HYDRAULIC MODELING OF MAGADALENA RIVER IN SOBEK

Cesar Antonio Cardona Almeida IA, MSc, PhD(c) [1]
Jorge Luis Sánchez Lozano InAg, MSc(c)[2]
José Javier Oliveros Acosta IA, MIC(c)[3]

1 Advisory Regional of the Autonomous Corporation of the Rio Grande of La Magdalena-CORMAGDALENA-in implementation of the Scientific Research Centre of the Magdalena River "Alfonso Palacio Rudas".Celle 93B No. 17-25.Office 504. +57 (1) 636909. Sanitary and Environmental Engineering, Master in Hidrosistemas, Doctoral Student in Engineering Pontificia Universidad-,Javeriana.-cesar-.cardona-@-cormagdalena.gov.co
2Asesor of the Regional Autonomous Corporation of the Rio Grande de la Magdalena-CORMAGDALENA-in implementation of the Scientific Research Centre of the Magdalena River "Alfonso Palacio Rudas". Calle 93B No. 17-25. Office 504. +57 (1) 6369093. Agricultural Engineer, Master Student Hidrosistemas Pontificia Universidad Javeriana, Student Master of Water Resources Engineering, National University of Colombia. jorge.sanchez @ cormagdalena.gov.co
3 Advisory Regional Autonomous Corporation of the Rio Grande de la Magdalena-CORMAGDALENA-in implementation of the Scientific Research Centre of the Magdalena River "Alfonso Palacio Rudas". Celle 93B No. 17-25. Office 504. +57 (1) 6369093. Environmental Engineering, Master's Student in Civil Engineering Hydraulics and Hydrology emphasis Pontificia Universidad-Javeriana.jose.oliveros-@-cormagdalena.gov.co

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ABSTRACT

This paper presents a brief description of the scope and project phases and activities and preliminary results of the initial construction phase of the hydraulic model of the Magdalena River in one and two dimensions. Likewise make comments about expectations and potential model and lessons,learned.in-its-development-process. In the first step were collected and analyzed the data available for the scope of the model of the Magdalena River. Subsequently, the data were converted.to-formats-suitable-for-direct-use-in-SOBEK-®. In the next step Construction Model (Model SOBEK 1D2D), the model structure was based on the functional design, for example, the distinction between purely 1D part (main channel), areas and floodplains and wetlands 2D represented by the storage nodes. The model is forced to discharge upstream according to the time series and limit water level downstream. The side to and from the river to tax downloads will be-included-in-the-model-using-time-series.
Keywords: Hydraulic Modeling 1D2D, Magdalena River, SOBEK

TÍTULO DEL ARTÍCULO EN INGLÉS

ABSTRACT

This paper presents a brief description of the scope and project phases, activities and preliminary results of the initial construction phase of the hydraulic model of the Magdalena River in one and two dimensions. Likewise comments are made regarding the expectations and potential of the model and the lessons learned in its development process.

As first step the available data was collected and analyzed for the scope of the model of the Magdalena River. Subsequently, the data was converted into suitable formats for direct use in SOBEK ®.

In the next step for the Construction of Model (SOBEK 1D2D), the model structure was based on the functional design, for example, the difference between purely 1D part (main channel), areas and floodplains in 2D and wetlands represented by the storage nodes. The model is forced to an upstream discharge according to time series and to water level limit downstream. The lateral flow upto and from the river tributaries will be included in the model using time series.

Keywords: Hydraulic Modeling 1D2D, Magdalena River, SOBEK.

1. INTRODUCTION

The Magdalena River is the largest river in Colombia, crossing the Andean region, which is the center of the development of Colombia. It flows from south to north with a length of about 1,536 kilometers and an average flow of 7,100 m³ / s. The basin area is around 257,000 square kilometers, which corresponds to 22.8% of the total area of Colombia. The annual rainfall is estimated at 2,000 mm with a variation within the basin of 800 mm to 5000 mm in some areas. With regard to flood risk, the Magdalena River is a major source of damage in Colombia and is responsible for about 90% damage and 70% of human losses (Goez,2005).

CORMAGDALENA has both the advantage and mission to preserve natural resources in their jurisdiction. This requires a broad understanding of the potentials, advantages and restrictions on the use of resources and therefore must develop a high technical and scientific capacity to make knowledge, certainty and research as main arguments supporting decisions related to achieving its constitutional order. ("Act 161 of 1994") The current Corporate Action Plan 2012-2014 includes hydraulic modeling for the Magdalena River in a stretch of 800 km and other strategic lines related to the technical and scientific capacity as the creation of the Research Center of the Magdalena River defined by Article 8 Act 161 of 1994 and the information system of the River. All these horizons and efforts are enhanced by the guidelines of the National Policy for Integrated Water Resource Management 2010 that aims for a vision of integrated management of resources based on an integrated knowledge of the players decisions and the effects thereof-(CORMAGDALENA,2012a).

The program of hydraulic modeling of the river-PMR-(analytical tool), Master Achievement-PMA-plan (intervention instrument and development), PMC (planning and management tool) and draft-POE channeling works - (instrument of promotion and growth), Cormagdalena is at the forefront in the development of tools and strategies for vision and integrated resource management. These tools however are increasingly talk internally towards maximizing benefits and impacts, so the understanding of the dynamics between society, natural environment and water resources are not only guidelines for national policy, but a necessity of the work of the corporation. In that sense the project to create the Centre for Research-CIRM-(knowledge generation tool) aims to meet that need targeted efforts towards understanding these dynamics and the use of tools for integrated analysis-of-the-systems-in-question,(CORMAGDALENA,2012a).

In order to achieve this aim, an interagency agreement with Deltares, a civil non-profit corporation, established in accordance with the laws in the Netherlands aimed at the research and development of advanced technology. Specializing in hydraulic research in the Rhine River delta, experience and technical capacity to meet expectations and necessities of the program of modeling the Magdalena River. This agreement is the means to develop the project of hydraulic modeling of the Magdalena River in a stretch of 800 km from Puerto Salgar to the mouth in Barranquilla in the project include technology transfer activities, data collection, model construction and calibration analysis of the current situation and selected scenarios, morphological modeling and pilot areas selected water quality-(CORMAGDALENA,2012b).pilot-studies.

To fulfill this purpose the Hydraulic Model SOBEK ® is used. SOBEK is a SOBEK is an 1D/2D software for numerical modeling of flow in rivers, canals urban and / or rural, pipes; able to solve the equations that describe the unsteady flow, saline intrusion, sediment transport, morphology and water quality. In SOBEK can simulate and solve problems in river management, flood protection, design of canals, irrigation systems, water quality, navigation and dredging (Deltares System, 2013; JI, de Vriend, & Hu 2003).

Two.-MATERIALS-AND-METHODS,Basic

2. 2.1Fundamentación

the flow dimension is described by two equations: equation of momentum and the equation,-of-conservation-of-mass.

