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JAMAICA PHYSICAL LAND EVALUATION SYSTEM

JAMPLES

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MINISTRY OF AGRICULTURE

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Jamaica Soil Survey Project

JAMAICA PHYSICAL LAND EVALUATION SYSTEM (JAMPLES)

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ABSTRACT

The Rural Physical Planning Division of the Ministry of Agriculture of Jamaica is elaborating and testing a computerized land evaluation system. It follows the FAO's Framework and uses a Geographical Information System (GIS). This article discusses the methodology which has been developed for the Jamaica Physical Land Evaluation System (JAMPLES). The feasible crops are determined on the basis of the land unit's agro-climatic characteristics. It is then assessed whether these crops can be grown taking into consideration the land unit's resistance to soil erosion and the crop's water demand. The remaining land qualities are then rated to be matched with the crop's soil requirements using computerized conversion tables. The location, extent and suitability class of the considered land unit can be mapped with the GIS. Upon further agro-economic studies, a qualitative land evaluation system will be established.

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1. INTRODUCTION

The contribution to Jamaica's GNP by the agricultural sector has always been significant even moreso now with the bauxite industry, the main foreign exchange earner, on the decline. In addition, it provides employment for approximately one-third of Jamaica's employed labour force. The Government recognises this and has developed a number of programmes to stimulate this sector to develop into a net foreign exchange earner. This involves detailed planning, the prerequisite being the generation of a nationally consistent data base.

Considering this, the Jamaica Resource Assessment Project was activated in 1981 in collaboration with Michigan State University. It is co-funded by the U.S. Agency for International Development (USAID). Its major objective is to establish within the Ministry of Agriculture a sound capability to develop agricultural production through a "Comprehensive Resource Inventory and Evaluation System" (CRIES). The results have been an inventory and evaluation of the potential and extent of land resources relevant to their physical setting, climatic conditions, and major soil properties (CRIES, 1982).

Parallel to these developments, the Jamaica Soil Survey Project has been established. It is co-funded under a grant by the Netherlands Government and aims at upgrading the soil data base to provide comprehensive information on the soil resources and their potential for crop production. As part of this project the "Jamaica Physical Land Evaluation System" (JAMPLES) has been established "in-house". This article discusses the methodology which has been developed for JAMPLES.

2. METHODOLOGY

Jamaica has a very comprehensive mapped data base which includes:

1) National coverage of the topography, scale 1:12,500 (Survey Department).

2) An established system of agro-climatic zones (IICA, 1983; RPPD, In prep.)

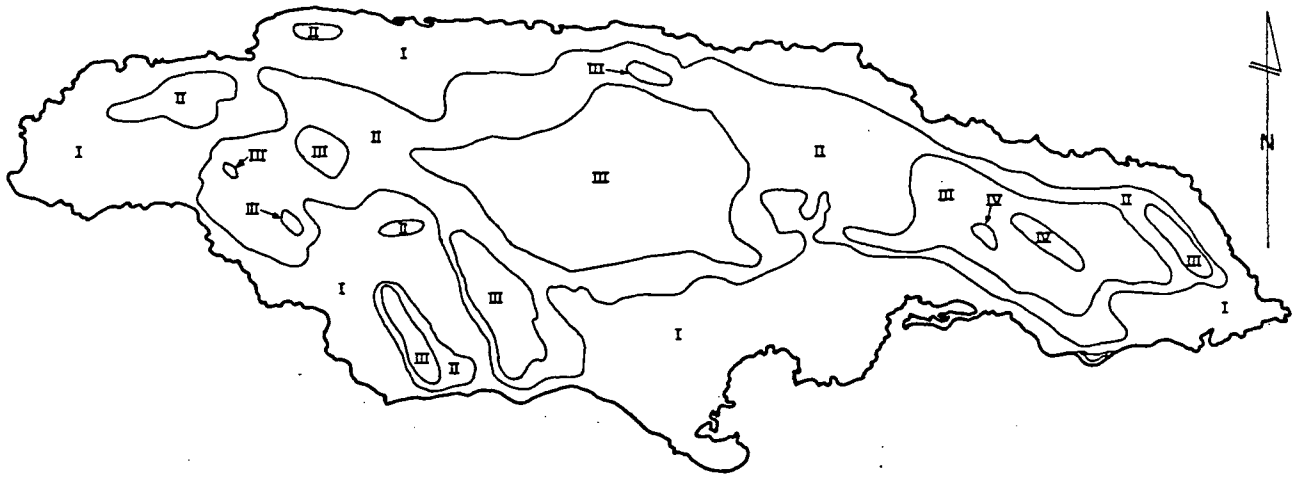
3) Complete national coverage in soil surveys, scale 1:50,000 (RRC, 1958-1970).

