

**CASE STUDY OF "CARCAVA SAN JOSE"  
LANDSLIDE - MITIGATION IN VENEZUELA.**

By **ALBERTO A. DAVILA.**  
**CADAFE. VENEZUELA.**

**INTRODUCTION**

The Venezuelan Republic is located in the extreme northern part of South America, and has an area of 912,050 km<sup>2</sup>. The population is close to 20 million people in 1990. This reflects a population density of 22 persons/Sq.Km.

It has a tropical climate with two main seasons, a dry period from November to April and a rainy season occurring from May to October, with mean temperature of 18 oC in the mountains to 28 oC in the lower plains. The annual precipitations varies from 250 mm. to 4100 mm.

The relief varies greatly from one region to another. Of the total area, 13 % is mountainous with altitude between 5007 and 1660 m., 45 % are the upper plains with altitude between 1660 and 500 m. and a 42 % of lower plains with elevations less than 500 m.

In Venezuela, the natural disaster occurs with more frequency in the rainy season. In the mountainous regions disaster are caused mostly by torrential floods with very short durations and practically no pre-warning time, resulting debris flows and land sliding, with the consequent loss of lives and properties, specially housing, roadways and livestocks, and also the reduc-

tion of the operational period of dam due to the solid sediment. In the plains, the major cause of disaster occurs by floods of big rivers with the consequent loss of crops, live-  
stocks, bridges and housing.

## **RESUME**

Small basin of San Jose constitutes an complex zone where is pronounced gully formation and this basin is formed by river Uribante, which has a higher sedimentation rate in the reservoir of the La Honda.

From 1968, various investigations have been carried out to diagnose and control this torrent. In the year 1985 CADAPE (Administration and Electrical Fomenting Company of Venezuela) starts to execute the corrective measures according to the feasibility study done in co-operation with U.L.A (Los Andes University).

Execution of the overall structure in the river bed is the first step. Previously to generate fundamental 'sufficient' information, contract was done with company and universities; there are altogether 5 steps recommended by the feasibility study.

## **THE PROBLEM**

The area of the small basin San Jose is localized in the sloping towards both side like the Venezuelan Andes of the Tachira state, which is the highest part of the basin, river Uribante

this place is considered as the highest purity of treatment because it is the basin which has the widest and deepest gully, called as Carcava of San Jose. This is an burning example of the most damaging soil erosion and gully formation.

The major problems can be pronounced as the active profoundness of river bed erosion, regression associated with land instability because of vertical slope on both sides, generates rotational landslides and scratches in the package form and slides. The small basin occupies surface of 239 hectre which is 0.2 % of the total area of the drain of the reservoir formed by the dam of La Honda, located 8 Km. down the confluence of the torrent of river Uribante. This small area has considerable sedimentation problem as for example, in 1982 approximately 2 million m<sup>3</sup>. sedimentation was estimated in this area.

#### **ANTECEDENT**

Since 1960 there is an well known erosive phenomenon of carcava San Jose which is the important problem and CORPOANDES & U.L.A studies the basic parameters to utilize the river Uribante for its potential hydroelectric generation.

In 1968 CORPOANDES & U.L.A again elaborated and performed the overall study, of the physical characteristic condition (geomorphology, soil structure, use of the soil pattern) for the basin of river Uribante and establish the recommendations especially for the small basin San Jose.

In 1971 Hopf (Austrian Engineer) did an semi-detail of the project for the correction of torrent and proposed the methods of correction, direction of terraces, deviation in the critical points and recommend the necessary sociological and biological characteristics to be improved.

In 1981 CADAFE creates the Office of Basin Management and incorporates an group of the technicians who initiates basic studies to control the San Jose torrent.

## **OBJECTIVE**

### **GENERAL**

Contribute by decreasing sedimentation gathering small and large which is originated in the small basin of San Jose and successful reoccupation of the areas by the process of degradation through planning and executing to conserve the soil and water.

### **SPECIFIC**

To propose and to design the structural system, vegetative system and socioeconomic system, in order to obtain or regain the occupied possible areas by the slope formations and destabilization caused by the river bed.

Instrumental and recollect data for the analysis of the geomorphological evolution of the zone of the carcavas in order to recommend corrective actions and to evaluate the methods,

whether it is efficient durable or economically feasible, viable or not.

#### **METHODOLOGY**

The strategy to take for the torrent control of San Jose appear from the elaboration of the paper "Management of Conservation of the Microbasin San Jose" that includes the necessary aspects compiled, and analysis of the basic information, design and calculate the control actions (socioeconomic, in river belt and its slopes), physical targets, financial and chronological program to execute.