Mass Conservation Equation 1D

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q_{lat} \tag{1}$$

Equation de Momentum 1D

$$\frac{1}{A}\frac{\partial Q}{\partial t} + \frac{1}{A}\frac{\partial}{\partial x}\left(\frac{Q^2}{A}\right) + g\frac{\partial y}{\partial x} - g\left(S_0 - S_f\right) = 0 \tag{2}$$

Where:

A is the total area of the cross section

qlat is downloading per unit length

Q is the flow
and it is the water level
g is the acceleration of gravity
Bottom slope S0
Sf slope of the power line
As in one-dimensional two-dimensional flow is described by two equations: equation of momentum and the equation of conservation of mass.
Equation of Mass Conservation 2D

$$\frac{\partial h}{\partial t}+\frac{\partial(uh)}{\partial x}+\frac{\partial(vh)}{\partial x}=0$$

Ecuación de Momentum 2D

$$\frac{\partial(hu)}{\partial t}+\frac{\partial(hu^2)}{\partial x}+\frac{\partial(huv)}{\partial y}+gh\frac{\partial h}{\partial x}=-gh\frac{\partial z_b}{\partial x}-gn^2u\frac{\sqrt{u^2+v^2}}{h^{1/3}}$$

$$\frac{\partial(hv)}{\partial t}+\frac{\partial(huv)}{\partial x}+\frac{\partial(hv^2)}{\partial y}+gh\frac{\partial h}{\partial y}=-gh\frac{\partial z_b}{\partial y}-gn^2v\frac{\sqrt{u^2+v^2}}{h^{1/3}}$$

Where:
u is the velocity in the x-axis
v is the velocity in the y-axis
h is the total height of the fluid column
g is the acceleration of gravity
n manning roughness coefficient
zb is the depth of water if the surface is at rest

2.2 Information Gathering

it has secondary information, results of previous studies such as friction coefficients of sections or geometric structures such as bridges and road. Moreover hydrological information is in the form of time series for each monitoring station on the river or basin. Additionally, the geographic location information of the river itself and components as estuaries, marshes, and the same monitoring stations and is mentioned structures. Finally the cross sections of the river round the base of basic information for model construction.

2.2.1 Spatial Data Set

• Shapefile of the delimitation of the Rio Magdalena basin with EPSG coordinate Magna Sirga Liners 3116

• Shapefile floor for the whole Magdalena River basin. Shp format with EPSG coordinate Magna Liners 3116

• Shapefile of the centerline of the Magdalena River from Puerto Salgar to the mouth of the river in Ottawa, the Rio Cauca from La Coquera to its mouth in the Magdalena, Canal Dam from the bifurcation of the Magdalena River at Calamar to the river mouth in the Caribbean Sea, arm Mompóx with EPSG coordinate Magna Liners Bogotá 3116

• Cross sections (converted to YR def files and dat recognized Sobek..) Fairway with the following characteristics:
or Puerto Salgar - Puerto Berrio Year 2009.
or Puerto Berrio - Barrancabermeja Year 2011.
or Barrancabermeja - Barranquilla Year 2013.
Arm or Mompox Year 2008, at the beginning and end of the arm; no sections in the intermediate zone.
Dam or Channel 2000.
2000 or Rio Cauca. • Spatial Data Structures (bridges) within the scope of modeling location Magna Liners Bogotá) and properties such as width of the structure and the bridge deck elevation (MSNMl)

2.2.2 Temporary data: river gauging stations
• Level and flow measurements available at stations, including both the observed values manually and automatically observed values for the period 2007-2012, along the river the following sections:
or Puerto Salgar - Puerto Berrio.
or Puerto Berrio - Barrancabermeja.
or Barrancabermeja - Barranquilla.
Mompox or Arm.
Dam and Canal Year. or Rio Cauca year from La Coquera to its mouth in the Magdalena.

• Level 0 to translate local values of m + MASL

• Location XY coordinates Magna Sirga Liners Bogotá EPSG 3116 seasons.

• Level 0 translate local values of m + MASL

• XY coordinate location in Bogota EPSG 3116 Magna SIRGAS stations

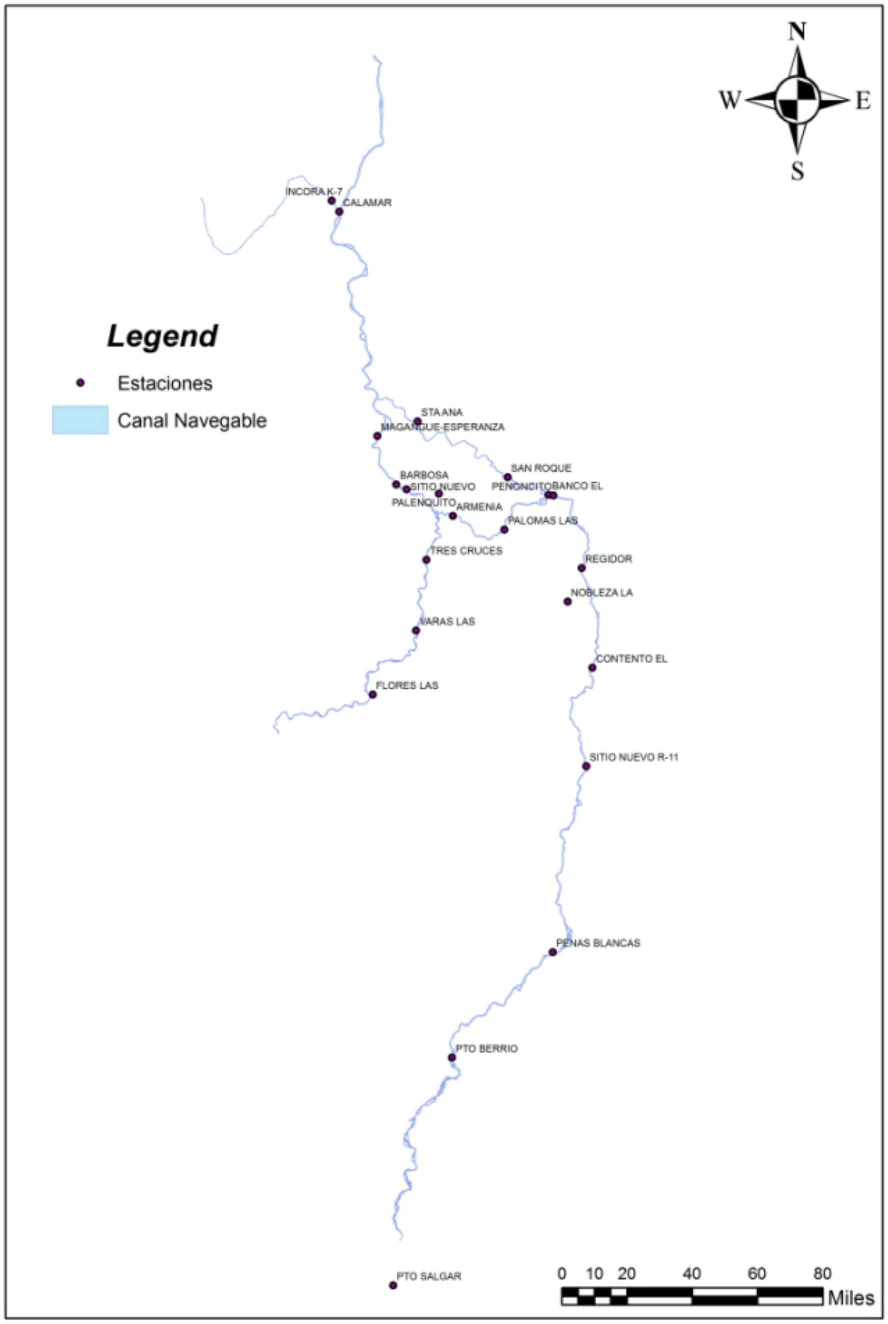

Fig.1 Hydrological Station on the Magdalena River.

The cross sections are in a different format used by Sobek, so must purge, sort and sometimes correct. This makes the treatment of the cross sections is the most demanding and complex step during model building process. This activity required considerable resources in both time and effort Cormagdalena team as Deltares. The process became a multilevel iterative activity verification and secondary data based on different criteria including automated one that will be described later.

The initial step in the preparation of cross sections consisted of a manual review of raw data of cross sections: The idea was to avoid redundancy, free points, outliers and even measurements on the bank, among others that can cause inconsistencies in processing data. Activity carried out mainly in ARCGIS manually by several professional teams. The river was organized into ten sections or sections namely 01_Barrancabermeja_SanPablo, 02_SanPablo_Gamarra, 03_Gamarra_ElBanco, 04_ElBanco_Magangue, 05_Magangue_Barranquilla, 06_PuertoSalgar_PuertoBerrio, 07_PuertoBerrio_Barrancabermeja, 08_Canal_del_Dique, 09_Rio_Cauca and 10_Brazo_de_Mompox.

Each cross section was formed by a cloud of points written in text files in which the XYZ coordinates of each of the points were established. Because the processing of these files was a huge task a computational routine was established to develop the task. During the initial step of manual review found many inconsistencies and redundant points, points of noise, in many cases the situation where you can not tell easily apparent if two contiguous sections correspond to two branches of the river or missing data is presented. In ArcGis proceeded to perform a debugging such situations, it eliminated, coordinated decisions he took between the team in cases where major inconsistencies were presented. Was checked by comparing with neighboring sections with satellite photos, also with the cross section of each segment of the section.

Deltares team developed a computational routines in Python language, in order to enlist the raw data of the cross sections and arrange them in the input format of cross sections of SOBEK conversion file XYZ bathymetry input format to Sobek. The computational routines and procedures are considered necessary due to the following reasons:

• The number of points XYZ each file is extremely large, so that it becomes unworkable.

• The number XYZ points within each cross section is very large, so routine requires a complex search.

• The complexity of the XYZ files:
- One file for each day of the measurements,
- With continuous XYZ points without any division into separate sections
- No apparent structure in the directional order of (from left to right or from right to left

• The fact that many of the surveys were not carried out perpendicular to the flow direction, making a complex routine to correct this.

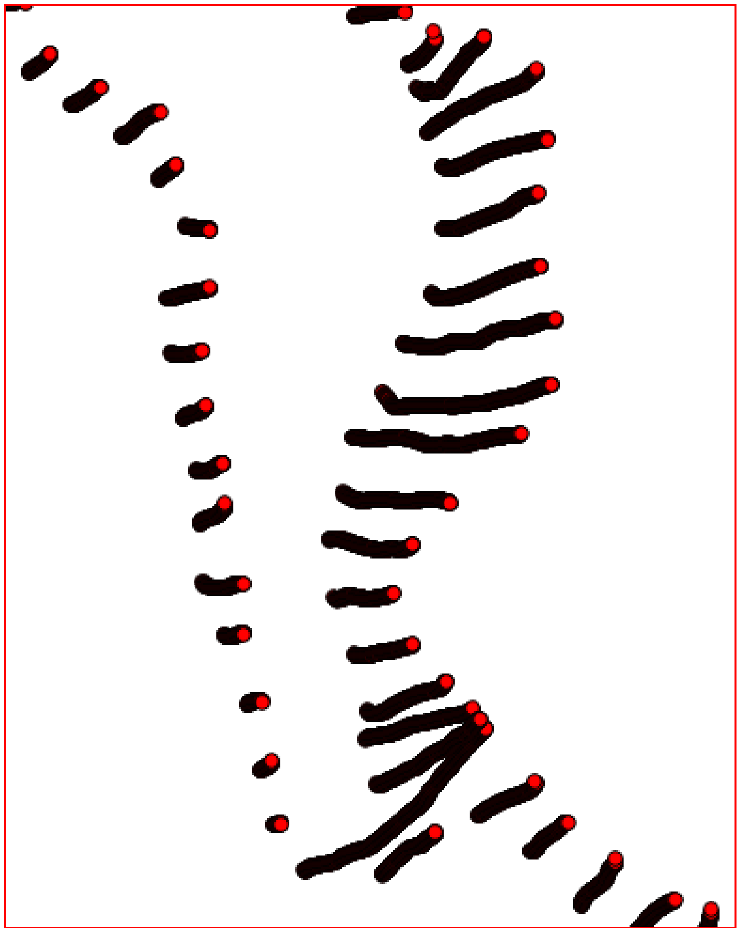

Fig. 2. Cross sections perpendicular to the flow

The following briefly describes the operation of the script:
1. XYZ_main.py. This script calls all other functions in succession. This means it is the only script that the user actually has to call.
Two. XYZCloudToXYZCloudPerCRS1.py. This script reads and processes all *. XYZ in a specified directory. Converts non-ordered XYZ bathymetry points (format: comma separated ascii files) as XYZ point cloud by cross section, recursive algorithms based on nearest neighbors.
Three. XYZCloudPerCRStoCRScutlines2.py. This script uses the point cloud cross section by (output script 1) as input. Makes setting first order poly-lines through each point cloud using the standard method of least squares. Generates files vector shapes with cut lines and output.
April. IntersectCRScutlinesWithHartline3.py. This script uses the output of the second script (cut lines) and the center line of the file as input river. Generates a file type shape with points of intersection of the lines cut and file so the center line of the river, as well as vector shape file with lines through the point perpendicular to the center line of the river intersection.
May. ProjectXYZpointsOnLinePerpToHartline4.py. This script uses the output of the indents 1 and 3 as input. Generates a csv file with XYZ point cloud projected on the perpendicular lines and a csv file with clouds sorted RZ points.

6. FilterRZtables5.py. This script uses the output as input script 4. It uses the Douglas-Peucker algorithm to filter clouds RZ points to a manageable amount. The result is written as RZ filtered point clouds.
7 WriteRZtablesToSobek6.py.. The sixth and final script uses the output as input script 5. Make this file format Sobek (PROFILE.DEF and PROFILE.DAT files).
With PROFILE.DAT and PROFILE.DEF along with CRS_intersection_points.shp file can be imported in SOBEK cross sections.

2.4 Central Processing Line

The base model is a 1D file georeferenced vector shapes showing the exact alignment of the branches of the rivers, which will be modeled. This shape file is imported directly into Sobek as a network.
Depending on the use of the model, the network model may follow either the deepest river line, the center line of the main channel, or the axis of floodplains. The first option is typically used for very low flow conditions; the second option is suited to situations where the flow is medium, while the third option is generally used if the flow conditions are high. Flood simulations are mainly used for the model. For this reason, it was decided that the network model follow the axis of the floodplains. However, there is interest in using the model for navigation and operation issues. It has become clear during the discussions that the model must be adapted to situations where the flow is low or medium. Consequently the river network in the model follow the centerline of the main channel and flood zones will now be included in the cover-2D.
Table 1 shows an evaluation of the pros and cons of each approach. The selected approach (red box) is better to model the expected behavior under low and high flow with the disadvantage of low efficiency (computational time high).

Table 1 Results of assessment of potential adjustments modeling
Traductor de Google para empresas:

Table 1 Results of assessment of potential adjustments modeling.

		Model setup		
Criteria	**condition**	1D → centreline main channel 2D → floodplains	1D → centreline floodplain 2D → floodplains	1D → centreline main channel + extend to floodplains 2D → Not used
Accuracy	Low flow	+	– –	+
	High flow	+	+	– –
Performance	Low flow	+	++	+
	High flow	– –	– –	+
Modelling effort	Low flow	+	–	+
	High flow	+	+	–
Usability	Low flow	+	–	+
	High flow	+	+	–

The centerline shapefile based on point clouds studied XYZ bathymetry was constructed considering a vector set to the center points of each cross section.
The first step was to manually review the classification of sections by Python routine. Secondly a central line linking the midpoints of all the filtered lines (ie the output of the script) is created. Finally the center line with the ARCGIS smooth function, in order to avoid the vertices in the cut points between the center line and cross sections softened.

2.5 Hydrological Information Processing

There are two important steps in the analysis and organization of hydrologic data, the first is the extraction of information in formats of time series and the second is the review period with complete data for model building. The extraction of data formats that are available for station information, year, location etc. for each year of sampling (see Figure 3) is presented, it required the development of a routine programmed in Matlab, which resulted in sampling each year gave a single row of data with 365 columns, one for each day and its corresponding data.
In this way it was possible to arrange an array in which each row corresponds to information of a different station, and each column represents data from successive days. With a conditional format colors, you can see which are the periods with more complete information.
Thus we selected the years 2009 and 2010 for the construction of the model, the water balance and calibration. Additionally favorable fact is that 2010 turns out to be exceptional by displaying simultaneously the most drastic minimum drought levels, and towards the end of the year and overflow phenomena most significant in decade’s droughts high levels.

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ELEVACION 0168 m.s.n.m REGIONAL 10 TOLIMA CORRIENTE MAGDALENA

DIA	ENERO *	FEBRE *	MARZO *	ABRIL *	MAYO *	JUNIO *	JULIO *	AGOST *	SEPTI *	OCTUB *	NOVIE *	DICIE *
01	330.0	751.0	482.0	1085	831.0	2310	1370	503.0	466.0	1190	2560	780.0
02	575.0	395.0	364.0	1208	769.0	2768	1100	440.0	440.0	1100	831.0	746.0
03	2138	950.0	338.0	1190	734.0	2435	1010	493.0	350.0	1070	1025	723.0
04	1970	723.0	286.0	950.0	757.0	1755	899.0	677.0	350.0	769.0	1172	780.0
05	1508	1025	253.0	734.0	1262	1388	831.0	617.0	545.0	711.0	1611	1316
06	1370	1063	298.0	617.0	1048	1085	769.0	593.0	723.0	557.0	3080	995.0
07	1100	988.0	310.0	617.0	908.0	1025	1063	514.0	780.0	617.0	2310	814.0
08	865.0	950.0	270.0	593.0	605.0	1460	1498	472.0	823.0	524.0	2310	857.0
09	694.0	575.0	346.0	524.0	587.0	1025	865.0	431.0	1055	593.0	2794	1370
10	780.0	545.0	225.0	413.0	569.0	950.0	797.0	377.0	950.0	1055	2218	1334
11	575.0	545.0	194.0	451.0	1334	950.0	769.0	395.0	797.0	711.0	2950	1100
12	545.0	382.0	182.0	524.0	1650	1334	1190	404.0	617.0	723.0	2253	1370
13	605.0	359.0	173.0	641.0	1280	1498	1190	440.0	723.0	899.0	2460	1172
14	535.0	355.0	197.0	605.0	1970	1280	1172	493.0	629.0	653.0	2335	605.0
15	395.0	422.0	182.0	617.0	1316	1070	1154	665.0	617.0	508.0	1797	1692
16	908.0	373.0	200.0	617.0	493.0	916.0	493.0	493.0	629.0	503.0	1713	1172
17	723.0	377.0	242.0	545.0	1244	950.0	1262	472.0	545.0	557.0	2435	950.0
18	908.0	253.0	310.0	524.0	1370	980.0	988.0	508.0	605.0	440.0	2080	882.0
19	694.0	1063	318.0	451.0	1370	950.0	1100	899.0	440.0	519.0	1926	1025
20	635.0	751.0	282.0	451.0	1460	933.0	757.0	581.0	395.0	477.0	2560	980.0
21	605.0	635.0	246.0	350.0	1208	882.0	641.0	524.0	404.0	557.0	1650	1734
22	575.0	575.0	200.0	386.0	950.0	1316	677.0	617.0	635.0	451.0	1370	2435
23	418.0	653.0	278.0	350.0	1145	1244	1040	723.0	933.0	605.0	1025	1442
24	440.0	723.0	404.0	330.0	1136	1316	757.0	493.0	797.0	482.0	950.0	1612
25	436.0	545.0	641.0	865.0	1298	1085	629.0	431.0	995.0	519.0	916.0	1190
26	519.0	823.0	641.0	950.0	2126	988.0	700.0	557.0	916.0	1190	950.0	865.0
27	973.0	641.0	751.0	1136	2373	950.0	1517	757.0	1584	933.0	1025	723.0
28	545.0	519.0	865.0	831.0	1755	780.0	916.0	814.0	746.0	1244	1370	665.0
29	519.0		1190	629.0	2742	1244	1190	694.0	933.0	1100	908.0	581.0
30	865.0		1118	823.0	2264	1517	734.0	482.0	723.0	665.0	848.0	519.0
31	950.0		440.0		2742		569.0	482.0		1025		472.0
MEDIA	796.7	641.4	394.4	666.9	1332	1279	956.4	549.7	704.8	740.2	1781	1061
MINIMA MEDIA	330.0	253.0	173.0	330.0	493.0	780.0	493.0	377.0	350.0	440.0	831.0	472.0

Fig. 3 IDEAM annual hydrological data Form..

2.6 Construcción del Modelo en SOBEK

La construcción del Modelo 1D-2D se basa mayormente en la importación de los archivos de origen de GIS a Sobek, el eje del río se importa como la red de drenaje, las secciones transversales se importan a partir del shape de puntos de intersección con el eje del río y los archivos .def y .dat de sobek generados desde algoritmos en python que reconocen los archivos originales. La grilla 2D, se importa a partir de nodos 2D y archivos raster en formato asc.

Las estaciones hidrométricas se suben con el shp de puntos como fixed calculation points en el caso de las intermedias y como nodos de Boundaries en las condiciones de frontera.

Los caudales de entrada laterales de los principales tributarios, se introducen al modelo como nodos de conexión con flujo lateral en la localización donde el afluente entrega su caudal al Río Magdalena, introduciendo las series de tiempo de caudales de estos afluentes donde se tienen los datos y determinando los rendimientos (m3/km2) promedios de las cuencas instrumentadas para obtener los caudales de las cuencas no instrumentadas.

2.6.1 La segmentación del Modelo

El Modelo se divide en tres partes a saber:

- De Puerto Salgar a Sitio Nuevo
- De Sitio Nuevo a Calamar incluyendo Brazo de Loba y Brazo de Mompox.
- De Calamar a la desembocadura en el Mar Caribe por Canal del Dique y Río Magdalena.

El principal motivo que nos lleva a dividir el modelo es el tiempo computacional que se toma en correr el modelo 1D-2D cuando se tiene completo; para ello se tomaron puntos de cierre en los que se tienen estaciones hidrométricas, para que un eventual acople de estos sub-modelos no sea traumático.

2.6 Construction of the model in SOBEK

Construction of 1D-2D model is based largely on the import of source files GIS to Sobek, the axis

of the river is imported as the drainage network, the cross sections are imported from the shape of the intersection points axis of the river and .def sobek and dat files generated from python algorithms that recognize the original files. The 2D grid is imported from 2D nodes and asc files in raster format.
Hydrometric stations up to shp point calculation as fixed points in the case of middle and Boundaries as nodes on the boundary conditions.
The flow inlet side of the main tributaries to the model as connection nodes are introduced with Inflow at the location where the effluent flow to deliver your Magdalena River by introducing the time series of these tributaries flow where you have the data and determining yields (m3 / km2) instrumented watershed averages for flows of ungauged catchments.

2.6.1 Segmentation Model
The model is divided into three parts namely:
• From Puerto Salgar to New Site
• From Site New Calamar including Mompox Arm and Loba.
• From squid mouth at the Caribbean Sea Canal Dam and Rio Magdalena.
The main reason that leads us to divide the computational model is the time it takes to run the 1D-2D model when it is complete; for this locking points which are gages, for eventual coupling of these sub-models were taken non-traumatic.

