Advanced hydraulic modeling of irrigation channel Aranca, Romania

BEILICCI ROBERT FLORIN, BEILICCI ERIKA BEATA MARIA, GIRBACIU CRISTIAN
Hydrotechnics Department, Civil Engineering Faculty
“Politehnica” University of Timisoara
Timisoara, George Enescu 1A, 300022
ROMANIA
beilicci@yahoo.com http://www.ct.upt.ro

Abstract: - Sinnicolau- Saravale drainage system is in the north part of the county of Timis. Sinnicolau- Saravale system comprises a total area of 20060 ha, of which occupied the land reclamation works of 19998 ha. own Sinnicolau Mare is located in the western part of Romania, Timis County. Numerical modeling was performed using the program MIKE11. Advanced computational modules are included for description of flow over hydraulic structures, including possibilities to describe structure operation. Flood risk maps were prepared using MIKE 11 model, show a high degree of confidence.

Key-Words: - irrigation channel, advanced modeling, flood maps, discharge hydrograph

1 Introduction
Sinnicolau- Saravale drainage system is in the north part of the county of Timis and Tisa - Mures river basin; sub-section II Aranca being bounded as follows:
- North Mures drainage system and left dam Mures km 32+000 - 43+400
- South Basin sub-section III Aranca Galatca
- To the west sub-section IV Aranca
- East sub Aranca compartment I - limit Arad County
Sinnicolau-Saravale system comprises a total area of 20060 ha, of which occupied the land reclamation works of 19998 ha.
Excess moisture in the drainage system appears differently on surfaces vary orographic conditions, soil and local hydro geological, created as a result of rainfalls in the area of flood drained system and Mures River that produce abundant groundwater supply in the area.
Natural slope of the land from east to west is a 0.02-0.05%.
Emissary is generally Mures River. Main collector depression Aranca regularized discharges conducted in Mures being achieved through a system of dams by Channel Silvia and SP Cenad in Aranca touched the border restrictions, the rest is done by channel flow periods Aranca across the border with Yugoslavia by downloading Tisa or channel in the DTD.
Main collector system for all departments is Aranca channel leading inland waters collected in general all over the Yugoslav Roman border until reaching 77.60 m registered share the wonder paddles - the confluence of the Tisa when the Yugoslav border dam close on Aranca .
In that moment close floodgates of Section IV and II (Aranca km 40+250) and compartment II and I (Aranca km 77+940) being performed proper division of domestic waste water collected and sub-drainage units.
Existing natural conditions imposed subdivision perimeter Sinnicolau-system drainage Saravale four independent functional units as follows:
1. UD Sinnicolau- Tomnatic an area of 6390 ha located on the left bank Aranca between 40+250 – 53+300 km forming the northern boundary, Dc27 Simpetru-Lovrin eastern boundary drainage system Aranca compartment III and Section IV southern boundary limit west.
2. UD Simpetru Lovrin area of 3885 ha located on the left bank of the canal all Aranca between 53 300-59 700 km northern boundary, bordered to the north-east and south Periam UD compartment III (Galatca) at west is limited to UD Sinnicolau-Tomnatic.
3. UD Saravale - Igris area of 3690 ha is located on the right bank of the canal Aranca (km 40 250-59 700) and Silvia (km 0 +000 000-3) limited to the north dike system Muresan and left Mures (km 31 000-35 000) and to the east by UD Periam.
4. UD Periam surface 6033 ha, is located in the upstream compartment II, Aranca (km 59 700-77 940) left with the dam north of the river Mures (35 000-43 500 km) to the east Aranca subdivision dam with section I, south drainage system limit Checeara-Jimbolia Aranca compartment III and UD Lovrin
Simpetru and west - Lovrin Simpetru UD and UD Saravale – Igris [2].
Aranca stems from the Felnac Mures valley (where the dam construction began in 1816) and flows into the Tisza River. Aranca Canal passes through the middle of town Sannicolau and been channeled since 1888 after flooding in the spring of that year. Starting in 1887-1894 was built hydraulic system Aranca.
Channel crossing Aranca Sannicolau Mare have been aimed drainage of flooded land, being widened and deepened in 1959 and 1960. On the city has a length of 10 km and 532 m and a width ranging from 6 to 16 m and a depth of between 1-3 m slope is 0.1-0.15 km, and the difference in level between entry points and out of the city is 2.5 m in spring time maximum flow and minimum flow in summer.

