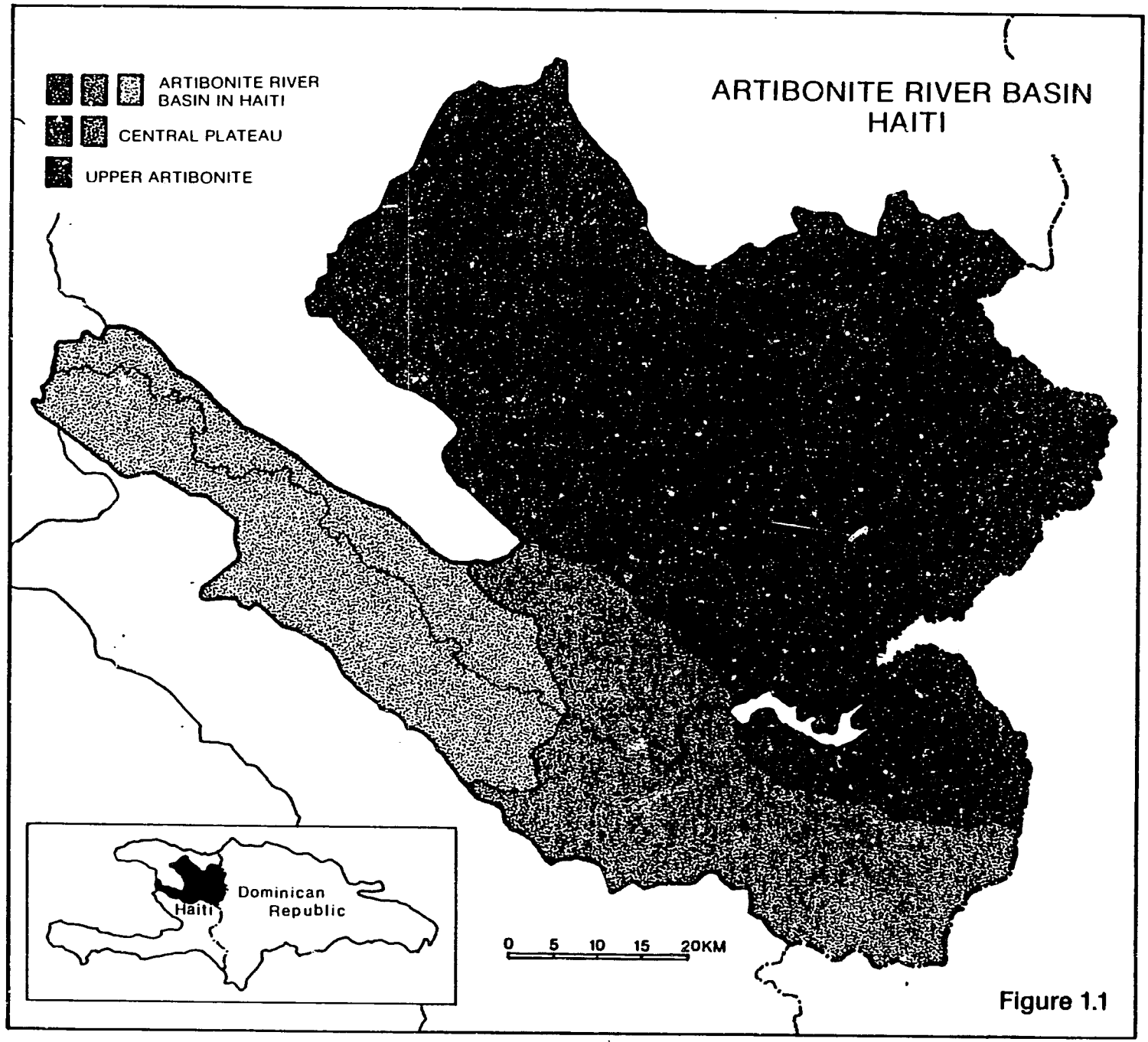

ARTIBONITE RIVER BASIN IN HAITI
CENTRAL PLATEAU
UPPER ARTIBONITE
ARTIBONITE RIVER BASIN
HAITI
Haiti
Dominican Republic
0 5 10 15 20KM

Figure 1.1

unifying physical attribute for these lands is not topographic features but the Artibonite river system network.

Again, within the comtemporary Haitian context, it is the Artibonite River that is the critical economic resource of this area. Two major economic activities at the national scale are directly linked to the river discharge of the Artibonite and the storage capacity of Lake Péligre. First, there is the generation of electricity associated with Péligre Dam; and second, there is production of irrigated rice within the Lower Artibonite flood plain between Saint Marc and Gonaives. Resulting from the existing land use practices in the Artibonite Basin, these two crucial activities are being threatened due to the excessive sedimentation occurring in the lake. Already over 22 percent of the reservoir's capacity has been lost (Consultants HQI - LGL - LMBDS, 1981: p.1). Given the dominant economic role of Lake Péligre, one assumption of this report is that proposed activities must be oriented toward ameliorating the existing land use operations that are a contribution to the reservoir's excessive sedimentation.

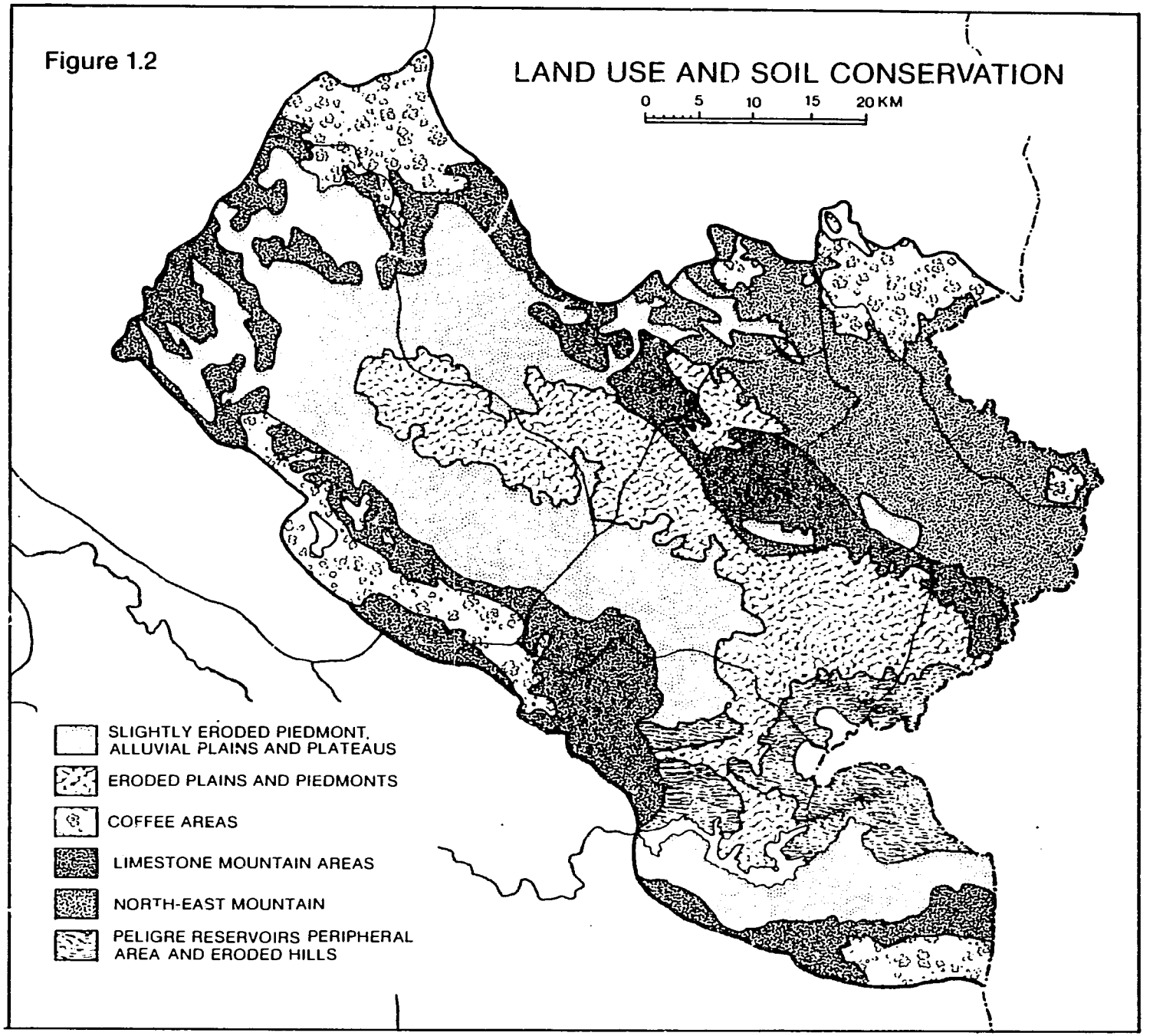
In order to be able to focus on the hydrologic, lands, and human relationships that impact on the lake, this report slightly redefines the Upper Artibonite from previous studies. Henceforth on, only lands within the Lake Péligre catchment are considered within the Upper Artibonite. The term "Central Plateau" will refer to all of the lands above the flood plain. Using this hydrologic boundary, instead of the geomorphic criterion of the initiation of the flood plain (River Capucins), is appropriate given the need to protect the lake in order to insure the long term vitality of both the hydroelectric and irrigation activities. With this definition, the Upper Artibonite is approximately 4,300 square kilometers.