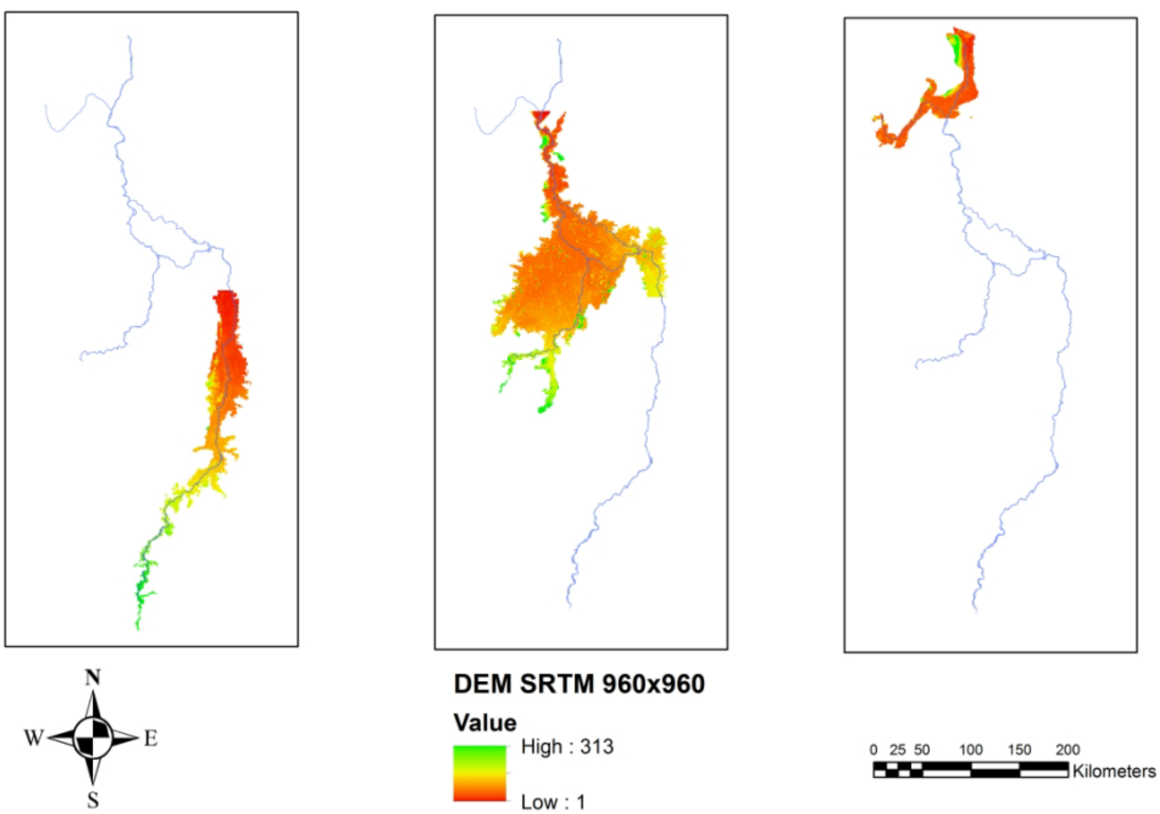

Fig. 4 Partition into three sub-models

2.6.2 Missing Information
For the current model is necessary to know
or Spatial data: Roughness.
o Data on the type of vegetation in floodplains,

or estimates of roughness values floodplains (Manning, Chezy or Nikuradse)
or estimates of the values of the roughness of the main channel
or Flow rate and level gauging stations further downstream along the major tributaries including level 0 to translate local values of m + MASL and the XY location of the gauging station

14.6.3 Desirable for the future
o files that describe how to line the center line and cross sections of at least the last 50kmde major tributary of the Magdalena River, and the upper part thereof.
shp file or a SIRGAS Bogotá EPSG coordinate Magna 3116 all Weather Stations Rio Magdalena basin, including a summary of the measured parameters (precipitation, evapotranspiration, etc.)

3 RESULTS

The results for the case study of sub model 1, the section of river between stations 23037010 and 23097030 Puerto Salgar Puerto Berrio, with modeling period between 23/03/2010 and 23/06/2010 are presented.

The boundary conditions for the sub model 1 upstream flows are input at station 23037010 Puerto Salgar and downstream water levels in meters at station 25027410 Regidor.

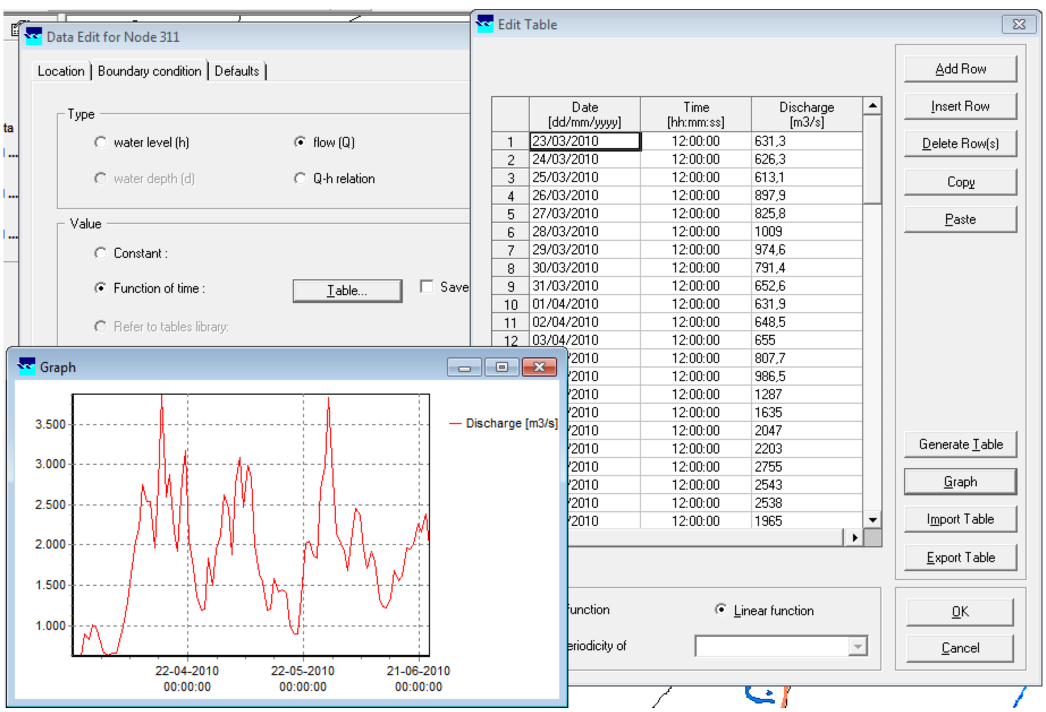

Fig. 5 Condition Border sub model 1 Upstream. Puerto Salgar flow Station 23037010.

Lateral flows for the case study of sub model 1, section of river between Puerto Salgar and Puerto Berrio, with modeling period between 23/03/2010 and 23/06/2010, for the flow depicted reported for Black River (station 23067040 Free Port), La Miel River (station 23057140 San Miguel) and Nare River (Puerto Belo station 23087230). For Hermit

Cocorná and rivers, the average water yield calculated from data from instrumented watersheds in m3 / km2 for the time series of these two ungauged catchments was used.

Finally Registered flow values will be compared in Puerto Berrio station 23097030 with modeled flows for the same station and 1D coupling 1D2D, generally finding that insufficient measures sections for the 1D model is not sufficient to carry flow system, especially in the era of high flow was selected as a sample.

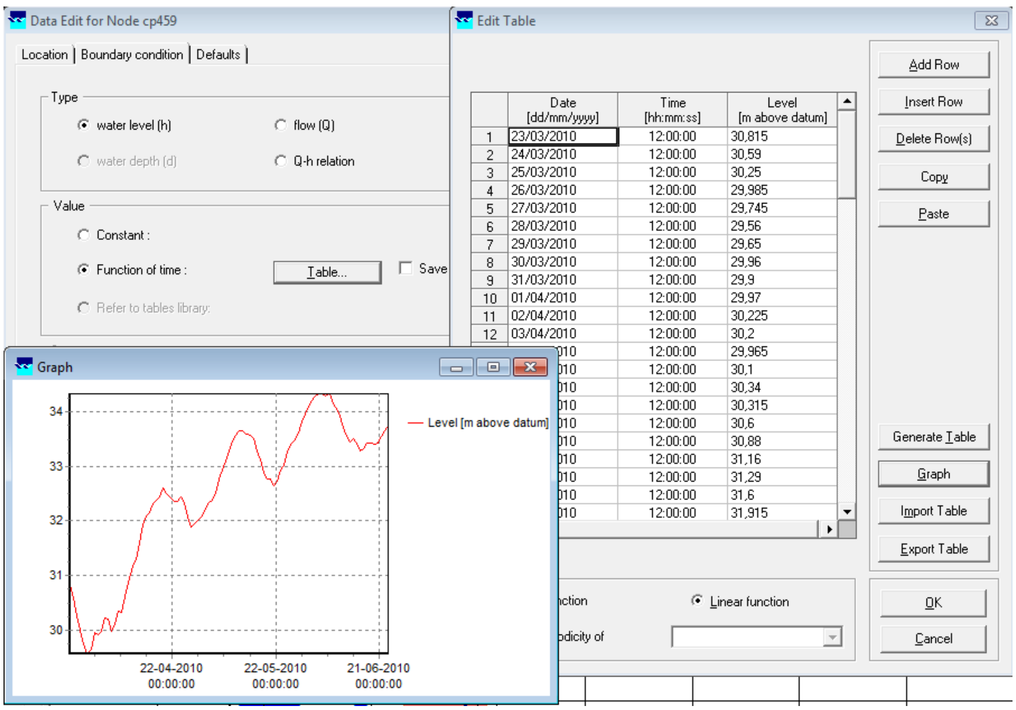

Fig. 6 Boundary Condition 1 Downstream submodel. Station 25027410 Regidor levels.