4) Currently updated land-use maps based on colour infrared photography.

This information has been partly stored in computer format using the Geographic Information System (ERDAS, 1982). This GIS forms the basis of JAMPLES. It uses a grid-cell concept to encode, process and retain geo-referenced data and can integrate multiple sources of digital data into the format for displaying, analyzing and mapping. It is envisaged that each grid-cell will have its specific set of topographical and climatic data in addition to the land quality ratings.

The axis of JAMPLES is the matching of the crop's requirements with the considered land qualities (section 5). Each of the envisaged combinations of crop and land unit has to fulfil two requirements before the actual matching is started:

1) Successful growing of the crop must be feasible, taking into consideration its general agro-climatic requirements. These requirements are defined in terms of the expected range in annual air temperature (Fig. 1) and the probable length of the main growing season (Fig. 2). The temperature zones have been obtained from linear regression against height and take into consideration the temperature requirements of the major crops. The growing season is the continuous period with rainfall exceeding more than half the potential evapotranspiration in at least 3 out of 4 years.



Zone	Height (m)	Yearly Temperature (°C)		
		Mean Minimum	Mean	Mean Maximum
I	< 300	> 19	> 24	> 29
II	300–600	17–19	22–24	27–29
III	600–1500	13–17	17–22	22–27
IV	> 1500	< 13	< 17	< 22

Figure 1: Generalized temperature zones-Jamaica

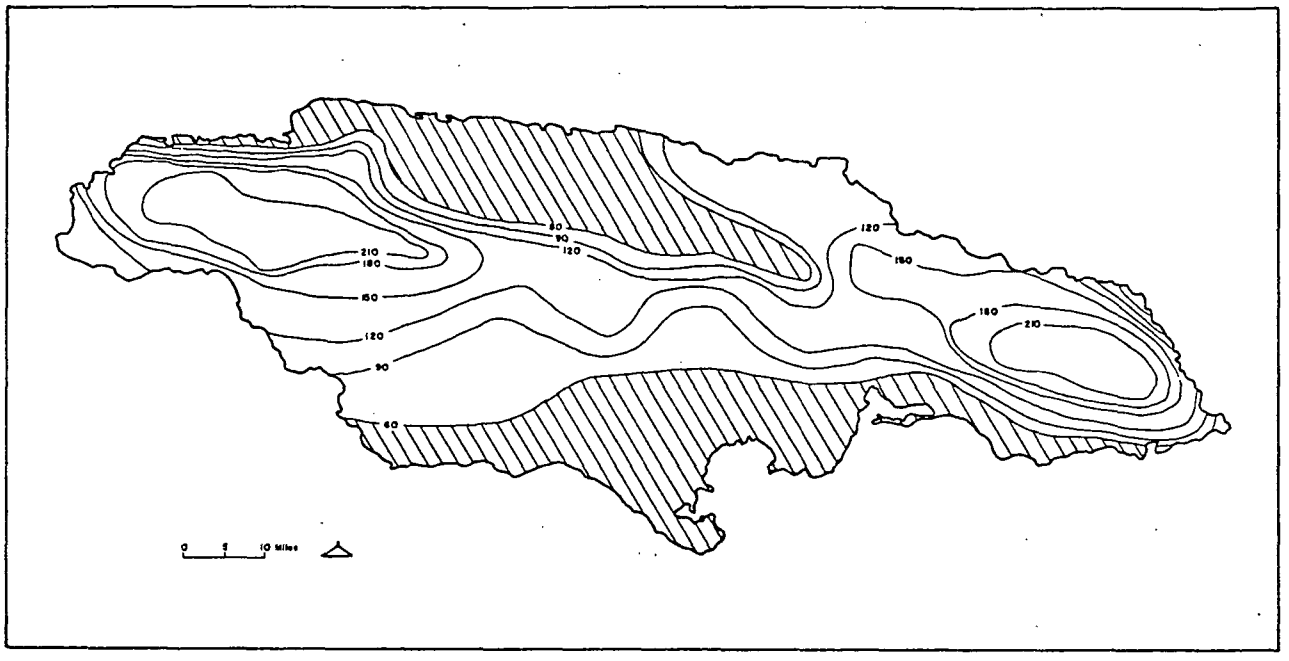


Figure 2: Length of the main growing season (in days)
(After IICA, 1983)