1.3 Land Use

Approximately 195,000 ha of land are cultivated in the Upper Artibonite under the existing agricultural system over a number of years (40 percent of total area). Given current farming practices and the quality of lands under cultivation, only 156,000 ha should be farmed if land degradation and sediment supply are to be minimized (SCET, 1980,vol. 4: p. 4). This overutilization of the land resource is resulting in excessive soil-loss especially in the mountainous areas having limestone derived soils as well as the immediate areas juxtaposed to Lake Péligre (Figure 1.2). As only approximately 80,000 farms exist throughout this whole area (average size about 2 ha), the excessive land degradation occurring under this low intensity farming (by Haitian standards) indicates the poor farming practices prevailing throughout the area.

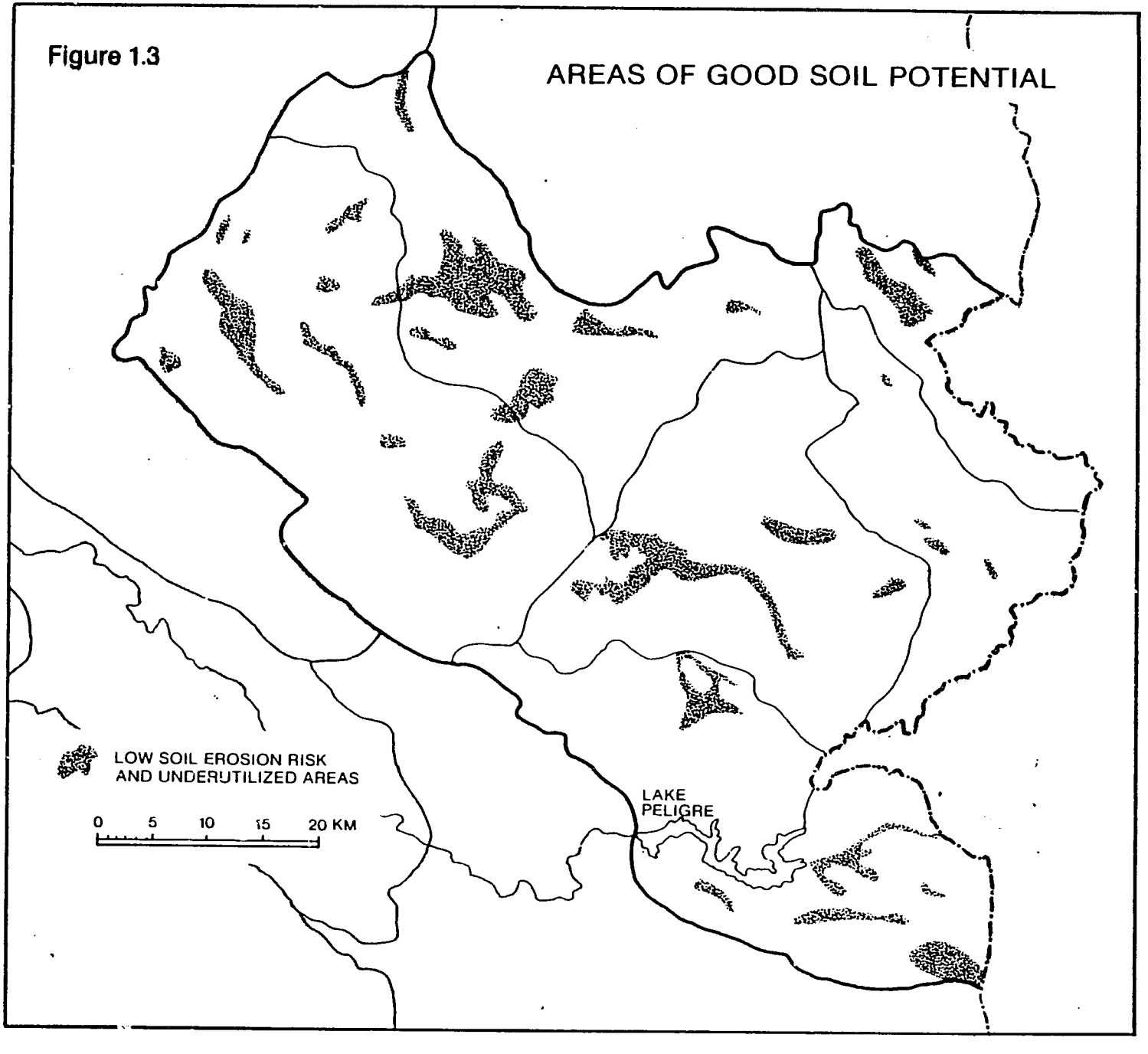
Palmer (1976: 11: 29-36) in his study subdivides a portion of the lands in the Upper Artibonite into three broad zones using "natural" ground cover properties as the critical variable. Zone I consists of open grasslands found in the neighborhood of St. Michel de l'Atalaye. This grassland has remained relatively unchanged since Spanish settlement. Zone II is grasslands mixed with low thorn scrub. This area, unlike Zone I was once forested; most of the tree clearing has occurred in the twentieth century. Madame michel (Themeda quadrivalvis) - very coarse, tall grass is the most characteristic vegetation in this zone. It is an indicator of poor soil. Prior to the twentieth century, it was uncommon; its rapid expansion is a good indicator of land degradation. The third zone in Haiti (Palmer's Zone V) are lands continuously cultivated. For planning purposes his classification is of little utility due to its emphasis on "natural" vegetation, its general nature, and lack of emphasis on human use.

Figure 1.2


LAND USE AND SOIL CONSERVATION
0 5 10 15 20 KM
SLIGHTLY ERODED PIEDMONT, ALLUVIAL PLAINS AND PLATEAUS
ERODED PLAINS AND PIEDMONTS
COFFEE AREAS
LIMESTONE MOUNTAIN AREAS
NORTH-EAST MOUNTAIN
PELIGRE RESERVOIRS PERIPHERAL AREA AND ERODED HILLS

Likewise, the four broad agricultural zones articulated in Volume 4 of Projet Mise En Valeur (P.9) are too general for project planning purposes. The four agricultural categories, Coffee Lands, Other Mountain Lands, Good Agricultural Lands in the Plains, and Other Agricultural Lands on the Plains do not provide sufficient information for rural land use management. The final report of Etude Sédimentologique Du Réservoir Péligre (pp. 83-85) also presents broadly defined descriptive land use classifications that would be difficult to apply in any analytical methodology. The land capacity classification as well as the erosion potential of the soils mapped in the DATPE series provide much better information for general rural land use planning than the previously discussed classifications. The land capability classification emphasizes the importance of slope declivity in affecting the agricultural potential of lands; the erosional potential of the soils incorporates the lithologic influence on soils as well as the slope/steepness factor. The greatest limitation of the DATPE data is the small scale (1:250,000) at which it has been compiled. By combining the information provided in the DATPE maps, Figure 1.3 was constructed to illustrate the areal distributions of lands having both good soil potential as well as the lands that can be planted in annual crops without major erosional risks. As a first approximation, the lands within the delimited areas on Figure 1.3, if not under cultivation are being underutilized from a purely agricultural perspective. However, it is clear, from the location of some of these areas, such as immediately east of Lake Péligre, that some of these lands are on valley bottoms; thus they are susceptible to flooding. What the figure clearly conveys is that overall, most of the lands within the Upper Artibonite should not be placed under annual agriculture.

Figure 1.3


AREAS OF GOOD SOIL POTENTIAL
LOW SOIL EROSION RISK
AND UNDERUTILIZED AREAS
0 5 10 15 20 KM
LAKE
PELIGRE

The uses to which the remaining overwhelming percentage of lands within the Upper Artibonite should be put are: permanent agricultural crops (e.g., coffee), improved pasture, and silva-agriculture. In actuality, most of the lands in this area are in unimproved pasture. Because of the large areal extent of the Upper Artibonite (it is approximately five times larger than the Cayes Plain Basin), a need exists to develop subareas before a coordinated rural development strategy can evolve to rationalize the land use of this area.