2 Problem Formulation
Movement of water in canals, rivers or partially filled pipes is examples of free level movements. Uniform motion is done free level canals, straight and prismatic (canals, galleries, gutters, ditches, etc.). Free level uniform motion is made in white artificial straight and prismatic (canals, galleries, gutters, ditches, etc.). Analytical solutions are obtained by hydraulic calculation formulas Chezy type by substitutions with Manning relationship with general equations of the form [1]:

$$Q = \frac{1}{n} \frac{S^\frac{3}{2}}{p^2} \sqrt{i}$$  \hspace{1cm} (1)

For the particular case of trapezoidal section we have [4]:

$$Q = \frac{1}{n} \left( \frac{\beta + m}{\beta + m'} \right)^{\frac{5}{2}} h^{2} \sqrt{i}$$  \hspace{1cm} (2)

where the \( m' \) were noted \( m' = 2\sqrt{1+m^2} \).

Commonly used in engineering applications, especially in sewers, standardized profiles such as circular profile, ovoid etc. An important feature of these channels is hydraulic fill level defined by:

$$\lambda = \frac{h}{H}$$  \hspace{1cm} (3)

where: \( h \) is the depth to fill current free level partial section; \( H \) - current depth of the solid section (geometric height section).

Given the complexity of the movements of water in surface streams is a difficult analytical calculation which takes into account the natural conditions of the land.
To solve theoretical problems of movement of water in the channel Aranca, it requires modeling of water flow.
Numerical modeling was performed using the program MIKE11.
MIKE 11 is the industry standard for simulating flow, water quality and sediment transport in estuaries, rivers, irrigation canals and other surface water bodies in many regions. The reason is simple. It provides a wealth of capabilities that span the entire range of applications - from basic routing to complex, fully dynamic modelling. Yet it remains user friendly and efficient.

The computational core of MIKE 11 is the fast, efficient and robust hydrodynamic simulation engine. This is complemented by a wide range of additional modules and extensions covering almost all conceivable aspects of river modelling.
The MIKE 11 hydrodynamic module (HD) uses an implicit, finite difference scheme for the computation of unsteady flows in rivers and estuaries.
The module can describe sub-critical as well as super critical flow conditions through a numerical scheme which adapts according to the local flow conditions (in time and space) [3].
Advanced computational modules are included for description of flow over hydraulic structures,
including possibilities to describe structure operation. The formulations can be applied to looped networks and quasi two-dimensional flow simulation on flood plains. The computational scheme is applicable for vertically homogeneous flow conditions extending from steep river flows to tidal influenced estuaries. The system has been used in numerous engineering studies around the world. Hydraulic models are increasingly applied for river management. Typical applications are in forecasting systems, for flood warning or planning of reservoir operations, and in the analysis of potential flood mitigation options. In the standard approach, the models provide descriptions of the flow and water level variations at points in the rivers, and this information is then interpreted by the model user in terms of the consequences for people and property near the river.

3 Problem Solution
Topographic studies for channel Aranca result input the following data: \( b = 3.0 \, \text{m} \), \( m = 2 \), \( i = 0.0002 \), \( n = 0.02 \). The construction curve for existing channel \( Q = Q(h) \) is presented in Figure 3:

![Fig. 3. Curve \( Q = Q(h) \) for Aranca channel](image)

Numerical modeling was performed with the program MIKE11. Initially modeled the existing situation with Aranca trapezoidal channel. Site plan in this situation is shown in Figure 4. Cross sections through the channel as topographical surveys are shown in Figure 5.

According to data entry or formulated boundary conditions, namely the upstream inflow at chainage 35600 are flood discharge hydrograph and in the downstream at chainage 34600 curve key for downstream section of the channel [5]. Flood discharge hydrograph is shown in Figure 6.

![Fig. 4. Plan view with the network model](image)

![Fig. 5. Cross section for Aranca channel](image)

After running the program MIKE11 was obtained through existing channel longitudinal profile, presenting water levels for all time period according with food discharge hydrograph along the channel (Figure 7).
4 Conclusion

This study presents the application of a 1-dimensional unsteady flow hydraulic model used for the simulation of flow in rivers: the MIKE 11 model from the Danish Hydraulic Institute (DHI).

The study area applied to the model is the Aranca channel in Romania; the stream length used for this model is 6 km.

Besides the model mentioned above, have been developed over the years other models applied in the preparation of flood risk maps.

Flood risk maps were prepared using MIKE 11 model, show a high degree of confidence.

MIKE 11 is the preferred choice of professional river engineers when reliability, versatility, productivity and quality are the keywords.

ACKNOWLEDGMENT

This project has been funded with support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

References: