

Problem Analysis for Watershed Development Programming in Jamaica *1

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자메이카국의 流域開發計劃上の 問題點 分析*1

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ABSTRACT

The author of this paper has participated for research on soil conservation and watershed management for two years as an Associate Personnel at the Inter-American Institute for Co-operation on Agriculture (IICA-OAS), in Jamaica. This paper is fundamentally based on the author's experience of researches as well as the results of studies with the references cited. The island of Jamaica having 11,440km² was divided into 33 groups of watersheds and eighteen watersheds were identified as severely disturbed areas of mostly upstream. There are approximately 164,000 ha of land in urgent need of rehabilitation and protection including a 36,900 ha of five watersheds first priority needed. A national programme of watershed management to conserve all the watersheds, particularly those inhabited by small farmers is urgently necessary.

Key words: watershed management

要 約

筆者는 자메이카국 駐在 美洲機構 農業研究所에서 약 2年間 土壤保全 및 流域管理分野 擔當研究員으로서 근무하였다. 이 論文은 자메이카국에서의 이分野 研究資料와 引用文献等の 分析結果로 作成된 것이다. 자메이카국의 国土面積은 約 11,440km²이며, 33개의 流域群으로 区分되는데, 이 중에서 18개 流域은 특히 그 上流流域이 심히 荒廢된 것으로 分析되었다. 流域의 保全 및 復旧對策이 긴급히 要求되는 面積은 約 164,000ha이며, 이 중에서 最優先의으로 處理되어야 할 5개 流域 面積은 約 36,900ha에 이른다. 流域資源을 最大로 保全하기 위한 國家的 次元에서의 流域管理計劃이 긴급히 要請된다.

INTRODUCTION

Jamaica is situated at the Caribbean Sea near Cuba and the largest West Indies island within the British Commonwealth (Fig. 1). It is positioned at or around 18°N in latitude and 77°W in longitude. The land area covers 11,440 km² with a maximum transverse length of 235 km and width varying from 35 to 81 km. The total population of Jamaica in 1980 was estimated about 2.2 million people.

Eighty percent of the entire country is rugged and the lands which exceed 20° in slope comprise about

51% of the island. Consequently, most of the island's watersheds in the upland areas are composed of steep slope. The island can be generally divided into three major geomorphic zones as the interior mountain ranges, the limestone plateau and hills, and the coastal plains.

The interior mountain ranges form the backbone of Jamaica and the most rugged. The highest peak is in the east where the Blue Mountains attain a height of 2,220 metres. Geologically, they are composed of shales, conglomerates and tuffs, and volcanic rocks intruded at various points. The limestone plateau

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and hills cover almost two thirds of Jamaica and slopes are mostly gentle and rolling. The coastal plains are broader on the southern side and much narrower on the northern side.

With a tropical and sub-tropical climate, Jamaicans enjoy a year round growing season for the most part. The average annual rainfall is about 1,980 mm ranging from 1,000 mm in some coastal areas to 7,000 mm or more in the north-east mountains. Its monthly distribution is uneven and rainfall intensities are extremely high. Temperature on the plains averages 30°~33°C during the day and 20°~24° at night.

The pattern of cultivation at the country's hilly watersheds is one of shifting cultivation mixed with food crops (mainly yams), pulses, and vegetables. For more than three decades the major soil conservation treatments applied on the cultivated slopes have been simple contour trenches and barriers. Most of these were inadequately laid out, poorly implemented and maintained, resulting in their gradual disappearance on the ground with few actual lasting benefits.

Due to the socio-economic situations, mainly more sloping lands are being farmed and more houses are being constructed in the upstream of watersheds resulting in serious deterioration of the national lands as well as in the water quality of streams and rivers. Watershed management problems for the protection, conservation and development of water resources in the upstream regions are, therefore, being under the consideration as one of the national development projects in Jamaica.