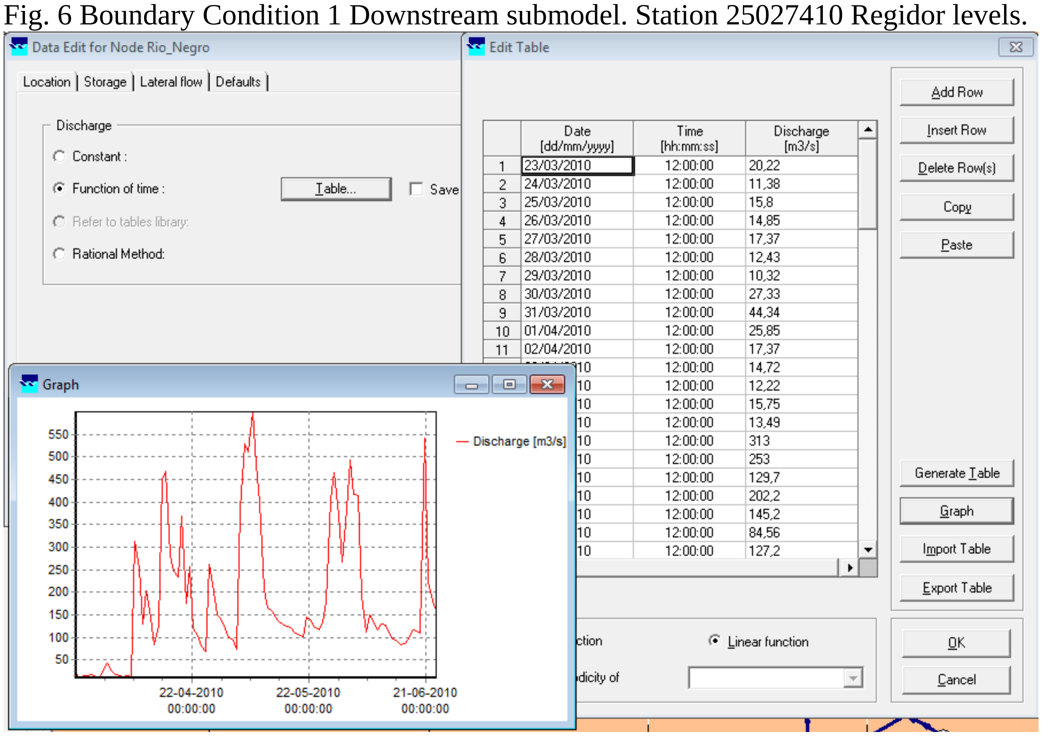

Fig. 7 Río Negro River lateral flow

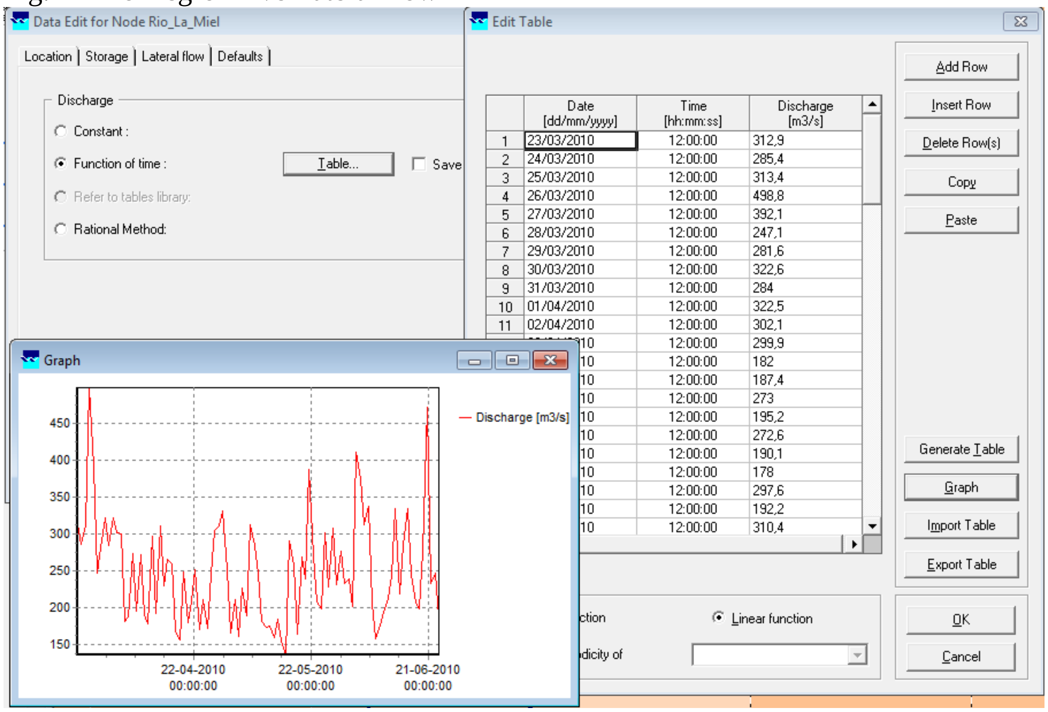

Fig. 8 La Miel River lateral flow

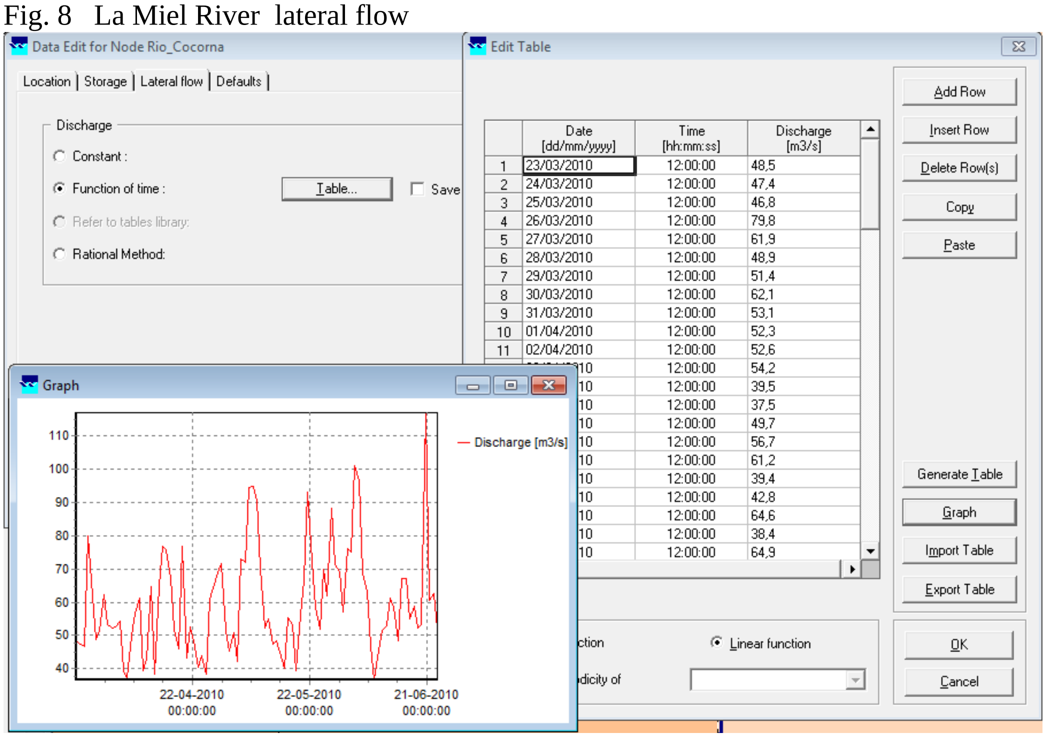

Fig. 9. Cocorná River lateral flow.