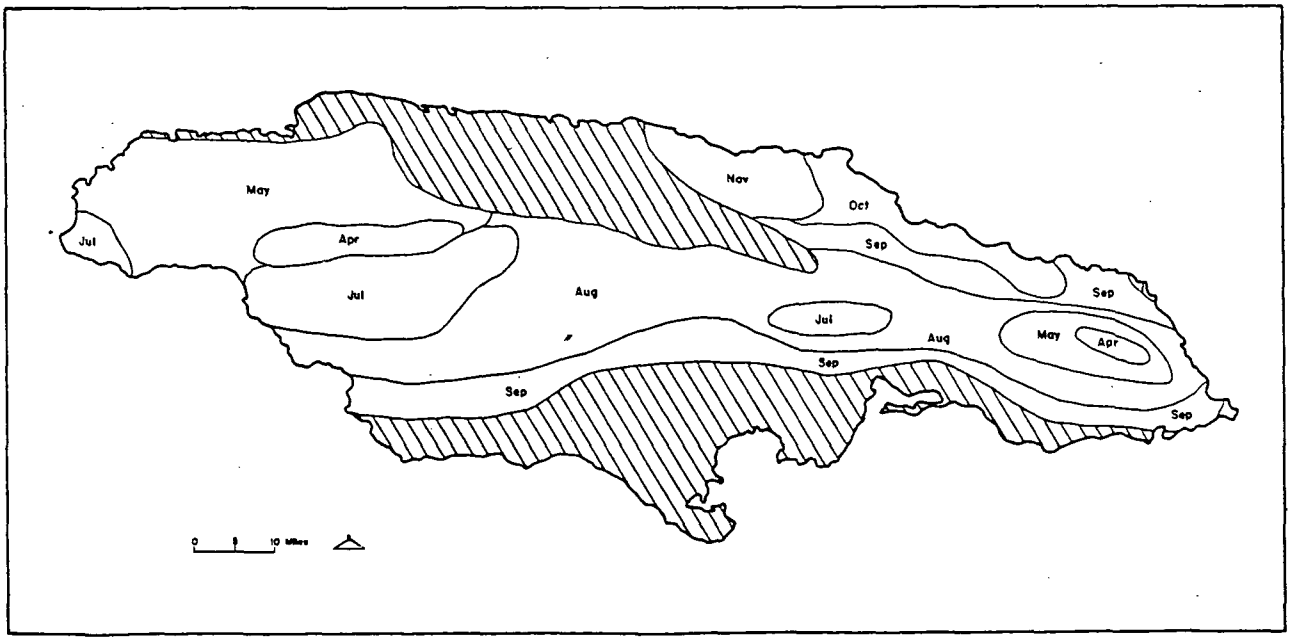


Figure 3: Beginning of the main growing season
(After IICA, 1983)

2) The sensibility to rainfall erosion, expressed as the estimated soil loss, is tested against the tolerable soil loss (section 3).

These pre-requisites permit the exclusion of any suitability classification of unfeasible land/crop combinations at a high level in JAMPLES.

Provided that a crop is suitable for a major agro-climatic zone, it is then assessed whether it can be grown on the basis of its water demand taking into consideration the soil's moisture retention characteristics (section 4). The matching of the remaining relevant land qualities to the crop's soil requirements is done with computerized "conversion" tables and results in the final (physical) suitability classification (section 5).

The flowchart of JAMPLES is attached as Appendix I.

3. SOIL DEGRADATION MODEL

The topography of Jamaica is mainly characterised by hilly and mountainous land which is highly susceptible to soil erosion. The land unit's resistance to soil erosion has therefore been given special emphasis in the JAMPLES methodology.