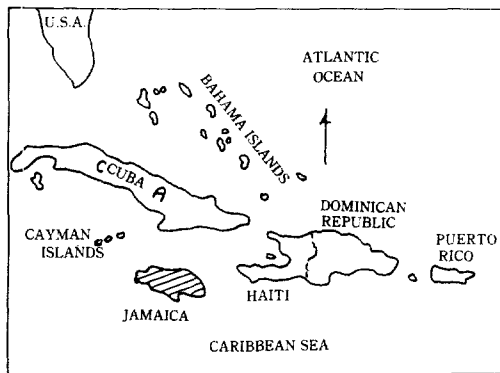


Fig. 1. Location of Jamaica in the Caribbean Sea

MATERIALS AND METHODS

The author of this paper has participated and worked for about two years as an Associate Personnel at the Inter-American Institute for Co-operation on Agriculture (IICA)-OAS, in Jamaica. He has been conducting some researches in the field of soil and water conservation and watershed management, particularly at the Olive River Soil Conservation Centre, Trelawny, Jamaica.

He has also collected and studied many good references for his research in the field of the subject. This paper is fundamentally based on the author's research experience as well as the results of summarized and analysed references cited for this paper.

RESULTS AND DISCUSSION

1. Major Land Uses Types and Land Capability Classification

The land use statistics compiled by the Town Planning Department (1971) and the Forestry Department are shown in Table 1.

It is apparent from Table 1 that a great deal of the lands are idle. According to the Town Planning Department (1971), the area of idle land is approximately 90,000 ha. In addition, there are another 210,000 ha of lands which are not intensively used, including barren land, swamp, some ruinated, natural wood and grass lands. This leaves about some 300,000 ha to 320,000 ha of land under intensive agricultural use.

Of total agricultural lands, about 50% (250,000 ha) are situated in rolling and steep uplands, mostly occupied by the small farmers. Their methods of cultivation are often primitive, causing erosion to the steep slopes. Not only the productivity of these lands have been reduced by a quarter to one thirds (Dumont 1963), but also these lands face the most serious problem in Jamaica's watersheds.

The Government of Jamaica has completed its island-wide soil survey by the soil survey team of the University of the West Indies in late 1960. In the soil survey report of each parish, lands have been divided into seven capability classes shown in Table 2 and land capability maps have been prepared from the soil survey maps by the Ministry of Agriculture Jamaica.

Table 1. Land use statistics in Jamaica (as 1970)

Land use types	Area		Land use types	Area	
	ha	%		ha	%
Forest including forest plantation	262	24.1	Swamp	20	1.8
Other woodland (including scrub forest)	215	19.8	Mining	3	0.3
Agricultural land (including improved pasture)	503	46.4	Urban	40	3.7
National range & grass land	41	3.8	Barren	2	0.1
			Total	1,085	100

Table 2. Land capability classes

Class	Slope	Acreages (ha)	Suitability and limitation
I	0 – 2° (A)	30,000	Level land with deep fertile soil with no factors limiting the use for Agriculture
II	2 – 5° (B)	130,000	Land suited for cultivation with moderate limitations due to erosion, wetness or soil
III	5 – 10° (C)	220,000	Land suited for cultivation with strong limitations due to erosion, wetness, soil or climate
IV	10 – 20° (D)	130,000	Land marginal for cultivation due to extreme danger of erosion, or extreme limitation of soil. Tree crops or grass lands should be established
V	20 – 25° (E)	100,000	Land not suitable for cultivation due to extreme danger of erosion, or adverse soil factors. Tree crops, food or forest trees should be established
VI	25 – 30°	100,000	Land not suitable for cultivation due to adverse factor of erosion, soil or climate. Should never be cleared of its normal vegetation
VII	Over 30°	290,000	Miscellaneous land not suitable for cultivation due to rock, out crops, river wash, etc. Should be left for wildlife

2. Water resources and hydrological situations

There are no exact figures about an overall water budget in Jamaica. Based on William's estimate (1960) and Town Planning Department's (1971),

however, such rough balance sheet in Table 3 has been worked out.

With an average rainfall of 1,980 mm annually, Jamaica has, in theory, sufficient sources of water to

Table 3. Quantity of water resources in Jamaica

Water resources	Quantity	Rate (%)	Depth (mm)
Rainfall	13,500 MGD*	100	1,956
Evapo-transpiration	7,500 MGD	55	1,067
Streamflow	5,000 MGD	37	736
Ground water shortage and deep seepage	1,000 M	8	153

* Indicates million gallons pem day.

satisfy all kinds of uses for the present time as well as for the foreseeable future. In addition to surface water, large areas of the limestone country possess sources of groundwater.

The main problem in Jamaica, therefore, arises from the distribution of water in location and time. Besides the north-east part of the Blue Mountains, the remaining island has a definite dry period ranging from two to six months. Even in normal years, trucking water for domestic use is a common practice in dry seasons for most of watersheds in Jamaica.