1.4 Demographic-Economic Characteristics

The 1971 population of the Upper Artibonite study area is estimated at 440,000. Of this total, approximately 9 percent may be classified as "urban" and 91 percent as "rural." The term "urban" is, however, potentially misleading in that the area contains no large urban centers (Table 1.1). Overall, the area's population is highly dispersed with only 30 percent living in agglomerations of 30 or more persons. Average population density is 102 persons per square kilometer (compared with a national average of 177). This, however, includes a wide variability in density, ranging between 20 per square kilometer in the "other mountain lands" (see section 1.3) to 200 per square kilometer in the "coffee lands" and the "good agricultural lands in the plain."

In summary, the study area may be regarded as one of the least populated areas of Haiti, in spite of what appears to be a considerable natural resource potential. One reason that is often cited for this underpopulation is the lack of accessibility of the area to other, more populated portions of the country. Palmer also cites historical as well as political reasons for the low level of development of Upper Artibonite. The Upper Artibonite area, like the more broadly defined Central Plateau area, may be regarded as one of the most archaic rural economies in the country. The peasants, living in relative

isolation in the rural areas, are among the poorest in Haiti; the 1971 annual per capita income of the rural population ranged between 510 gourdes, in the poorer lands, and 590 gourdes, in the better lands (SCET, 1980, vol. 10). Up to and into the 1950s, however, some areas were reasonably prosperous due to large scale cotton cultivation as well as agricultural and livestock production. A number of crop blights caused a sudden drop in the productivity of the area, a set-back from which it has never recovered.

TABLE 1.1

Upper Artibonite Population Centers, 1971

Rank	Name	Population
1	Hinche	8,465
2	St. Michel de l'Atalaye	4,559
3	Lascahobas	3,173
4	Pignon	3,086
5	St. Raphael	2,688
6	Dondon	2,521
7	Maissade	2,288
8	Belladère	2,204
9	Thomonde	1,899
10	Saut d'Eau	1,852

The study area is characterized by a weakly developed physical and social infrastructure. Water and sewage systems are rarely found in the area; transportation routes and communications facilities are inadequately developed; full-time electrical service is not available in all "urban" centers. Outside of two under-equipped hospitals at Hinche and Belladère, medical care is restricted to dispensaries and health centers with limited facilities and expertise for the treatment of serious illness. Similarly, the scarcity of educational facilities and personnel contribute to the creation of an inadequate level of educational services. Hinche and Belladère constitute the area's principal educational centers.

As noted above, approximately 91 percent of the area's population may be classified as "rural," and over 90 percent of this segment is engaged in some form of agricultural production. There are some extractive industries in the area but these are not of a significant level. Manufacturing activity is almost nonexistent, save for some artisanal activity -- textiles, clothing, leather -- and some small scale agricultural-based processing. In the urban centers over one-half of the labor force is involved in tertiary activity, principally administration and retailing.

Trading patterns and the flows of goods suggest that, from an economic perspective, the area possesses no internal cohesion or unity. The principal economic flows focus upon centers external to the area rather than those within the area. Thus, from an economic viewpoint the area should not be considered as a region. Figure 1.4 illustrates this external orientation. The northern portion of the study area is oriented toward Cap Haitien and Gonaives, while the southern portion is oriented towards Port-au-Prince. Hinche, the largest center in the study area, provides a local focus for the central portion of the

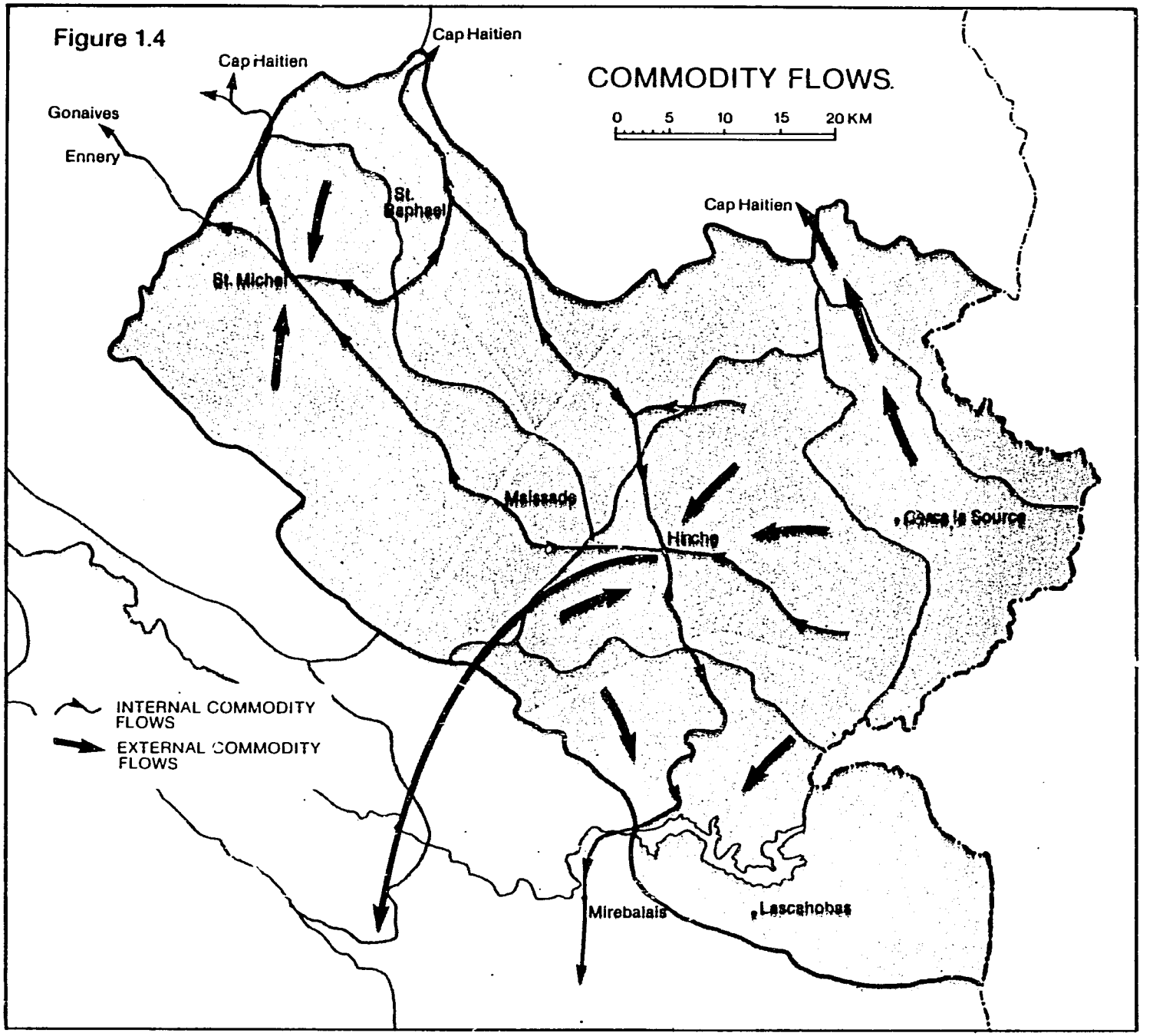


Figure 1.4
COMMODITY FLOWS.
0 5 10 15 20 KM
Cap Haitien
Cap Haitien
Gonaives
Ennery
St. Raphael
St. Michel
Cap Haitien
Maissade
Hinche
Cerca la Source
Mirebalais
Lascahobas
INTERNAL COMMODITY FLOWS
EXTERNAL COMMODITY FLOWS

area; due to the limited size and range of functions of Hinche, however, this portion of the study area is ultimately oriented towards Port-au-Prince.

Figure 1.5 indicates the type and location of markets existing in the study area. Fifty-seven markets may be identified; five of these are classified as "regional" markets and fifty-two as "semi-rural" markets.[1] Relative to the large area encompassed by the Upper Artibonite, the small number of markets -- especially of "regional" level is a manifestation of the low level of economic activity throughout the area.

2. PLANNING UNITS

2.1 Regionalization Criteria

In the selection of appropriate regional planning units for the Upper Artibonite the principal concern is with improving the area's level of development while minimizing sedimentation within Lake Péligre. The first attempt at regionalization employed the approach developed in the context of the Cayes Plain Basin study, i.e., the use of both physical and socio-economic criteria to define functional regions. In the Upper Artibonite this approach was found to be not entirely appropriate. First, in the physical domain, we are dealing with a fragmented system. A significant portion of water and sediments originates within the Dominican Republic. Thus, it is not possible to control the entire system from only one side of the international border. In addition, the large areal extent of the system (approximately seven times greater than the

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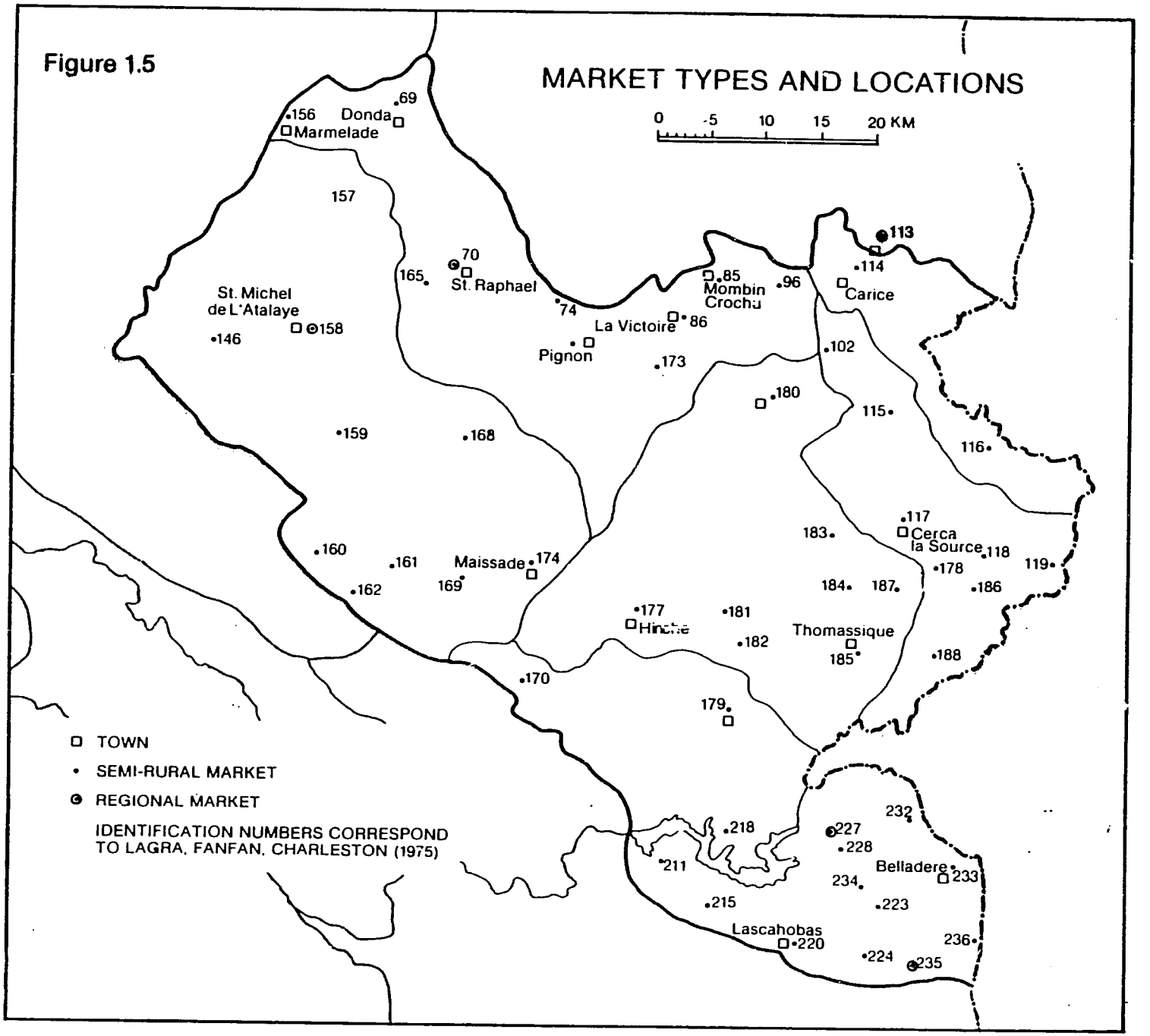
1 This classification is based upon that presented by LaGra, Fanfan, and Charleston (1975). The principal distinction between the two types is that the former serve major portions of the country, while the latter serve local areas only. Figure 1.5 identifies market locations by code in common use by Haitian government. See LaGra, et al. for full list of locations by name.

Figure 1.5


MARKET TYPES AND LOCATIONS
0 5 10 15 20 KM
156
Donda
69
Marmelade
157
70
St. Raphael
165
St. Michel
de L'Atalaye
158
146
74
La Victoire
86
Pignon
85
Mombin
Crochu
96
113
114
Carice
102
173
180
115
116
159
168
117
Cerca
la Source
118
119
183
178
186
160
161
Maissade
174
169
162
184
187
177
181
Hinche
182
Thomassique
185
188
170
179
TOWN
SEMI-RURAL MARKET
REGIONAL MARKET
IDENTIFICATION NUMBERS CORRESPOND
TO LAGRA, FANFAN, CHARLESTON (1975)
232
218
227
228
211
Belladere
233
234
215
223
Lascahobas
220
236
224
235

Cayes Plain Basin) in an area of heterogeneous terrain introduces considerable complexity into the system. It, therefore, becomes necessary to introduce a set of smaller units in order to develop a workable planning strategy. Second, from a socio-economic perspective, as indicated in section 1.4, preliminary data suggest that the Upper Artibonite lacks an internal focus; instead, it is fragmented and polarized towards three external urban centers. These results stand in direct contrast to findings for the Cayes Plain Basin, where both physical and human flows complement one another within a clearly defined and functionally integrated region.

A third set of regionalization criteria were considered -- existing administrative units. This was discarded as a feasible alternative since these units are quite artificial, in the sense of accurately reflecting neither physical nor human flows. Further, although in theory these units could be potentially useful for planning purposes, in practice, except for military functions, local administrative posts are either greatly understaffed or non-existant (Kulibaba, 1983: Ch. 2). Thus, the river basin criterion has been judged to be the most useful concept to employ in the delineation of planning units in the Upper Artibonite. While not entirely consistent with human flows, the planning units derived certainly do not misrepresent the externally-oriented movement of people and commodities. On the other hand, these planning units will enhance the implementation of interventions designed to minimize the siltation of Lake Péligre, which must be considered a national priority, as well as general agricultural and livestock activities.

2.2 Delineation of Regional Planning Units

Seven major planning units, each corresponding to a primary tributary river basin, have been identified within the Upper Artibonite (Figure 2.1). These seven basins have been assigned to three groups (Table 2.1). The Type I basins function as the primary Artibonite hydrological unit within Haiti. The streams combined in this grouping contribute the greatest discharge to the Artibonite River and, eventually, into Lake Péligre. The Type II basins flow directly into Lake Péligre. While contributing a lower quantity of discharge to Lake Péligre than the Type I basins, their contiguity to the lake indicates that they are major sources of sediment. The Type III river basins have strong fluvial interactions with adjacent basins in the Dominican Republic. Interventions in these areas will yield minimal results unless they are coordinated with initiatives in the Dominican Republic. In addition, the relative isolation of the Type III basins from other areas within the Upper Artibonite, and from the rest of Haiti, compounds the difficulties in inducing development within them.