The chronological resume of work is as follows:

- In 1982, CADAPE executed the topographical map of the principal river belt of small basin in an scale of 1:500 with each intervals of 20 m. transverse profile.
- In 1983 U.L.A realize this study "Analysis of the evolution of the carcava San Jose" as a means to correct geomorphological base.
- In 1984 U.L.A executed the geomorphological instrumental project of San Jose carcava thus: elaborate the slope profile in a scale of 1:2500 taking how principal criteria of occurrence in the geomorphological process, installation instrument to measure the (erosion, erode, denudation), as indicators of increase of flood level and pluviometric stations; establishment of places of photographic control and to measure changes of amplitude of the river belt and the other

kind of changes, continuous measures with chemical marked; location of Young hollow for measuring the displacement and the intensity of the mass flow.

- In 1985 CADAFE executed the first phase of construction beginning with reinforcement works so as to check the big rock falling 13 m. height its bottom is protected by forming the barrier (travieza); 5 dikes preconstructed with galvanized steel, 1 dike of revested gavian, 2 big longitudinal walls; and 2 culverts.

- In 1986 CADAFE built 3 preconstructed steel dikes.

- In 1987 CADAFE built 12 preconstructed steel dikes.

- In 1987 U.L.A did this study "Measure of sediment transportation in the highest portion of the San Jose torrent".

- In 1988 CADAFE executed the maintenance of the construction works, of the above mentioned constructions, reinforce steel dikes and built breakwaters in the bottom of the dikes on the same year was constructed 6 more gavian dikes, 2 built with combination of steel and revested concrete gavian, 1 torrential dike that checks the torrent and it was constructed by revested with gavian, one check dam for deposit the sediments, and one channel for connection.

- In 1988 CIDIAT (Inter American Development Center for Integral Water and Soil) executed the study "Evaluation of the sedimentation of river Uribante"

## **DESCRIPTION OF THE STRATEGY**

### **A. SOCIOECONOMIC METHODS**

To obtain the change of the necessary utilization of the land, within a short time, it is necessary to acquire places located in the carcava area. This objective could be obtained by implementation of programmers of soil conservation by mass participation in order to obtain the effective results within a long time.

### **B. VEGETATIVE METHODS**

To reduce volume and velocity of water flow like the flash floods structural and vegetative methods must be carried out to protect the soil erosion. To obtain this objective it suggest a change of land use pattern, producing forest cover in the land actually utilize for pasture.

#### **B.1. AFFORESTATION**

Plantation are the measures to maintain the water level saturation and strengthen the stability of weight of biomass and soil as well as to , maintain the vegetational succession. With the above mentioned measure, balance of proportionate water level, the incremental loss indices of interception by rainfall and water loss by transpiration can be checked and maintained.

#### **B.2. SHRUB PLANTATION.**

The shrub plantation is the measure on those loosely stabilize zones where is presence of scars of old geomorphological

movement and this zone will not be capable to support the weight of big and large trees so needs the plantation of shrubs which hopes to provide good protection to the soil and achieve adequate and rapid stabilization of soil.

### **B.3. REVEGETATION - NATURAL.**

The plants are measure or modes in those zone which affects the dynamic process of erosion, zone of human intervened forest, pasturing causing space distribution of trees, where we presume that the influence of the natural agents (little birds which acts like the carrier of pollen grains and facilitates the process of pollination) permits the dessimation of the seeds without the human intervention and the zone is reoccupied with natural vegetation.

### **B.4. FOREST CIRCLE. (PLANTATION)**

The plantation of the trees are so designed that the perimeter of the small basin in protected by animal and human intervention i.e. the intervention caused by pasturing and the cattle is prohibited naturally.

## **C. STRUCTURAL METHOD.**

### **C.1. STRUCTURAL METHOD IN THE RIVER BED.**

The pilot project of 1983 mentioned the possibility of construction of the parts of the works in the river bed on section basis according to the priority of the vulnerable areas.

## WORK TYPES.

- Reinforcement construction works to prevent the big rock falling.
- Construction of galvanized steel dikes in preferable (appropriate) place and stuffed and compact with the locally available material (soil and stones).
- Dikes made from the mixture of concrete and rocks.
- Dikes of concrete covered gabion wall.
- Check dam (for deposit of sediments) of concrete and rocks.
- Construction works to check the damage caused by heavy rainfall.
- Barrier to protect the river bed.
- Culverts.
- Channels.
- Longitudinal walls.

## C.2 STRUCTURAL METHODS IN THE SLOPES.

Designate the various measures in the slopes, it is possible to construct the next work types like drain, deviation channel, torrenteras pipe system, dissipation box, longitudinal walls and ditches.

## CONCLUSION.

As the control work is very expensive, the effort should be to find out the best and economically viable construction material, design and types of structure as well as the ways to reduce the transport cost thus decreasing the final cost involvement.

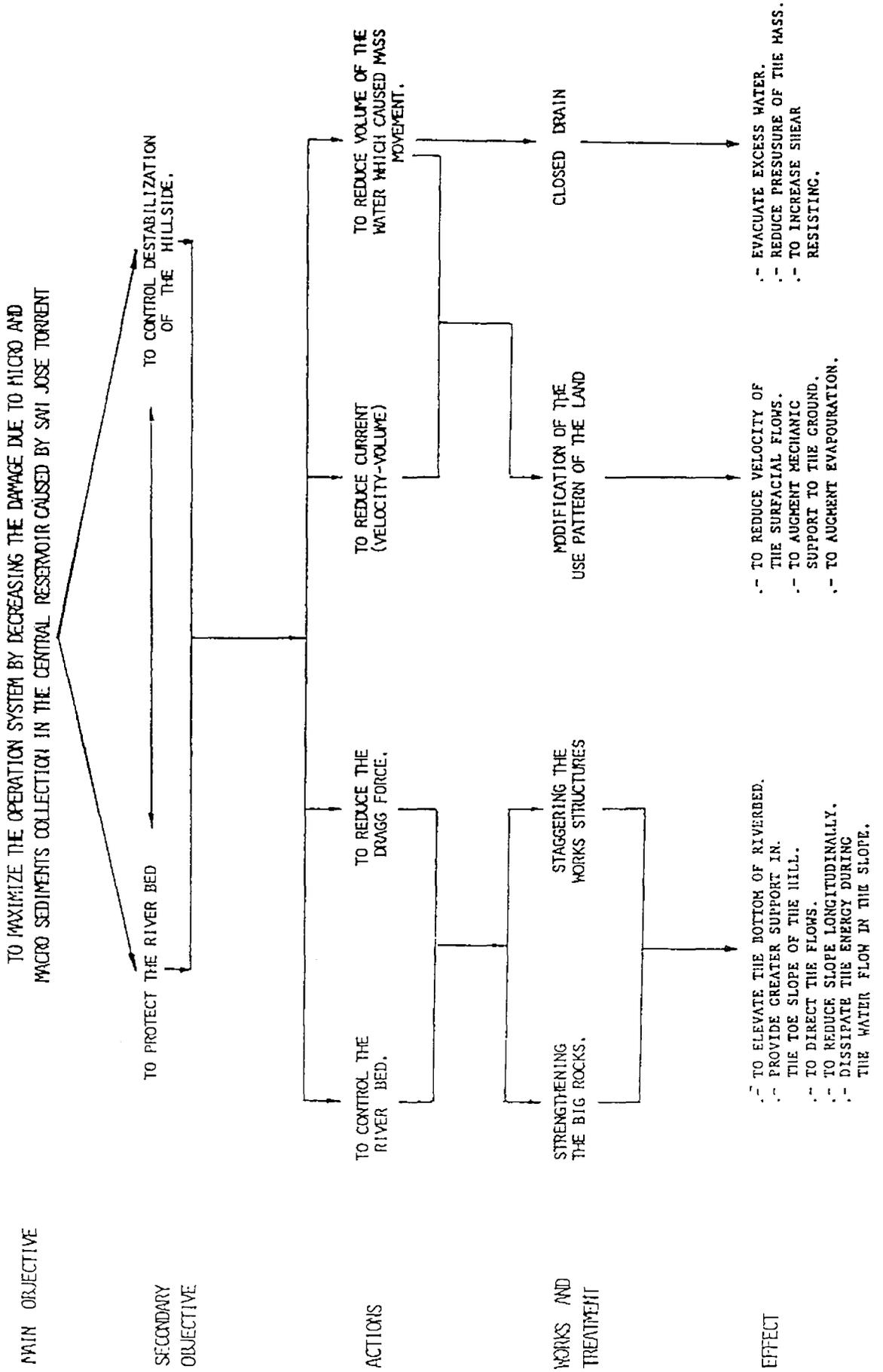
To mitigate the landslide disaster it is necessary to impart education and technical support to the population of the susceptible vulnerable areas.

