Land drainage in the Atlantic region of Costa Rica

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1 Introduction

Costa Rica is a small tropical country located in the southern part of Central America with an area of 51 000 km^2 and a population of approximately 2 500 000 inhabitants. It is in between the latitudes 8 and 11 degrees North and the longitudes 82 and 86 degrees West and has borders with the Republic of Nicaragua in the north and with the Republic of Panama in the south-east. Furthermore Costa Rica has a coast-line with the Caribbean Sea in the east, and with the Pacific in the west and south-west.

The climate is predominantly warm (mean annual temperature varies from 28 to 32°C) and humid in the lowlands and coastal areas lower than 500 m above sea level (the Atlantic and Pacific regions), temperate in between 900-1500 m above sea level and cool in the mountainous regions. There is a great variety of microclimates due to the irregularity of the topography in Costa Rica.

Figure 1 shows the mean annual rainfall in Costa Rica, varying between 1000-7000 mm. Mean rainfall values are 1600 mm at the Central plateau, 1900 mm in the Pacific region and 3500 mm in the Atlantic region.

Since colonial times the agricultural activities have been the main source for economic development of the country. The main agricultural products are coffee, sugarcane and rice. In the Atlantic and Pacific humid regions bananas, oil palm, cacao, corn, pineapple and recently tropical and ornamental plants are cultivated.

2 Drainage problems and solutions

According to governmental investigations, Costa Rica has extensive areas with very good soils, although some areas have drainage problems. It has been estimated that in the Atlantic region out of a total area of 300 000 ha with drainage and flood control problems (temporary, seasonal, or permanent), an area of 250 000 ha with high agricultural potential could be reclaimed by drainage and flood control measures. At the moment, in spite of the almost uniform rainfall distribution except in critical periods with more than 400 mm per month, these areas are hardly used for agricultural purposes.

The development of the areas in the Atlantic region is mostly initiated by private companies, who are introducing drainage and flood control measures. They built dikes and cleared waterways near the plantations together with land smoothing. Results were not always positive, sometimes even negative. Flash floods during the wet season in the sediment-loaded rivers with small hydraulic cross-sections caused flooding and

as a consequence high groundwater levels in the plantations.

In recent years the banana production of Standard Fruit Company and some others has increased considerably due to the introduction of subsurface drainage systems, especially in areas with medium and coarse textured soils where pipe drains were installed. Corrugated pipes (Rib-loc and ADS) have been used. In sandy or silty textured soils, the pipe drains were mostly prewrapped with a spun bounded nylon filter. The high hydraulic conductivity values of these soils in the banana plantations are an advantage for the proper functioning of the installed subsurface drains (see Table 1).

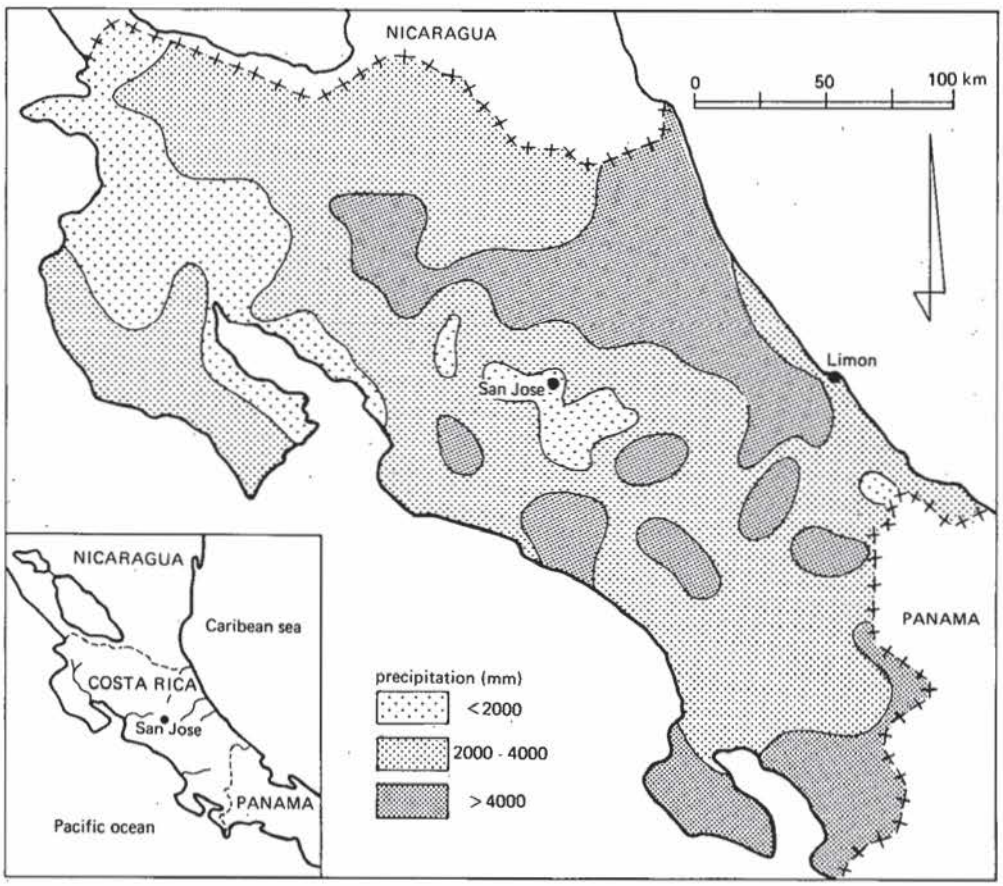

Figure 1 Mean annual rainfall inCosta Rica

Table 1 Hydraulic conductivity values of soils in different areas of La Estrella Valle, Limon, Costa Rica

Place	K(m/d)	Place	K(m/d)	Place	K(m/d)	Place	K(m/d)
M-8	9.39	N-3-1	4.09	0-1-1	16.70	Q-1-3	8.45
M-9	15.96	N-3-2	16.74	0-1	7.71	Q-1-3	8.84
M-10	11.63					Q-1-4	16.48
M-11	20.15						
M-25	12.70						
M-26	15.65						
M-27	17.00						

(Source: Fernandez and Aguilar, 1981)

Some of the general criteria used in the design of these drainage systems are:
- The watertable must decrease to a depth of 1.10-1.20 m in 24 hours;
- The formulas to calculate the drain spacing are the Hooghoudt formula for homogeneous soils and the Ernst formula for stratified soils;
- The drainage coefficient is 60-70 mm/day, which value is derived from a 3-day average rainfall of 100-125 mm/day for a return period of 5 years. These intensities are in general smaller than the soil infiltration values in these plantations (5-15 cm/hour).

The reliability of the above described drainage design criteria has been evaluated by measuring watertable levels and drain discharges. The hydraulic conductivity values elaborated by this method were similar or higher than the values previously determined by applying the auger-hole method.

The construction of the pipe drainage systems is done manually to avoid damages within the plantations. Machinery is only used for digging of the collectors and main drains.

The main steps during the construction of the pipe drains are:
- Surveying and levelling of the pipe lines in the field;
- Installation of wooden stakes at every 20 m of the pipe line indicating the respective cuts for control of the trench bottom slope (3-4%);
- Man-made excavation of the trench to the required depth;
- Installation of the drain pipes at the trench bottom, sometimes a filtermaterial is placed in an extra operation;
- Backfill of the trench with the excavated soil.

Careful supervision is needed during the whole construction period.

The drain spacing varies between 20-45 m, while the mean drain depth ranges from 1.2-1.8 m and the maximum pipe line length is more than 300 m (see Figure 2). A jetting nozzle is used for cleaning these pipe drains.

With an average total pipe line length of 300-400 m per ha, the average cost of these pipe drainage systems amounts to US$ 1200-1500/ha including open drains, pipes, filtermaterial, etc.

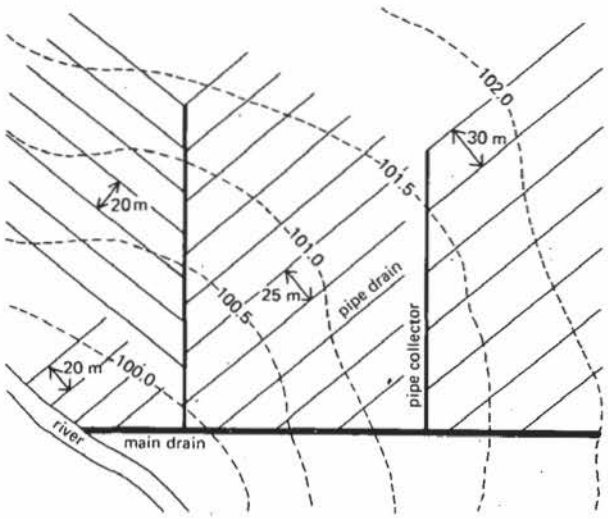

Figure 2 Typical lay-out of a subsurface drainage system in a banana plantation in the Atlantic region of Costa Rica

3 Other drainage programmes

The Costa Rican government policy is to stimulate these types of projects for improving agricultural production. The aims of these projects are:
- To reactivate agricultural production in the country;
- To increase national production levels and to create jobs for the population in the Atlantic region of Costa Rica.

Some of the main actions to attain these purposes are:
- The creation of the National Service of Groundwater, Irrigation and Land Drainage (SENARA) in 1983 to give an impulse to the farming development in the country through drainage, irrigation and flood control;
- The National Development Plan 1982-86 gave priority to the farming sector, setting the basis for adequate watershed management for flood control in the Atlantic region;
- A technical cooperation programme signed with the government of Japan in May 1985.

Due to these actions the Costa Rican government, represented by SENARA, and the government of Japan, represented by the Japan International Cooperation Agency (JICA), signed an agreement in order to obtain technical assistance for an agricultural development project in the northeastern part of the Atlantic region. This agreement considers the study and development of three watersheds along the rivers Reventazon,

Pacuare and Chirripo covering a total area of 64 000 ha (pilot areas). It also considers the establishment of a pilot watershed to be used as an experimental and demonstration area.

The criteria for the selection of the three watersheds were:
- Good agricultural soils;
- Good accessibility to the main population centers.

The estimated cost for the development of the pilot areas and the feasibility studies in the pilot watershed is US$ 300 000 and 700 000 respectively. The agreement sets a tentative 20-months period for the field work and 23-months for the final results.

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