TABLE 2.1
Classification of Major River Basins: Fluvial-Geomorphic Properties

Type	Basin
I (Primary Hydrologic Unit)	Canot Bouyaha Guayamouc-Aval
II (Adjacent to Lake Péligre)	Thomonde Péligre Sud Basins
III (Interacting with Dominican Republic, Isolated)	Lociane Libon

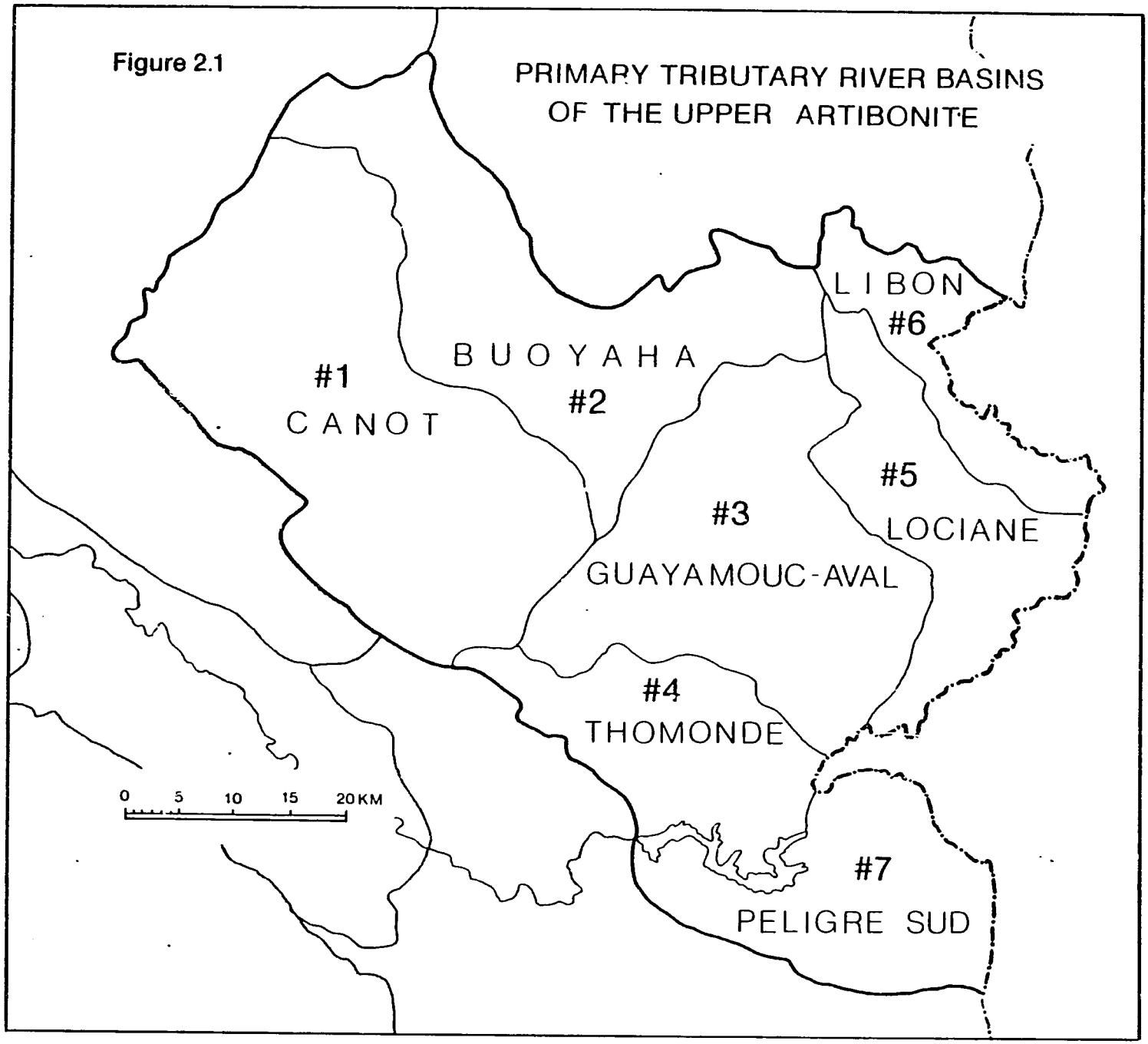

PRIMARY TRIBUTARY RIVER BASINS
OF THE UPPER ARTIBONITE
#1
CANOT
BUOYAHA
#2
LIBON
#6
#3
GUAYAMOUC-AVAL
#5
LOCIANE
#4
THOMONDE
#7
PELIGRE SUD
0 5 10 15 20KM

Figure 2.1

2.3 Assessment of Planning Unit Development Potential.

For each of the seven tributary basins, a set of characteristics describing critical attributes pertinent to its development potential have been compiled (Table 2.2). These attributes include: the quality of the land resource; irrigation potential; potential for coffee cultivation (a cash crop that can overcome the existing transportation and storage difficulties in the area); relative accessibility (road index); and presence of population agglomerations and markets. Due to the lack of uniform data coverage it was necessary to restrict the range of attributes considered to this very basic set. Further, because of the wide range in the completeness and quality of information concerning even these attributes, it was necessary to aggregate the data from various sources into an ordinal ranking. This at least permits us to evaluate the relative strengths and weaknesses of each of the planning units. While it is recognized that this approach is somewhat limited, few alternative methods are available since most data are aspatial and thus not disaggregated to a useful level. For example, the National Transport Study - Volume 7 - Agricultural Development in the Central Plateau contains no site-specific information for locating proposed agricultural activities. All quantitative information and recommendations are completely aspatial; the vast Central Plateau is treated as a homogeneous unit.

Three apparently distinct groupings of planning units emerge from Table 2.2. The first group, A, the Canot and Bouyaha tributary basins (see Figure 2.1) have the highest overall potential for development in the Upper Artibonite, based upon the criteria considered. The second group, B, the Guayamouc and the basins of Péligre Sud, manifest an intermediate level of potential while the remaining three basins (Group C) have the lowest degree of potential. The highest ranking in five of the seven categories utilized was

TABLE 2.2

Ranking of Planning Units[1]

ID No.	Basin	Good Land[2] (Total Area)	Good Land[3] (Percent)	Road Index[4]	# Pop. Centers	# Markets	Potential[5] for Coffee	Irrigation[6] Potential	TOTAL Score	Ranked Grouping
1.	Canot	7	5	5	4.5	5.5	4.5	7	38.5	A
2.	Bouyaha	6	7	5	7	5.5	7	5.25	42.75	A
3.	Guayamouc-Aval	5	3	5	6	3	2	4.75	28.75	B
4.	Thomonde	2	2	5	2	2	2	4.5	19.5	C
5.	Lociane	1	1	1.5	2	4	2	3	14.5	C
6.	Libon	3	5	1.5	2	1	6	1	19.5	C
7.	Péligre Sud	4	5	5	4.5	7	4.5	1.5	31.5	B

Notes:

1. 7 = highest; 1 = lowest

2. Good land includes agricultural potential (Class 1, 2, 3 soil - LCC classification) and erosion status and risk (DATPE erosion map)

3. Good Land/Total Area

4. Road length/Total area

5. Project mise en valeur du plateau central - synthese du deuxième rapport, 1980, p.7

6. Index combining irrigable surface (DATPE surface water map, 1982) and lithologic characteristics (OAS geology map, 1972)

attained by either the Bouyaha or Canot basins, indicating their high potential relative to other units. It must be stressed, however, that the relative strength of these two units should not imply that they have high potential for development in absolute terms.[2]

A detailed inspection of the background data used to determine the rankings shown in Table 2.2 illustrates this point (Table 2.3). For example, the road density across the seven planning units in the Upper Artibonite ranges from a "high" of .08 km/km^2 to 0.00. This lack of road development is further emphasized if road quality is considered. Nowhere in the Upper Artibonite does an all-weather paved road exist. Further, almost all river crossings are fords rather than bridges. These latter two properties severely restrict overland transportation during the rainy season on the few roads that do exist. Likewise, the absolute quantity of "good" agricultural land is scarce throughout the entire study area. The Canot basin, which has the greatest absolute amount of "good" agricultural land, contains only 92 square kilometers scattered throughout a total area of 1,135 square kilometers. The Bouyaha basin, which has the greatest percentage of "good" agricultural lands, has only 10.8 percent (88 km^2). It must be emphasized that none of these "good" agricultural lands fall within the highest LCC category.

A comparison of Table 2.1 (Fluvial-Geomorphic Classification) and Table 2.2 (Ranking of Planning Units) indicates a high degree of correspondence between groupings. The Guayamouc-Aval basin (lower Guayamouc) which is linked hydrologically to the Canot and Bouyaha basins falls into the intermediate

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2 In the judgement of the authors no single planning unit in the Upper Artibonite manifests a level of development potential approaching that of the Cayes Plain Basin.