The diverse and sustainable knowledge obtained in the advanced study course of landslide including the observation trip to Nagasaki Prefecture is very much important for further research, adapt research methodology and design the type of works for the landslide countermeasures and prevention.

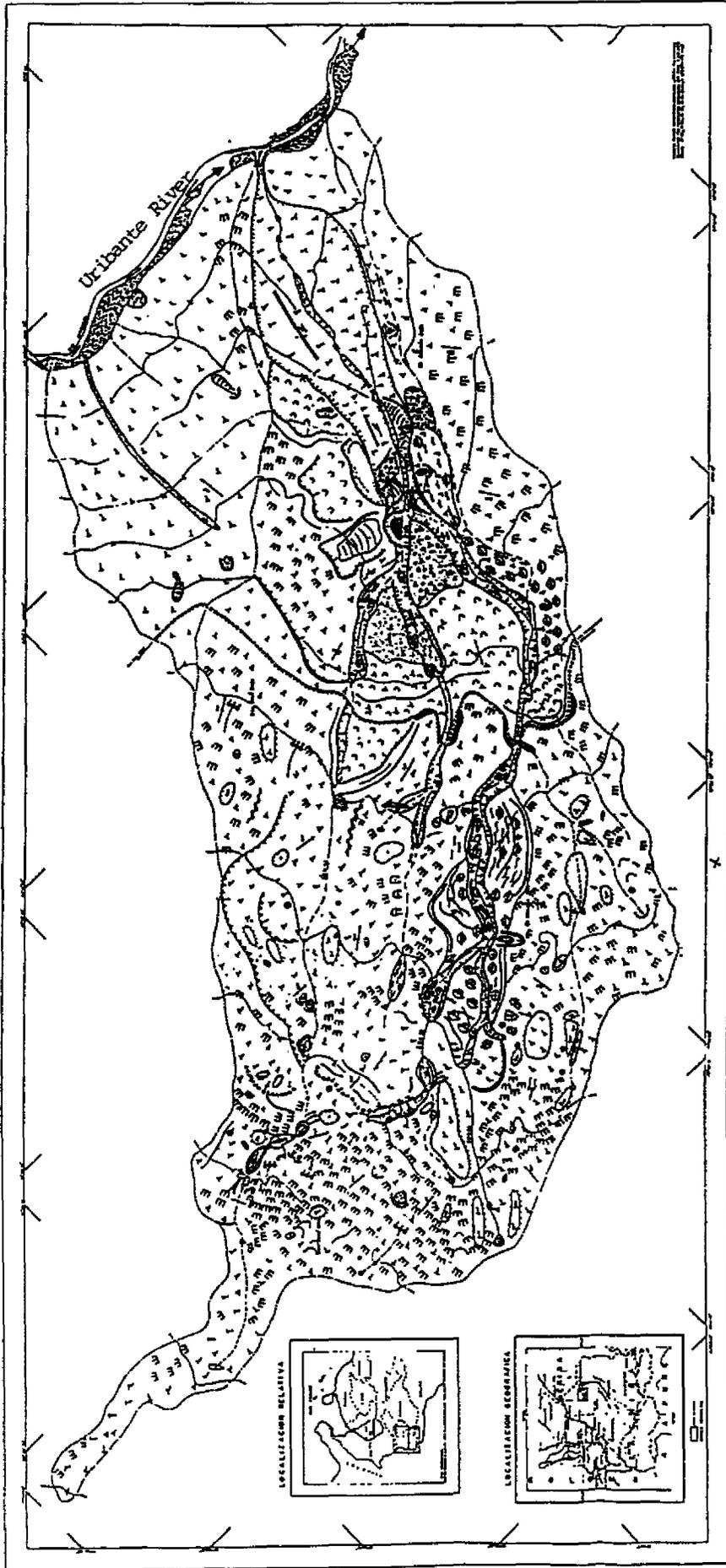
#### **ACKNOWLEDGMENT.**

I would like to express my gratitude to the Japan International Cooperation Agency, (JICA) and to the Administration and Electrical Fomenting Company of Venezuela (CADAFE) for giving me the opportunity to come to Japan to participate in this seminar. I owe special acknowledgment to Dr. Kinoshita, Dr Oyagi and all the dedicated staffs of National Research Center For Disaster Prevention (NIED), and to Mrs. Nannichi including Miss Ebisawa also. My heartfelt thanks goes to their dedication and cooperation the whole group of participants for the kindness, co-operation and friendship extended to me.

STRATEGY



GEOMORPHOLOGICAL MAP OF CARCAVA SAN JOSE, TACHIRA - VENEZUELA. 1983.



ANALISIS EVOLUTIVO DE LA CARCAVA SAN JOSE, PREGONERO-ESTADO TACHIRA

ASPECTOS GEOMORFOLOGICOS  
 (NIVEL DE DETALLE)

ESCALA 1/2500



GEOLOGIA

CROMOESTRATIGRAFIA

GR4 QUATERNARIO (RECIENTE) MEDIOVENTE

GR6 QUATERNARIO RECIENTE (DESECCIONADO)

J1q JORDANO (LA OROTA)

RASBOS ESTRUCTURALES

TRAZA DE FALLA NORMAL (CIZALLAMIENTO, DESPLAZAMIENTO)

TRAZA DE FALLA INVERSA

LIMITE FALLA/DESPLAZAMIENTO

MOVIMIENTO PRESIONADO DE LOS ESTRATOS

DESPLAZAMIENTO VERTICAL

ASPECTOS GEOMORFOLOGICOS

PROCESO

MOVIMIENTOS DE MASA PROFUNDOS

MOV. (DORSAL) ACTIVO

MOV. (DORSAL) PASIVA

MOVIMIENTO ACTIVO

MOVIMIENTO INACTIVO

DESPLAZAMIENTOS ROTACIONALES

DESPLAZAMIENTOS ROTACIONALES INACTIVOS/LATENTES

DESPLAZAMIENTOS EN MANCHETES

DESPLAZAMIENTOS ROTACIONALES CON INCLINACION DE LA MASA DESPLAZADA

DESPLAZAMIENTOS LINDIERS

DESPLAZAMIENTOS EN BLOQUES

DESPLAZAMIENTOS ROTACIONALES CONTINUOS

COLAPSO DE BARRIO

INDICACIONES

MOVIMIENTOS DE MASA SUPERFICIALES

MOVIMIENTO CONTINUO

MOVIMIENTO PERIODICO

MOVIMIENTO TEMPORAL

MOVIMIENTO DE DESPLAZAMIENTO

ESCURRIMIENTOS

ESCURRIMIENTO LINDIERS

ESCURRIMIENTO DESDELLADO

RETIENE DE BARRIO

ESCURRIMIENTO SUBSUPERFICIAL (DIFUSION)

PUNTO CON TENDENCIA A LA CAPTURA

MOVIMIENTO DE FONTE PROGRESIVO POR AGOTAMIENTO

VALLE DE FONTE

VALLE EN "U" SUPERFICIAL

LINIA DE SUPERFICIE

FORMA DE SUPERFICIE

SUPERFICIES COLAPSADAS

DEPRESIONES DE SUPERFICIE (CON BARRIO)

DEPRESIONES DE SUPERFICIE (CON BARRIO)

MOVIMIENTO PASIVO

VALLE COLGANTE

MOVIMIENTO PERIODO

MOVIMIENTO PERIODO

SALIDA DE UNO O VARIOS PUNTO PERIODO

MOVIMIENTO PERIODO

CRESTAS

CRESTAS COLGANTES

MOVIMIENTO Y DESPLAZAMIENTO

DINAMICA FLUVIAL

DESPLAZAMIENTO LATERAL

MOVIMIENTO DE EMISION PERIODO

MOVIMIENTO VERTICAL

MOVIMIENTO

PUNTO (MOVIMIENTO) ESTACIONAL

PUNTO (MOVIMIENTO) DURANTE TODO EL AÑO

MOVIMIENTO

MOVIMIENTO

MOVIMIENTO

MOVIMIENTO EN FONTE DE BARRIO

MOVIMIENTO

MOVIMIENTO PROGRESIVO DE LOS "LEAST" SUPERFICIALES

MOVIMIENTO

MOVIMIENTO

MOVIMIENTO

MOVIMIENTO DE CAPTURA (BARRIO)

MOVIMIENTO

OTROS SIMBOLOS

MOVIMIENTO

MOVIMIENTO DE FONTE DE BARRIO

MOVIMIENTO DE FONTE DE BARRIO

SIMBOLOS CONVENCIONALES

MOVIMIENTO

MOVIMIENTO

MOVIMIENTO

MOVIMIENTO

GENERALES

MOVIMIENTO

MOVIMIENTO

MOVIMIENTO

MOVIMIENTO