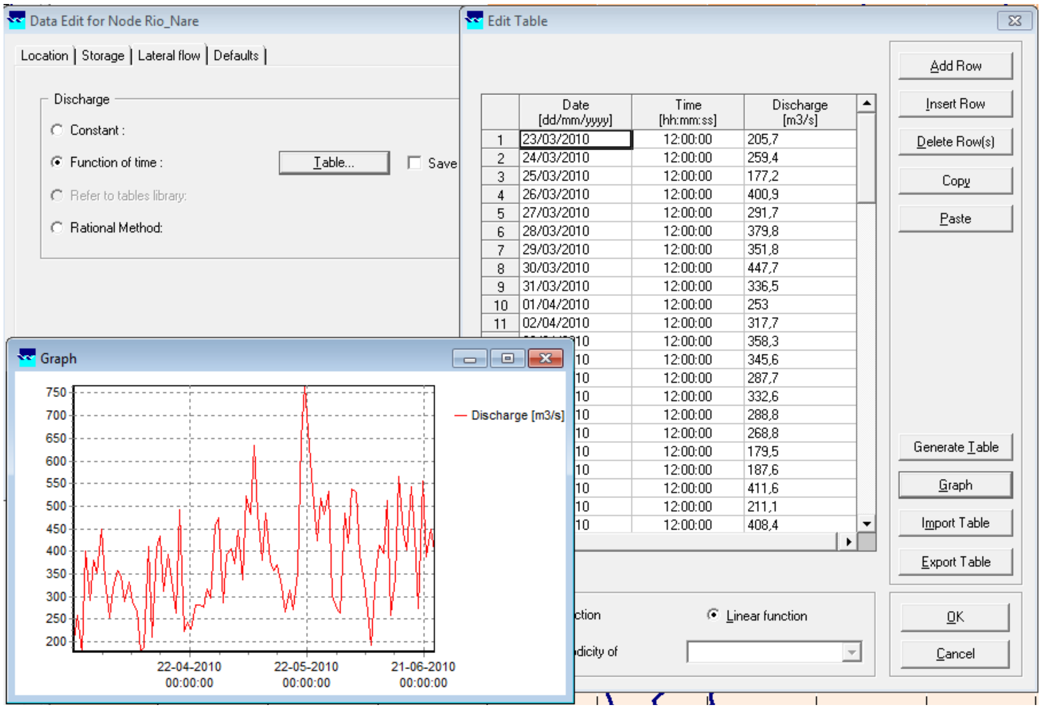

Fig. 10 Nare River lateral Flow

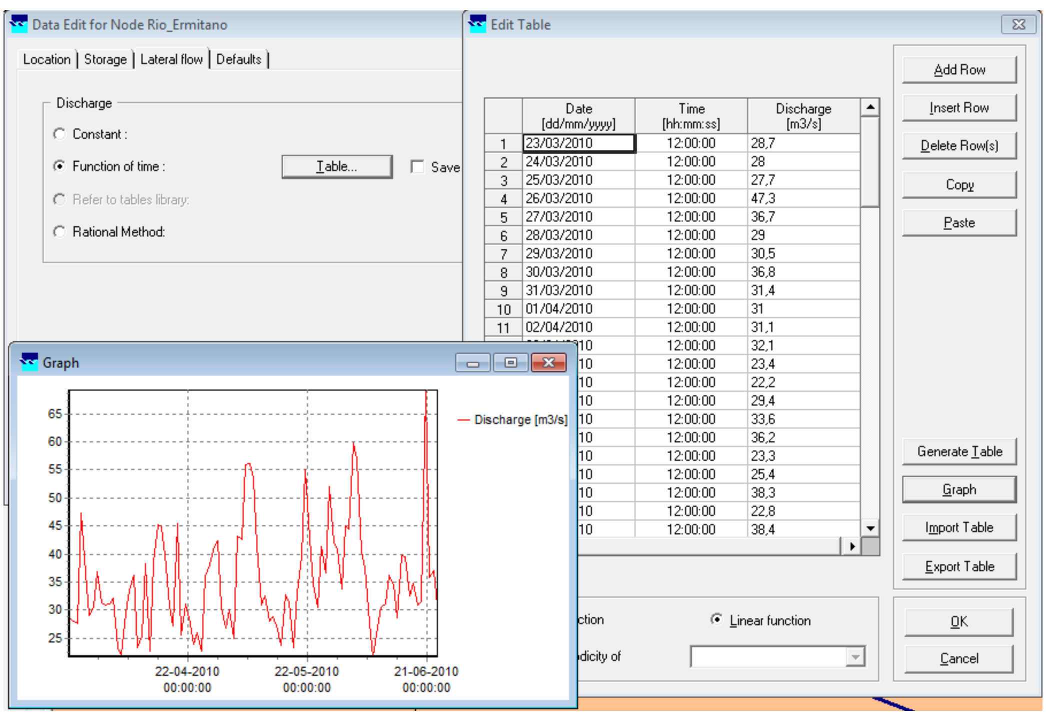

Fig. 11 Ermitaño River Lateral Flow

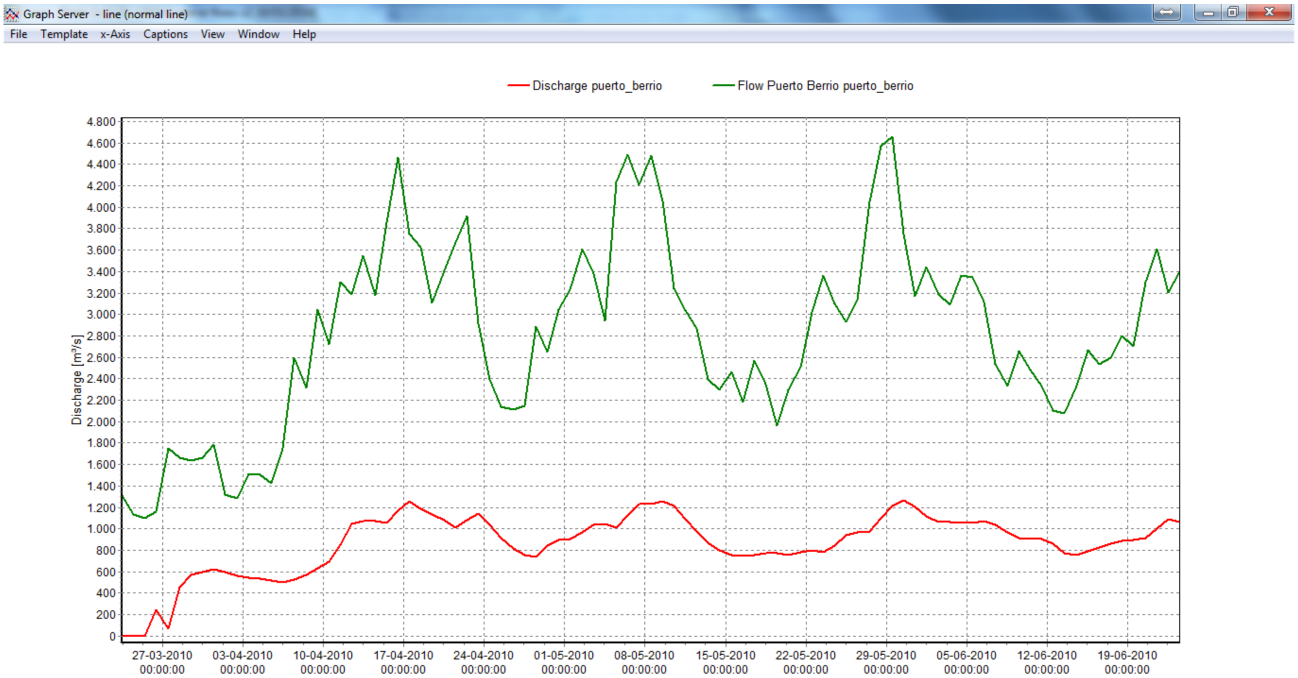

Fig. 12 Measured flow at station 23097030 Puerto Berrio (Green) and simulated for Puerto Berrío section 1D Flow Model.

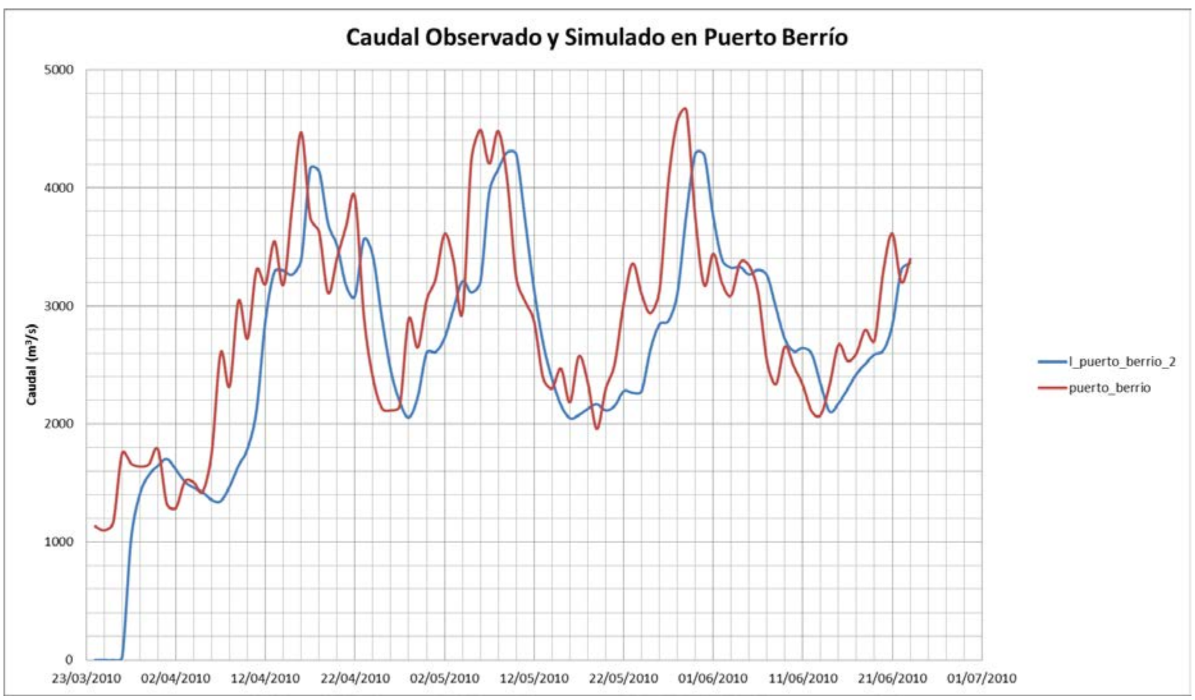

Fig. 13 Measured Flow in Puerto Berrio station 23097030 (Red) and simulated for Puerto Berrío section 2D Flow Model

4 DISCUSSIONS

Despite a lack of data and other poor quality, it is important in the overall view of the management of resources, initiating processes that the inertia of the technical inability to break. That inertia of rest in which the institutions can not advance projects of significant technical or scientific ambition due to lack of information, data and precariousness of expertise.

The beginning is the most difficult step because it represents a gamble unprecedented in one's environment, a commitment to tools which we see common or relevant. In that sense Cormagdalena has advanced a pioneering effort to seize the knowledge of their object management: The Magdalena River. This implies an overall institutional transformation, an entity created in the last decade of the twentieth century, focusing on investment of state resources to an entity with the intention of meeting and decide on an informed his work. An entity that uses techniques and technological tools towards their beneficiaries, who are ultimately the citizens of the Colombian state. And above all, a state entity that takes responsibility to know as much as possible the object management.

In general, technology transfer projects are not straightforward processes, but rather multiple and various complications arise in their development. In this particular case of modeling the Magdalena River, the difficulties are partly due to the complexity of the river, partly because not, as is evident, there is the institutional practice of making use of these technologies and partly because the entity itself not have a structure that easily nest such projects. For example essential activities such as finding information from previous studies or data from other projects, are not a technical but administrative task as information structures of the corporation are not designed to develop knowledge and speed of information systems, but to manage and conserve information projects implemented. This creates division and difficulties of creating institutional knowledge.

It should be noted that this project is called Permanent Modeling Program Magdalena River, and this name is intended to reflect what it means to make use of such tools: it is a permanent corporate attitude, as there are always questions to solve and there is always information to add or appropriating knowledge. In this sense the transformation for the use of hydraulic modeling tools, also involves transformation towards knowledge management and to improve decision-making processes. It's that sense it is advisable to start internal disclosure processes and training project on the scope and potential with the officers of the corporation so that the use of this tool is potentiated by different teams and expertise.

Technically there are great difficulties from the nature of the Magdalena River, the process of verifying the information river became a chore. Over ten thousand cross sections and dozens of hydrological stations sometimes information from the early 50s up a huge computer arrangement. In any case, the construction of the computer model of the river is a fact, and now the system calibration and learning are the steps to follow. It is therefore important to provide that information sets and modifications are part of ongoing work with the simulation tool, as it is advisable to design and implement a data management system tailored to the needs of this project and in which it is easy monitor and track previous simulation exercises and likewise add and improve information bases.

Several reviews and checks were made of the centerline, the major disadvantages resulted from the various arms and twisted channels and in some cases cross sections are difficult to interpret because it is not reached until the measuring bench full, that is to where the river reaches its highest levels. This further creates a difficulty for coupling cross sections with two-dimensional map of the terrain elevations, because the way it is unknown as banking ends and form is unknown in certain cases of floodplains. This situation reinforces the idea part continuous feed model and permanent improvement thereof, based on the systematic acquisition of more detailed and accurate information for the entire river. Moreover is a low accuracy of the model in response to high levels means that is to overflow phenomena. Do not forget that one of the functions of the corporation is to provide technical support to entities or sectoral environmental sector with regard to the river, its operation or care, and in this sense the modeling project not only provides valuable and relevant information but allows Cormagdalena exercise that role and interact more substantial form with sector entities. It is therefore desirable from this stage begin the process of disclosure and enrichment of the model with actors outside the corporation.

5 **OPTIONAL ACKNOWLEDGEMENTS**

Recognition to support CORMAGDALENA, IDEAM is done, the Adaptation Fund, its officers and contractors, without whose contribution would not have been possible to develop this case study.

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