TABLE 2.3

Background Data Used in Rankings (Table 2.2)[4]

Basin	Approx. Area of Good Land (km^2)	Approx. Total Basin Area (km^2)	% of Good Land	Road[1] Lengths (km^2)	Road Length/ Total Area (km/km^2)	Population[2] Centers	Markets
1. Canot	92	1,135	8.1	68	.06	2	10
2. Bouyaha	88	812	10.8	49	.06	6	10
3. Guayamouc	65	850	7.6	65	.08	3	7
4 Thomonde	17	399	4.3	29	.07	1	3
5. Lociane	6	433	1.4	0	.00	1	8
6. Libon	21	241	8.7	0	.00	1	2.53
7. Péligre Sud	35	433	8.1	28	.06	2	12
	1,324	4,303					

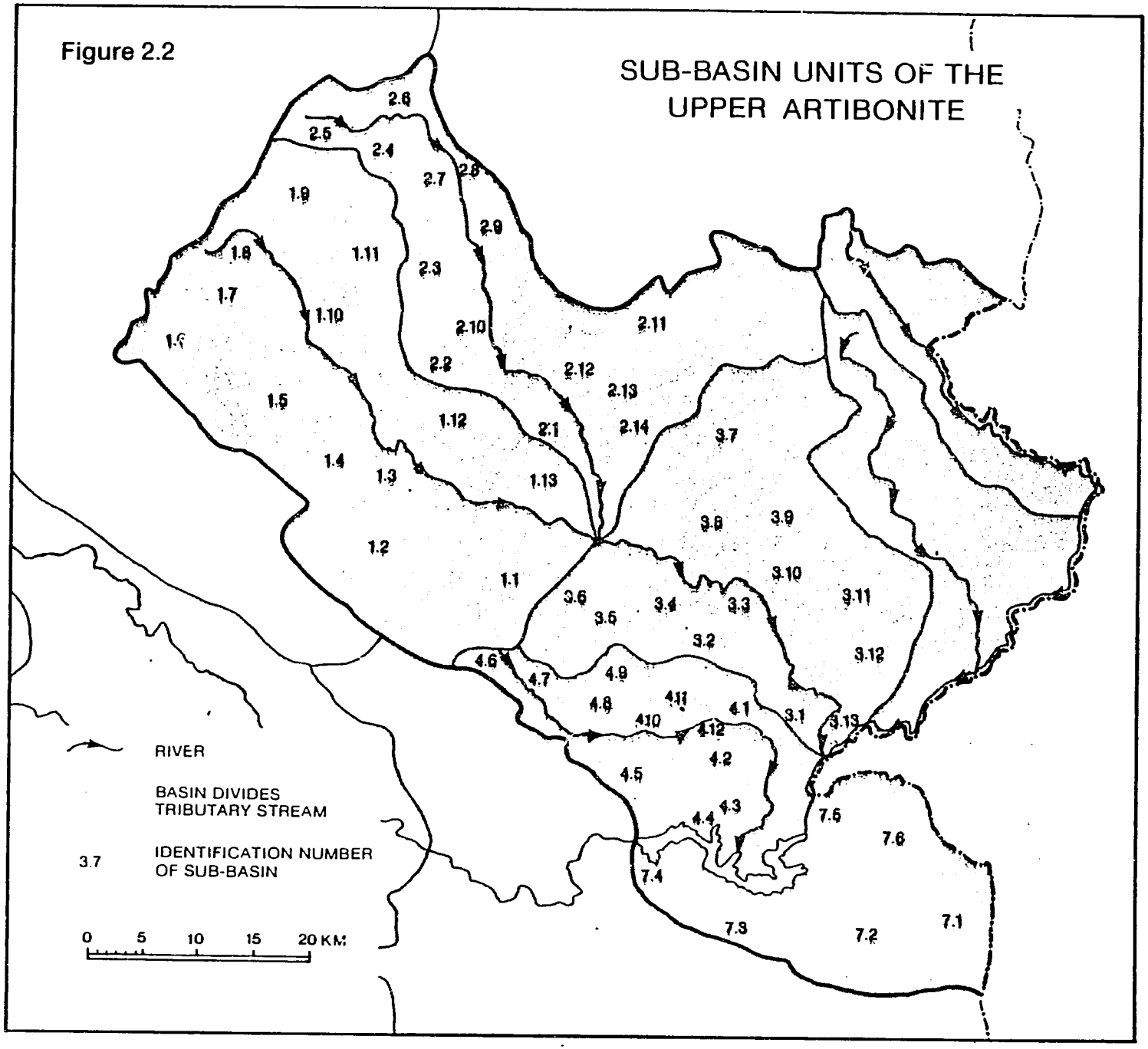
Note:

1. All connected roads (Source: DATPE Roads, Urban Centers and Market Map)
2. Urban Agglomerations as shown on DATPE Roads, Urban Centers and Market Map.
3. One Market Located on Artibonite Basin divide
4. Irrigation and Coffee Potential Land were determined directly from the DATPE maps in relative terms.

category in terms of its development p ntial. Likewise, the Thomonde basin, which is hydrologically similar to the ligre Sud basins, falls into the lowest development potential category ng with the Lociane and Libon basins. As shown, the latter two basins manife the lowest level of controllable environmental impact and potential ret s on investment in development initiatives. For these reasons these two pl ing units (Locaine and Libon) are assigned the lowest priority for inter tion and are not given further consideration in this report. Each of e five remaining planning units is relatively large in areal extent, and marked by a considerable degree of internal diversity with regard to phys l and socio-economic properties. In order to facilitate a coordinated appr h to rural regional development planning the five remaining major planning its in the Upper Artibonite are further divided into a total of 58 sub-ba units (Figure 2.2; Table 2.4). Each of these sub-units is approximately eq valent in areal extent to the Acul river basin within the Cayes Plain Bas .

In order to accomplish the goals improving the land resource base within the Upper Artibonite, increasing th standard of living of its inhabitants, and preserving the storage capacity of ke Péligre, it appears that interventions should initially be focused u the two Group A planning units: the Canot and the Bouyaha. However, given at these two basins, along with the Guayamouc-Aval basin, comprise a singl ydrologic system (the Canot and the Bouyaha are tributaries of the Guayamo -Aval), and that plans are underway to develop the hydroelectric potential on e Guayamouc (Consultants HQI-LGL-LMBDS, 1982), it is logical to include e Guayamouc-Aval basin among the primary planning units. If this hydro ical relation had been evaluated and included in the ranking, the Guayamouc- al would have fallen into Group A.

Figure 2.2


SUB-BASIN UNITS OF THE
UPPER ARTIBONITE
2.6
2.5
2.4
2.7
2.8
2.9
1.9
1.8
1.11
2.3
1.7
1.10
2.10
2.11
1.6
2.2
2.12
2.13
1.5
1.12
2.1
2.14
3.7
1.4
1.3
1.13
3.8
3.9
1.2
3.10
1.1
3.6
3.5
3.4
3.3
3.11
3.2
3.12
4.6
4.7
4.9
4.8
4.11
4.1
3.1
3.13
4.10
4.12
4.2
4.5
4.3
4.4
7.5
7.6
7.4
7.3
7.2
7.1
RIVER
BASIN DIVIDES
TRIBUTARY STREAM
3.7
IDENTIFICATION NUMBER
OF SUB-BASIN
0 5 10 15 20 KM

24

TABLE 2.4

Sub-Basin Identification

Canot Basin

1.1 Rio Frio
1.2 R. Fond
1.3 R. RocBlanc
1.4 R. Baille
1.5 Rio Belle
1.6 Nan l'Etoile (Internal Drainage)
1.7 R. Platana
1.8 R. Pina
1.9 R. Dèo
1.10 R. Coupeye
1.11 R. De l'Atalaye
1.12 R. Pouèque
1.13 Roberta

Bouyaha Basin

2.1 Nan Vincent
2.2 Ravine Sable
2.3 Sainte Marthe
2.4 Mare La Roche
2.5 R. Gros Roche
2.6 R. Vaseuse
2.7 Nan Guinee
2.8 Camp Sec
2.9 Chêry
2.10 Localité
2.11 R. Gouape
2.12 R. Caiman
2.13 R. Boroc
2.14 R. Coladaire

Péligre Sud River Basins

7.1 R. Las Aguas
7.2 R. Roche Blanche
7.3 R. de Lascahabas
7.4 R. Mare Rouge
7.5 (nom inconnu)
7.6 R. Onde

Guayamouc-Aval Basin

3.1 (nom inconnu)
3.2 R. Juana
3.3 Pablocal
3.4 Roche-à-Pierre
3.5 R. Hinquitte
3.6 R. Bonbon
3.7 R. Samana
3.8 (nom inconnu)
3.9 (nom inconnu)
3.10 Ouangouman
3.11 R. Hondo
3.12 Thomassique
3.13 Guayamouc-Artibonite

Thomonde

4.1 R. Roche Blanche
4.2 R. Felician
4.3 Aux Piègues
4.4 (nom inconnu)
4.5 Ravine Cange
4.6 (nom inconnu)
4.7 Bois Rouge
4.8 (nom inconnu)
4.9 R. Goyable
4.10 (nom inconnu)
4.11 (nom inconnu)
4.12 (nom inconnu)

In summary, upon considering all relevant factors, the three basins comprising the Guayamouc hydrologic system represent the most logical unit in the Upper Artibonite for the development of a planning strategy. This recommendation is reinforced when one considers that the ODBFA is already concentrating its efforts in the two remaining planning units -- the Thomonde and Péligre Sud river basins (ODBFA, 1983; Kulibaba, 1983: Ch. 7). Given the strong degree of hydrological interactions between the three primary planning units, a broad and systematic approach cognizant of these linkages needs to be developed. However, in terms of an implementation strategy, it is necessary to limit initial interventions to smaller and more tractable units. In the following section, a broad strategy for the development of the Guayamouc hydrological system will be considered. Further, one of the three primary planning units will be designated for initial interventions. Finally, since each primary planning unit is both large and diverse, it will be necessary to utilize the sub-basins that have been previously identified in order to construct a practical development plan.