A water pollution seminar was held in May 1972 to discuss policy, planning and programming or pollution and quality control. There is every reason to believe that the pollution and water quality problem will become more and more severe in the coming years unless overall control measures are practised.

Jamaica has at present a total of 109 stream gauging stations well distributed in the major watersheds. Over half of the stations are less than fifteen years old; the older stations have existed for about 33 years. The whole network is the responsibility of the Water Resources Division of the National Water Commission, Ministry of Local Government.

Collection of rainfall data in Jamaica dates back more than 100 years. There are well over 500 rainfall stations, however, including about 80 stations with homogenous records longer than 25 years.

3. Watershed Problems in Relation with Soil Erosion.

Awareness of soil erosion and the subsequent problems and hazards are not new to Jamaica. As early as 1937, Croucher and Swabey,³⁾ in their article entitled "Soil Erosion and Soil Conservation in Jamaica," emphasized the chief causes of soil ero-

sion in Jamaica as: (a) unsuitable agricultural practices; (b) unwise selection of land for agriculture; and (c) lack of appreciation for the seriousness of the problem.

During the evaluation studies carried out by the UNDP/FAO Forestry and Watershed Management Project in 1972, soil erosion and sedimentation were identified as the major watershed problems in Jamaica. Erosion has been the chief cause of the low productivity of hillside lands in Jamaica. This productivity has continued to fall at an alarming rate and there is dramatic deterioration in soil and water resources. This rapid rate of sedimentation has often hampered water resource development in some watersheds since that portion of the total storage capacity which has to be reserved to allow for siltation in a reservoir presents a severe constraint on the economics of such project.

Two major sources of erosion and sedimentation are identified as (a) the cultivating of sloping lands without proper soil conservation practices, and (b) the construction of roadways in mountainous terrain.

The Hermitage Reservoir constructed in 1929 near Kingston, having a watershed of about 1,360 ha lost 45% of its storage capacity or 210 million imperial gallons by 1963, i.e. 36 years after its completion. The rate of sedimentation estimated by both the Harza Engineering Co. and Champion (1966)²⁾ was at 4-acre-feet per year per square mile. It should be noted that the Flora rains in October 1963 is reported to have caused massive sediment inflow to the reservoir, although the cover of the entire watershed is better than average.

In cultivated watersheds the rate of erosion might be much higher. Champion (1966)²⁾ estimated the soil loss from the Upper Yallahs Valley where about one thirds is under cultivation at any time, at 40 tons per acre per year or 14 acre-feet per square mile per

year.

A soil loss experiment on Wait-A-Bit clay loam (No. 95) conducted by Mitchell, USAID Soil Advisor, at James Hill, Central Clarendon, indicated that a bare escarpment lost an average of 1.4 inches annually during the three-year period 1962-65.

By soil loss experiment on 17 degree slopes according to the UNDP/FAO JAM 505 Project (1969-1973) at the Smithfield Demonstration Centre average soil loss from the yam cultivation on the individual hills without any soil conservation treatments was 136 tons per ha per year whereas from bench terrace plots it was 18 tons per ha per year.

4. Watershed Problems in Relation with Socio-Economic Situations

Many socio-economic problems of watersheds in Jamaica may be enunciated. Most of the hilly lands are occupied by over 200,000 small farmers who cultivate less than 2 ha of these lands and who practice a system of shifting cultivation coupled with clean farming practices. The intensive cultivation of these marginal lands coupled with tropical rainfall of high intensity without proper soil conservation practices has resulted in severe erosion problems.

The unemployment rate in the watersheds is high and for a while has been officially estimated to be in the region of 20-25 per cent. The migration trend from rural to urban at present can be expected to continue or even accelerate if present conditions in the watersheds are not made sufficiently attractive and drastically improved.

Over the past years the production of domestic food crops has increased considerably due to the efforts and achievements of such government schemes as Project Land Lease and the Emergency Production Programme. However, the performance of the major exported crops has been disappointing and some have been showed a sharp decline. While the reason for the above-mentioned situation may be various, a major reason is deterioration of the hilly land resources on which a fair proportion of these exported crops are grown without the appropriate soil conservation measures.