The soil degradation model (SODEMOD) considers rainfall erosivity, soil erodibility, slope gradient and slope length in determining the potential soil loss using a modified version of the Universal Soil Loss Equation (Bouwman, 1985; App. II). Fourteen pre-specified combinations of mechanical and cultural conservation practices are included.

The soil loss from a crop/land system is computed for all of these combinations starting with the least effective conservation method. If the estimated soil loss is less than the tolerable soil loss the option is feasible. The model also allows for the calculation of the corresponding cost of construction and maintenance for later use in the Agro-economical Information System (section 6).

4. SOIL MOISTURE BALANCE MODEL

The availability of soil moisture for crops has been rated with the soil moisture balance simulation model or SOMOMOD (Batjes, in prep.; App. III). It is a further refinement of the broad agro-climatic zoning which has been described in section 2.

The crop's water requirements during its successive stages of growth are entered into the model taking into consideration the expected start of the growing season (Fig. 3). They are weighed against the soil's moisture retention differences with the water budgeting module which is based on a 4 layer root-zone model. The departure from optimum to sub-optimum moisture conditions in the soil in each crop development stage has been empirically related to the expected departure from optimum yield levels. This rating system is still in the development stage pending correlation between the theoretical and field findings. SOMOMOD finally gives a rating which is in terms of "absence of limitations for rainfed crop growth in 3 out of 4 years" during the pre-specified growing season for a given soil.

5. MATCHING MODEL

5.1 Rating of the Land Qualities

The broad agro-climatic zoning and the subsequent appraisal of the land unit's resistance to soil erosion and potential for rainfed crop growing gives a broad suitability assessment for crops. The next stage in JAMPLES consists of rating the remaining land qualities considered to be relevant for crop growing in Jamaica. These have been specified in RPPD (1986) and will only be mentioned without going into detail.

T	Textural group of the soil between 25 and 100 cm depth
pH	Soil reaction in the topsoil (0 to 25 cm depth)
NR	Nutrient retention in the topsoil
NA	Availability of nutrients in the topsoil

CC Content of finely divided calcium carbonate between 25 and 100 cm depth.

SA Salinity hazard

SO Salinity hazard

O Availability of oxygen for plant roots

F Availability of foothold for plant roots

W Workability, both manually and mechanically

From item W follows the fact that two input levels have been considered in the appraisal of the rating of the workability and hence also in the final suitability assessment.

5.2 Matching Procedure

The crop's soil requirements are finally matched with the land qualities using the matching model (MATMOD). To enable this, the climatic and soil requirements of 50 crops have been listed (Barker, In Prep.) and summarized in crop requirement tables using the ranges pertaining to the respective suitability classes. These classes are: highly suitable, moderately suitable, currently non-suitable and permanently non-suitable. The result is a series of conversion tables which have been computerized using the dBASE II software.

The procedure has so far been tested for a limited number of soils and crops. Presently, it gives a classification of the current suitability at two input levels (see section 5.1). The final version, however, will indicate the main limiting factors of the land for the defined use.

6. SUMMARY AND CONCLUSIONS

The development of a national computerized land evaluation system for Jamaica is a considerable task. It will take some time before it can become fully operational and provide a user's service.

The Rural Physical Planning Division (RPPD) of the Ministry of Agriculture actively started to develop its in-house physical land evaluation system, JAMPLES, from November 1985. The methodology has been designed, the rating systems for the land qualities prepared, the crop requirements listed, and the individual software models designed and programmed. With further analysis of the sensivity of these models for changes in the parameters and input data, the system will be tested against field findings and refined where necessary.

JAMPLES still interposes manual stages among the various models thereby losing one of the main advantages of an interactive computer-user system. However, the various models of JAMPLES will be linked under the technical assistance program funded by USAID.

RPPD follows a "two-stage" approach in land evaluation of which JAMPLES forms the first, physical, stage. For the economic stage a software package for the economic analysis of multi-period and multi-enterprise farm budgets (MULBUD; Etherington & Matthews, 1984) is being tested using data collected by Rural Physical Planning Division staff. It is anticipated that the economic and physical land evaluation sections will be "melted" into a comprehensive, qualitative system in the near future. In combination with GIS, this system will form a powerful tool in planning studies designed to determine the location and extent of the land most suitable for the envisaged uses. The system should be able to provide a user service within the next two years.