3. DEVELOPMENT OPTIONS

3.1 General Strategy for the Guayamouc River System

The two principal river systems of the Artibonite are the Río Macasia, flowing within the Dominican Republic, and the River Guayamouc, draining a significant portion of the Upper Artibonite area of Haiti. As noted previously, the latter has been divided into three primary planning units, each of which corresponds to a major tributary basin and covers approximately one-third of the Guayamouc river system.

Within the Guayamouc river system there are two broad classes of problems that need to be addressed by development initiatives. First, at the regional level, the overriding concern must be the preservation and enhancement of land resources so as to ameliorate the standard of living of the local inhabitants. Second, at the national level, it is essential that land management measures be implemented so as to protect the existing dam at Lake Péligre, as well as several proposed dams on the Guayamouc river. The following sections address these two priorities.

3.1.1 Planning Unit Characteristics

Inspite of the generally low population existing within the Upper Artibonite, it is clear that the land resource is under stress. Partially this is a result of the scarcity of good agricultural lands within the area under existing farming practices. Today, the population density is over 370 people per square kilometer of farming area, or greater than 3.7 inhabitants per ha. Soil erosion and declining soil fertility are reflected on the landscape by low agricultural yields. Estimated average yields for the principal crops of the area are low (Table 3.1). Likely principal causes for the degrading soil conditions in the area are deforestation, increasingly intensive and extensive use of the land without fertilization, and lack of soil control practices. Haiti's subsistence type of agriculture production is based on exploitation of natural soil fertility. The high price of fertilizer and the lack of credit are two other factors contributing to the decrease in soil fertility (Brummitt and Culp 1973: pp. 10-26). The traditional method of soil rejuvenation, having long periods of fallow, is becoming ever less effective as the existing population pressure prevents sufficient fallow periods. The result of these

population and economic/resource constraints is the use of ever more marginal lands which exacerbates both the environmental situation and the agricultural production. More labor inputs are likely required each year on these marginal lands just to maintain the status quo in terms of total production.

TABLE 3.1

Crop Yields of Upper Artibonite[A]

Crops	Yields (tons/ha)
Corn	0.6
Sorghum	0.4
Beans	0.5
Sweet Potatoes	2.0
Manioc	3.5

A. Louis Berger, 1977.

An indicator of declining soil fertility in the upper Artibonite is the change in crops grown under rainfed agriculture. By the 1950s, the principal staple in the Upper Artibonite inhabitant's diet had changed from upland rice to sorghum. Even though today a wide mixture of interplanted crops are planted in most fields, the trend is toward an ever larger percentage of low nutritive demanding root crops including manioc, yams, and sweet potatoes. In addition, deep rooted plants such as sorghum and congo peas are increasing at the expense of corn and many other varieties of beans due to their ability to produce satisfactory yields on more marginal lands. All of these changes in crop mix result in a lower daily nutritive balance in the small farmer's diet.

Except for the presence of coffee and black beans found solely in the uplands of the area, very little crop diversification is found within the Upper Artibonite in spite of environmental variability. Most Haitians are aware of the danger of crop specialization. If a crop failure were to occur, a Haitian usually must provide his own insurance. Past experiences have shown the small farmer that government aid or relief programs in time of crop short-falls cannot be relied upon. The response to minimizing risk of a given crop failure is to maximize crop diversity. The net result is that the Haitian can survive largely by his own work. However, this strategy minimizes the likelihood of improving the rural standard of living. Today, the small farmer in most cases is locked into a system which provides little possibility for material advancement, no matter how ambitious he is in trying to extricate himself from this cycle. At the same time, the system of insuring his short-term survival is threatening the long-term vitality of the country by resulting in an ever degrading resource base. The task ahead is to develop the interventions which will encourage the small farmer to change his farming system, to improve his well-being, and at the same time accrue benefits at the national scale.

3.1.2 National-Scale Priorities

Preliminary investigations are well under way in determining sites for the construction of one or two multi-purpose dams in the lower Guayamouc. The purposes of this dam(s) are to reduce the rate of sedimentation into Lake Péligre; to produce hydroelectric power; to regulate the discharge of water into Lake Péligre so as to maximize its potential for hydroelectric generation and irrigation; and to provide water for the expansion of agriculture in the vicinity of the dam(s), particularly to benefit those farmers that will be displaced by its construction (Consultants HQI-LGL-LMBDS, 1982).

Within Haiti, dam construction has occurred largely with a minimal level of land management in the catchment areas of reservoirs. This practice has resulted in a decrease in the life expectancy of dam projects, as well as a decrease in the overall economic returns of the projects. Nowhere is this more apparent than on the Artibonite where capital investments, significant conservation interventions, and new levels of administrative structures have recently been required due to the rapid siltation of Lake Péligre (Kulibaba, 1983). In order to increase the potential effectiveness of the proposed Guayamouc dam project(s), as well as to enhance efforts to protect Lake Péligre, a set of land management measures need to be instituted in the three planning units comprising the Guayamouc River System prior to the completion of dam construction.

3.2 Selection of a Priority Planning Unit

Due to the large areal extent of the Guayamouc river system, it is essential that development efforts be focused upon a smaller and more tractable unit, one for which a workable strategy can be specified and implemented. Although each of the three planning units that have been defined is, in itself, still too large an area to be utilized for a development strategy, we begin by selecting one for more detailed examination. In section 3.3 our focus becomes more specific as we select particular sub-regional units.

It should be noted that, from the viewpoint of a donor agency such as USAID, the selection of as specific an area as possible (within the constraint of preserving regional functional integrity) for the implementation of development initiatives is highly desirable, in order that these efforts not become ineffective through their dispersal over too broad an area. In addition, the

information and data available for conducting this exercise necessitate that we restrict our discussion to a relatively localized area for the following reasons: first, very few data are locationally specific, and those that are exhibit a high degree of generality; second, the information available for this exercise comes from secondary sources, the primary purposes of which are not always complementary to the present purpose.

For the reasons which are enumerated below, the Canot river basin planning unit appears to hold the greatest potential for development in the Upper Artibonite. Although it placed second to the Bouyaha basin in our ranking of planning units (Table 2.2), there are cogent reasons for selecting it as the priority area. First, from an agricultural perspective, it contains an adequate amount of good agricultural land, characterized by a relatively low erosion risk (see Figure 1.3). This implies that, with the application of appropriate management practices, it can become a more efficient productive unit. In addition, land resources appear to be available in relatively accessible areas of the planning unit. Further, in the southwestern portion of the basin, there are lands suitable for coffee production, thus, providing the opportunity for some cash cropping in the hilly lands (SCET, 1980, vol. 4, p.10).

Second, the savanna areas of the planning unit, and Savanne Diane in particular, provide a large expanse of underutilized land that has the potential for increased livestock activity, if new and systematic livestock management practices are introduced. Third, two areas of the planning unit have been identified as having reasonably good irrigation potential (SCET, 1980). These are located immediately in the vicinity of St. Michel and in the area around Nan Paul.

Fourth, of all of the seven planning units in the Upper Artibonite, the Canot basin is the most accessible to the three external population centers with direct links to the Upper Artibonite (Figure 1.4), i.e., Gonaives, Cap Haitien, and Port-au-Prince. A paved road begins at Ennery which, although outside of the basin, is only 30 kilometers from St. Michel de l'Atalaye, the largest center in the planning unit, location of one of the few regional markets in the study area, and the second largest center in the Upper Artibonite. In addition, during the dry season there is a reasonably good degree of accessibility between St. Michel and Hinche, the largest center in the study area. Fifth, some mineral deposits exist in the basin, notably lignite near Maissade and guano near St. Michel. There is a possibility that the latter could be utilized as fertilizer.

In summary, for the above reasons, the Canot river basin planning unit has been chosen as the focus for development initiatives in the Upper Artibonite study area. Due to the large size of even this one planning unit, however, it is necessary to select a certain set of sub-regional units (see Figure 2.2) manifesting the highest potential for achieving the purposes articulated in sections 3.1.1 and 3.1.2.