5. Watershed Management Activities

Early in 1951, the government enacted the Land

Authority Law. Two Land Authorities of the Yallahs Valley and Christiana were established during that decade and in 1969 a further eleven Land Authorities were created, under the Ministry of Rural Land Development. The physical boundaries of the Authorities tended to follow the main watershed divides. Following the change of government in 1972, the Land Authorities were incorporated in the Ministry of Agriculture.

In 1963, the government promulgated the Watershed Protection Act, under which the Watersheds Protection Commission was established the same year. According to the Watersheds Protection Act, the general policy of watershed protection and rehabilitation is "to promote the conservation of water resources". This has been interpreted by the Watersheds Protection Commission as: (a) maintaining and if possible, increasing the quality of water available; (b) minimizing erosion and sediment hazards; and (c) reducing flood damage.

The Watersheds Protection Commission was incorporated into the National Resources Conservation Department in 1974. The Department now administers the Watershed Act. The Land Authority Law is slightly different in objectives although the programme may be similar to that stipulated in the Watersheds Protection Act. The Law is rather land-oriented, i.e. improvement rehabilitation and development of the area, and aims to "encourage the secure the proper economic and efficient utilization of all lands in the declared area". The Land Authority Law is more production-oriented while the Watersheds Protection Act tries to secure protection for water benefits.

The Government has, to date, declared seven watersheds, totalling 60,800 ha; Cane River (2,560 ha), Rio Minho (8,680 ha), Rio Nuevo (9,600 ha), Rio Pedro (8,040 ha), Lucea/Cabaritta (8,440 ha), Negro/Johnson (13,040 ha), Roaring River (10,440 ha). Recently two other watersheds, Two Meetings watershed having 4,000 ha and Pindars River Watershed having 8,000 ha, were declared on the recommendation of the USAID/GOJ integrated Rural Development Project.

Beginning with the Yallahs Valley and Christiana Area Land Authority, Watershed rehabilitation work in Jamaica now spans more than a quarter of a coun-

try. However, during the first decade, knowledge and experience were limited.

In more recent years, limited funds and some trained personnel have been spreaded thinly throughout the seven declared watersheds and the thirteen Land Authorities.

Between 1969 and 1975 a UNDP/FAO project assisted the Government in setting up small demonstration sub-watersheds on public lands, and in personnel training. Six major soil conservation treatments have been developed and have been proved to be suitable for protection of the soil resources under Jamaican conditions by the UNDP/FAO Project and Ministry of Agriculture, Jamaica. They are bench terraces, hillside ditches, individual basins, orchard terraces, mini-convertible terraces, hexagons, and protected waterways. These used singly or in combination can safely protect sloping land up to 30 degrees.

Since 1975 Jamaica has become a member of the Inter-American Institute for Co-operation on Agriculture (IICA) and in 1976 signed the Agreement for its first project with IICA. The project (Allsides Pilot Development Project) was aimed at developing crop technologies best adapted to newly terraced land.

According to the Agreement among the Governments of Korea/Jamaica/IICA-OAS in 1979, the Olive River Soil Conservation Centre was established at Lowe River, Trelawny, Jamaica for "establishment of demonstration plots for farming systems treated with soil conservation methods other than bench terracing". The author of this paper was an expert in charge of the Project for about two years.

6. Priorities for Watershed Development

The land was divided into 33 groups of watersheds and the acreage of each was estimated. The Town Planning Department (1971) with the assistance of the UNDP Physical Development Planning Project, and the Geological Survey Department has produced a surface drainage map consisting of 20 major drainage basins chiefly for water resource planning use.

This grouping attempt of the watershed provides the basis for further study and investigation leading to a meaningful classification of the islands water-

sheds. For the time being, however, it appears that dividing the island into 33 watersheds with more emphasis on non-limestone areas is more appropriate. They show varying degrees of disturbance by man, by nature or by a combination of both. The location of watersheds and the degree and nature of past disturbances will dictate priorities for protection, rehabilitation or improvement.

Eighteen watersheds out of 33 were identified as severely disturbed areas. The areas disturbed are mostly in upstream and the proportion in a whole watershed ranges from a small amount to over 90 percent. After consultations with the Agricultural Planning Unit on the criteria to be adopted, a priority list was prepared.