ACKNOWLEDGEMENTS

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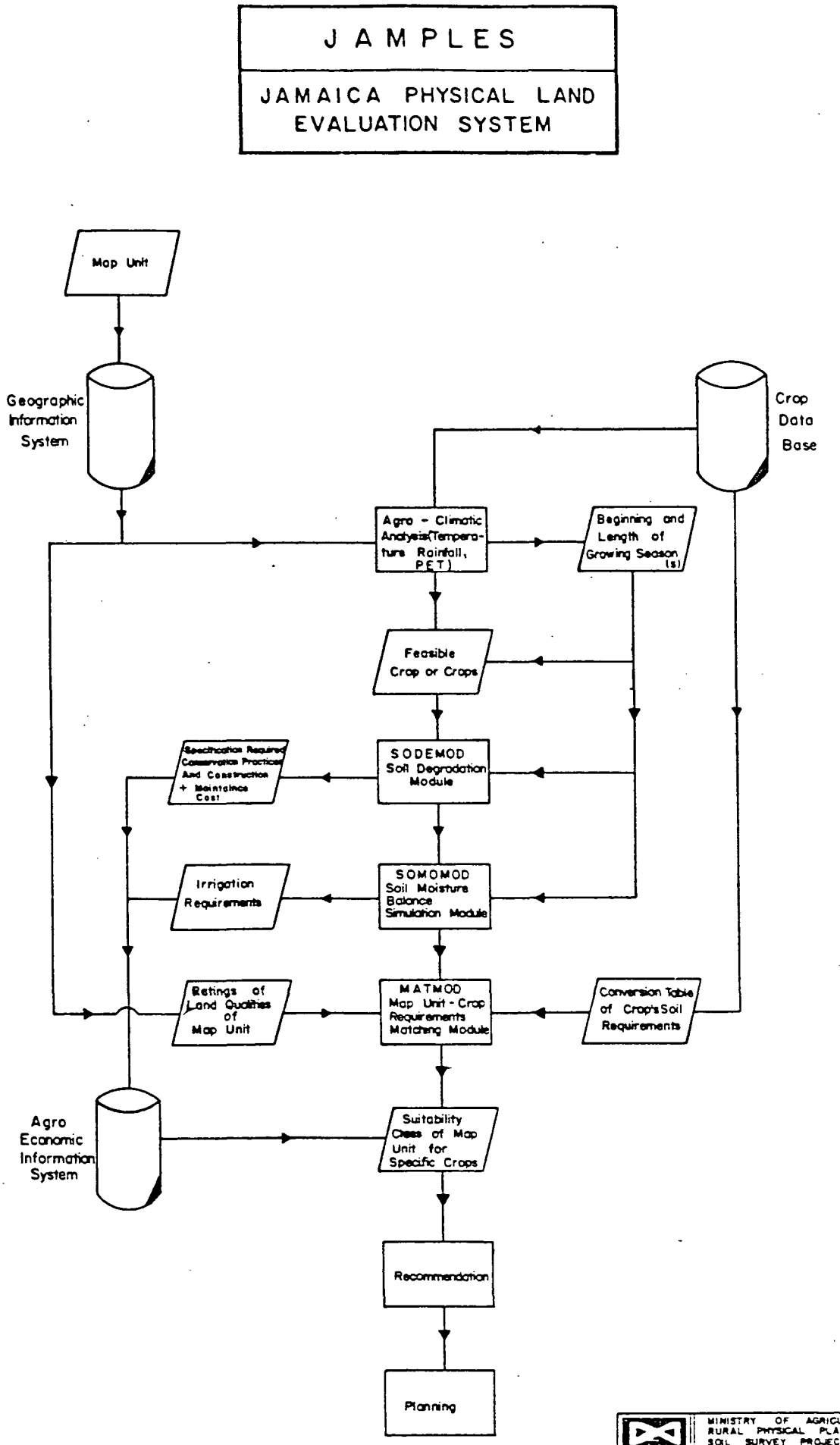