3.3 Units for Potential Development Interventions

From among the 13 sub-regional units comprising the Canot basin, two sub-basins appear from both physical and economic perspectives to be favorable for agricultural expansion. Both the Nan l'Etoile (Basin 1.6) and the Coupeye (Basin 1.10) sub-basins have significant areas favorable for irrigation (SCET, 1980). Additionally, the lands in these basins being in close proximity to St. Michel minimize costs in making these areas accessible. Given the improvements necessary to initiate and make the irrigation endeavor a success, existing

rainfed agricultural activities will likely expand. To insure that this expansion will not stress the environment, improvements in the existing farming systems will need to be introduced. Furthermore, both areas should interact directly with St. Michel, where an existing marketing and commercial infrastructure already exists. Thus, improvements in the infrastructure needed to facilitate the agricultural development of these areas will complement existing processes. Besides developing the agricultural sphere in the Upper Artibonite, given the relatively low percentage of good agricultural land within this area, from both environmental and economic perspectives expansion and improvements in livestock activities are essential. The Savanne Diane is the logical area to initiate this activity. However, given its extensive area, first activities should be concentrated in those portions of the Savanne in proximity to St. Michel. This will not only allow coordination between the agricultural and livestock sectors to be easily accomplished, but will also minimize duplication in infrastructure investments. Besides improvements in the rural countryside, there is an immediate need to improve the urban functions that will be required to serve the developing Upper Artibonite.

The four areas of intervention identified in the preceeding paragraph -- irrigation, rainfed agriculture, urban functions, and livestock expansion -- each require further detailed analysis. This analysis must be oriented towards specifying the manner in which these activities can complement one another utilizing the coordinated rural regional development approach introduced in the Cayes Plain Basin study. While sufficiently detailed information for recommending specific strategies involving these activities is not presently available in the Upper Artibonite, some general observations concerning required interventions can be presented.

First, with regard to urban-rural complementarity, it is clear that the Canot basin, in general, and the two selected sub-basins, in particular, need to develop a strong association with a major urban area in order to become more fully integrated into the national economic system. Such a "growth center" serves several functions: the origin from which investments, technology, and growth impulses will "spread" or "trickle down" into the Canot; an interface through which the region can more easily channel social and commercial interactions both internally and with the national system; a source of non-agricultural (i.e., processing and service) employment opportunities for the region's population; and a center for the provision of administrative and social services within the region. Neither St. Michel de l'Atalaye (population 4,559), the second largest center of the Upper Artibonite which lies within the Coupeye sub-basin (No. 1.10), nor Hinche (population 8,465), the study area's largest center, located in the Guayamouc-Aval planning unit, are sufficiently large or developed to fulfill this function. While the continued upgrading of the infrastructure and functions of St. Michel (e.g., processing activities associated with increased agricultural and livestock production) is clearly indicated, it is evident that a center external to the Upper Artibonite will need to serve as the growth center for the Canot basin. Gonaives, lying approximately 75 kilometers by road (45 kilometers of which are paved) from St. Michel, appears to be the logical candidate for this role. Its growth pole function is further enhanced due to its high level of accessibility to Cap Haitien and Port-au-Prince.

Second, with regard to the initiation of a commercial livestock activity, it is necessary to develop the Savanne Diane in both an environmentally and economically sound manner. To accomplish this, a whole set of interventions

will be required. First, criteria need to be established in the human resource area to insure that today's small farmers shall be integrated into the scheme in more than a labor-providing role. Otherwise, benefits resulting from the expansion of economic activities in this large underutilized area could benefit inhabitants largely living outside of the Upper Artibonite. One method of selection could be to encourage inhabitants currently engaged in rural functions in areas that are undergoing severe degradation to become active in this new endeavor. If this would be implemented, decreases in soil movements into stream systems could be reduced and sedimentation likewise would be lowered.

To improve the carrying capacity of the land, improvement in the natural pastures needs to be considered. Introduction of drought-resistant, higher protein grasses to replace the poor natural grasses, especially in areas where Madam michel is concentrated, need to be initiated. Additionally, local water supplies need to be established for the livestock. Care must be taken to prevent overgrazing in the vicinity of the water supplies in order to prevent accelerated soil erosion, as has occurred in many Sahaelian areas. In areas where gullies and other severe land degradation exist, conservation actions should immediately be put into place to prevent grazing activities from compounding these problems. The development of a livestock economy will necessitate a set of interventions in the human/economic/physical domains that to discuss adequately is beyond the scope of this paper. The National Transport Study, Vol. 7 highlights many factors that need to be considered. However, its approach, which appears to be modelled on the American Southwest, needs to be greatly modified for successful implementation in the Haitian milieu.

Finally, activities associated with improving both the rainfed and irrigated agricultural sectors cannot be restricted solely to lands currently or potentially under cultivation. For example, the vegetation cover in the water recharge areas likely will need to be altered to increase infiltration/decrease surface runoff. The steeper slope areas throughout the Nan Paui and St. Michel areas, from our cursory reconnaissance, are largely denuded. Most of these areas should never be brought again under cultivation. Reforestation and other conservation practices are clearly in order. While specifics cannot be given at this time, the eventual recommended measures must be conceptualized within a coordinated framework. Some of the suggestions presented for Les Platons in the Cayes Plain Basin SIP could provide a framework of reference for agricultural/irrigation improvements. The overriding consideration in this sector must be preservation/rehabilitation of the land and water resources while increasing agricultural production.

4. SUMMARY

1. The purpose of this report has been to lay the groundwork for a coordinated approach to rural regional development in the Upper Artibonite. Due to the magnitude and diversity of this area, in its entirety it cannot be regarded as a tractable regional planning unit.

2. From a hydrological perspective, oriented towards resource preservation, three major sub-systems may be identified, each requiring a different set of planning interventions. The first is composed of three basins which together form the Guayamouc hydrologic system -- the Canot basin, the Bouyaha basin, and the Guayamouc-Aval basin. The second set includes the relatively small river basins which have been artificially truncated by

the creation of Lake Péligre -- the numerous basins grouped together as the Péligre Sud basins, and the Thomonde basin. All streams within this set flow directly into Lake Péligre and contribute a disproportionate amount of the sediment entering the reservoir. The third set consists of two basins -- the Libon and the Lociane -- which flow directly into the Artibonite along the Dominican border. The hydrological components of this latter set strongly interact with fluvial activities originating in the Dominican Republic. Thus the three major sub-systems comprise a total of seven large river basins.

3. From a human-economic perspective, the Upper Artibonite contains no internal unifying focus. The largest population center in the area, Hinche (pop. 8,465) contains neither sufficient population nor functions to exert more than a local influence. The area is polarized towards three large external centers -- Port-au-Prince, Gonaives, and Cap Haitien. High order market functions, as well as social and administrative services, are largely satisfied from these three external centers.

4. Due to a lack of existing cohesion in terms of human interaction, and due to the potential usefulness of river basin units for the successful implementation of interventions designed to improve agricultural and livestock activities, as well as to minimize the current deleterious level of siltation in Lake Péligre, the seven river basins appear to be the most appropriate units for regional planning purposes.

5. When the seven planning units (basins) are ranked according to their human and physical characteristics the three river basins which compose the

Guayamouc hydrological system -- the Canot, the Bouyaha, and the Guayamouc-Aval -- emerge as having the highest level of development potential. Therefore, it is recommended that this area be given development priority within the context of the Upper Artibonite.

6. In order to establish a development plan and associated implementation strategy, it is necessary to restrict the scope of activity even further, due to the large areal extent of the three-basin Guayamouc hydrological system. The Canot basin is the unit having the highest degree of development potential in the Upper Artibonite, under existing physical and economic conditions. For this reason, it was selected for more detailed analysis. In order to accomplish this the Canot basin was examined utilizing its thirteen sub-basin units.

7. Two of the Canot basins sub-units, Nan l'Etoile (in the vicinity of Nan Paul) and Coupeye (in the vicity of St. Michel de l'Atalaye) are identified as areas for initial concentration of development activities. From an agricultural perspective, these areas possess potential for irrigation, an adequate area of good quality soils, and areas characterized by climatic conditions which are favorable for the cultivation of coffee. In addition, the Savanne Diane, part of which is situated in the vicinity of St. Michel, is an area favorable for the development of livestock expansion. Further, these two sub-units are relatively accessible to the large urban center of Gonaives, which may be able to provide some of the growth center functions internally lacking within the Upper Artibonite.

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