With limited budget and personnel, the question of which watershed is to receive first attention is always important. Of the eighteen disturbed watersheds, five watersheds or sub-watersheds were classified as first priority and the other five as second priority. The five first-priority watersheds are consisted of 36,920 ha including Rio Pedro (in Rio Cobre) (8,040 ha), Pindars River in Rio Minho (7,680 ha), Hope River (5,200 ha), Yallahs Valley (12,000 ha), and Two Meetings at Christiana (4,000 ha). Additional information was collected for the five first-priority watersheds including population, registered idle lands, government priorities, crop suitabilities and the availability of maps and large scale air photos for future detailed planning.

The five second-priority watersheds are consisted of 63,400 ha including Wag Water (19,080 ha), Upstream area of Rio Minho (16,680 ha), Lucea River, Northwest Coast (6,800 ha), Upstream area of Cabaritta (2,400 ha), Negro River, in Morant River Watershed (10,760 ha), and Upper Rio Grande at Alligator Church in Rio Grande (7,680 ha).

There are further 62,720 ha urgently needed for watershed management and soil conservation activities and may be considered as third priority. These watersheds are consisted of 11 sub-watersheds such as Black River (South Trelawny and North Manchester, 4,160 ha), St. Ann (South Trelawny, 2,000 ha), Cane River (4,800 ha), Rio Minho (18,720 ha), Northeast Coast (4,000 ha), Rio Grande (4,000 ha), Buffer Bay River (6,000 ha), Plantain Garden (4,000 ha), Morant River (4,000 ha),

Montego River (8,000 ha), and Great River (4,000 ha).

In 1974, the Ministry of Agriculture approved three watersheds out of the first priority group for rehabilitation planning, after examination of information on degree of disturbance, downstream interest and potential for agricultural development. These are Hope Watershed, Two Meetings Watershed and Pindars River Watershed.

Since that time, a plan of development has been prepared for the Two Meetings and Pindars River Watersheds; the implementation of which is being financed jointly by the Government of Jamaica and the United States Agency for International Development. As funds and enough trained personnel become available, other priority watersheds will undergo detailed planning for implementation of development programme.

CONCLUSION

Jamaica is the third largest island of the Caribbean Sea having an area of 11,440 km² and a population of about 2.2 million persons. Average annual rainfall is about 1,980 mm ranging from 1,000 mm to 7,000 mm in some regions.

The main land use types are 46% for agricultural including improved pasture, 24% for the forest including forest plantation, 20% for other woodland including scrub forest, 4% for natural range and grassland, and about 6% for the idle land including swamps, some ruinate and barren lands.

Over 90 soil types have been identified from soil surveys. Land capability classes (Classes I-VI) based on slope have been identified and land capability maps have been also prepared from the soil survey maps. Rates of each capability class are 3.12% for class I, 12.97% for class II, 22.09% for class III, 12.64% for class IV, 20.20% for class V, and 29.98% for class VI, respectively.

Total of 108 stream gauging stations have been established in the major watersheds. Collection of rainfall data dates back more than 100 years and the number of rainfall stations is well over 500.

Early in 1951, Jamaica enacted the Land Authority Law, and also promulgated the Watershed Protection Act in 1963. The Law and Act are similar, pro-

viding the government with the power of declaring watersheds or areas for rehabilitation and improvement. The Government has, to date, declared nine watersheds totalling 72,800 ha.

The island was divided into 33 groups of watersheds and the acreage for each was estimated. Eighteen watersheds were identified as severely disturbed areas of mostly upstream. Detailed information was collected for the five first-priority watersheds totalling of 36,920 ha. There are approximately 164,000 ha of land in urgent need of rehabilitation and protection.

Six major soil conservation treatments have been developed and have been proved to be suitable for protection of the soil resources under Jamaican conditions. They are bench terraces, hillside ditches, individual basins, orchard terraces, mini-convertible terraces, hexagons, and protected waterways. Besides these measures, the "grass buffer strip" measures introduced by the author of this paper to Jamaica, has been recognized as one of the best methods for soil conservation from hillside farms.

Many simple, less expensive and less permanent watershed management practices in the past have been inadequately designed and implemented, resulting in uneconomic and ineffective programmes of watershed management devoid of lasting benefits.

A national programme of watershed management and soil conservation to serve all the watersheds, particularly those inhabited by small farmers is urgently needed. However, such a national programme can only proceed as fast as the trained personnel are available. To speed up the national programming, a close co-ordination among the related Agencies such as Soil Conservation Unit, the Forestry Department, the National Resources Conservation Department, and National Water Commission is recommended with the division of duties.

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