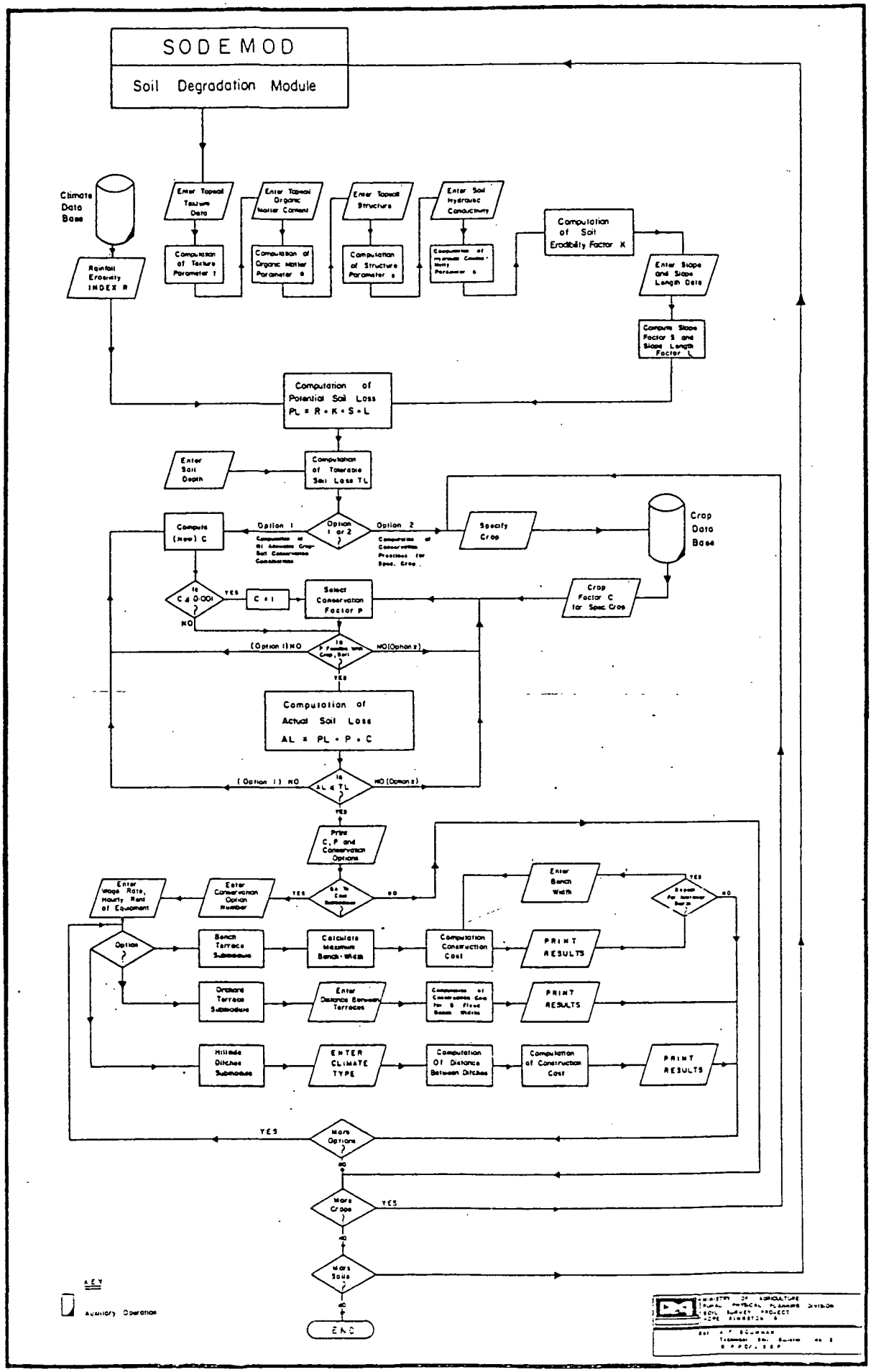
SURVEY DEPARTMENT (--) Jamaica 1:12,500 topographical map sheets. Government Printer, Kingston, Jamaica.

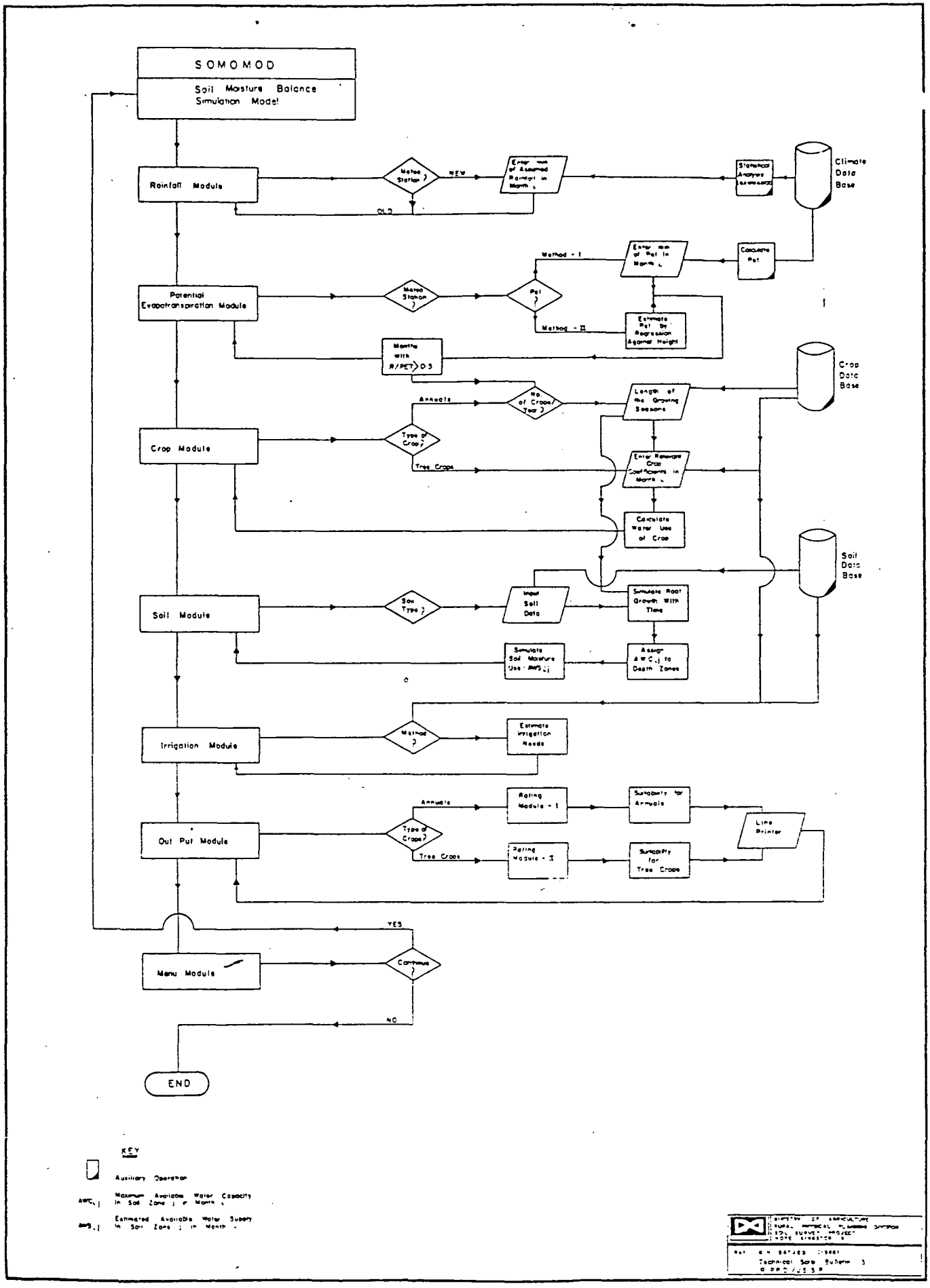
APPENDIX I: Flow chart of the Jamaica Physical Land Evaluation System (JAMPLES)



APPENDIX II: Flow chart of the Soil Degradation Model (SODEMOD)



APPENDIX III: Flow chart of the Soil Moisture Balance Simulation Model (SOMOMOD)



ERRATA:

Abstract, line 17	qualitative = quantitative
page 3, line 9	qualities to = qualities with
page 3, line 29	economical = economic
page 4, line 2	model or SOMOMOD = model (SOMOMOD)
page 4, line 8	module = model
page 4, line 9	differences = difference
page 5, line 23	defined use. = defined use and the current suitability ratings.
page 6, line 19	qualitative = quantitative
page 8, line 3	International = Internal
Appendix I	Maintaince = Maintenance

Note: = (should read)