

Chapter 7

Contribution of GIS and Hydraulic Modeling to the Management of Water Distribution Network



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Abstract Increases in the growth of urban regions along with climate change have contributed to a scarcity in water resources. For arid regions, this problem may be aggravated by inadequate management plans and a lack of proper data collection related to the geographical location of water distribution networks. A possible solution is the utilization of a geographical information system (GIS) as a tool in decision-making process in the field of water distribution management. Coupling external hydraulic calculation models with GIS can further enhance this management tool. The current study utilized these tools in assessing the performance of a drinking water distribution network of an urban cluster in Tlemcen, Algeria. A methodology was developed by coupling GIS to a hydraulic calculation model (EPANET). The results showed that it is possible to obtain an alphanumeric description of the pipes, tanks, and all the accessories constituting the network. Design irregularities in the Tlemcen urban cluster's network were identified. The approach adopted in this chapter contributes effectively to the management of water distribution networks using GIS. This offers operators a management tool that allows for analysis of malfunctions with an instantaneous response, to study various solutions and to plan for future situations.

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7.1 Introduction

Increased urbanization as well as droughts, floods, and wildfires can present major challenges to potable water managers and can interrupt the delivery of high-quality safe drinking water to customers (Deere et al. 2017). Furthermore, effective water resource systems planning and management require precise knowledge and technical data of the distribution structure (Loucks and Van Beek 2017). These requirements make it necessary not only to size the network but also to maintain it in a satisfactory state (Eisenbies et al. 2002). The collection and gathering of information related to the geographical location of the distribution network on the same computer medium then become necessary, even mandatory. Geographic information systems (GIS) provide a solution to this problem by creating a database of urban space (i.e., network plans) and containing information related to the hydraulic characteristics of the network and its behavior. The effective application of GIS in the field of water distribution requires coupling to hydraulic simulation models so as to support management goals. Combined with external models such integration enhances overall benefits.

As with other technical networks, water distribution systems belong to an urban and peri-urban environment in which they act and interact with other networks (Blindu 2004). The operator of a drinking water supply grid is usually faced with the difficulty of trying to understand the network, given its diversity (Abdelbaki et al. 2012; Blindu 2004). To streamline the management of a water distribution network, it is necessary to know precisely all the relevant elements or components, to be able to prevent incidents, and to have a diagnostic tool to remedy incidents as quickly as possible. Thus, it is essential to keep track of what has been done so as to build a “memory” of milestones to best target programming and investment decisions (Blindu 2004).

Water distribution networks may experience increasing management constraints that require the use of more and more data representative of the entire network. This data is necessary for an efficient management so as to operate the grid continuously in a profitable way with a level of service adapted to the expectations of the customers. The implementation of a GIS for the drinking water network management with descriptive databases is essential and remains a prerequisite for any attempt at analysis.

The aim of the current work was to assess the performance of a drinking water distribution network using the Tlemcen urban cluster in Algeria as a case study. A GIS (MAPINFO) was coupled with a powerful calculation software model (EPANET). This chapter describes the system design and outlines the type of data used and their acquisition.

7.2 Design and Management of a Drinking Water Distribution Network Using GIS

The decisions to be made in the management services of water distribution networks go beyond simply posting a map or finding an address, it involves building equipment, developing or managing an area, managing a public service, or intervening in case of an incident occurring in the network. This means making decisions involving people and taking corrective actions. Indeed, it may be more cost-effective to set up information organized, maintained, and managed on a permanent basis, ready for several needs or for an unforeseen need, rather than reacting piecemeal with the means at hand. In this context, one of the essential prerequisites before embarking on the implementation of a GIS application is the questioning of the intended (or possible) use of geographic information. These possibilities can be grouped into several broad categories:

- *The accumulation of scattered knowledge.* It is often difficult for a given problem to acquire a fast and accurate knowledge of the terrain. The information is often distributed among several managers (networks, geology, etc.), of more or less ancient origin, possibly known to a small group of specialists (archaeological data). In this case, updating and knowledge of the accuracy of the data are imperative.
- *The operational use of updated plans.* The user wishes to have precise information (cartographic and alphanumeric) and homogeneous of the reality of the ground at the moment when it must intervene (for example, various pipes buried under a road). However, these data (erosion, modification of plots, modification of characteristics, etc.) evolve over time. Updating is essential; it means to have a traceability of the way how information is collected (Sauvagnargues-Lesage and Ayrat 2009).
- *The representation of archived “shadow copies”.* Some situations need to preserve the image of previous situations, especially for the study of evolutionary phenomena, whether for graphic data (for example, the evolution of a flooded area) or for descriptive data (evolution of population).
- *The simulation of events.* The study of the impact of an event (accident, development of a zone, effect of the closing of a valve of a network) requires a readability of the results and an operational character of the data. Modeling then requires the establishment of functional relationships between the data as precise as possible (topological relations in particular) (Tena-Chollet et al. 2010).

The large volume of information to be collected, the enormous quantity of documents to be inventoried as well as the diversity of the information regulating organisms represent a great difficulty in the process of developing a database (Abdelbaki et al. 2012; Blindu 2004). The inventory operation for the current report consisted of identifying, describing, and locating the cartographic data related to the drinking water supply network of the case study area, the Tlemcen urban cluster.

Data analysis consisted of determining the characteristics of the documents to be retained, in order to properly comprehend and represent the water distribution. It is difficult to define in advance all the possible uses imaginable that could be

made by the geographical information system. Adding to these difficulties, there were numerous gaps in the mapping of the water distribution network. The most important were:

- Non-georeferenced map background;
- Absence of legend summarizing the conventional signs relating to networks;
- Old plans not updated;
- No mention of geometrical characteristics of certain sections of network;
- Different scale from one plan to another;
- Projection system not mentioned on plans;
- Date of establishment and date of update of plans not mentioned;
- Absence of directional arrow showing north; and
- Nonexistence of geodesic points which allow attachment of cartographic breaks.

For cartographic support to be exploited, it was necessary to remedy certain shortcomings, namely, georeferencing the background. This operation is of great importance for the digitization phase; correcting the contradictions presented by the plans by confrontation and crossing of the latter; need to correct some drawings in plans that do not conform to the documents selected; complete missing plan information from documents deemed reliable.

The traditional paper plans which are difficult to manipulate and complex to update were replaced by digitized plans. This method is best suited to the needs of this work because it allows a person to enter the geometry of basic graphical objects: point, line, or polygon. From a cartographic point of view, the network is represented by all segments along which the diameters, the material, the length, the state, and the date of commissioning have been indicated. All elements of the network such as valves, suction cups, poles and fire hydrants, types, and importance of driving (connection, main pipe, and artery) are listed and are identified by different codes. Figure 7.1 shows the procedure adopted to cover the background of the Tlemcen urban cluster in order to report the water distribution network. Figure 7.2 shows an excerpt from a prepared part to trace the water distribution network.

7.2.1 Choice of GIS, Creation of Database, and Correcting Errors

Faced with the numerous available geographical information systems for micro-computers, the choice was made to use Mapinfo and ArcGis so as to benefit from a set of high-performance and scalable products. This makes it possible to create, display, and modify all forms of geographically referenced information. Their main characteristics can be summarized as follows: overlay operations: superposition of thematic layers; statistical treatments; output types: cartographic representations, numeric or textual values, histograms, and graphs; availability of a library of symbols, lines, frames, and captions that can be edited interactively; data exchange

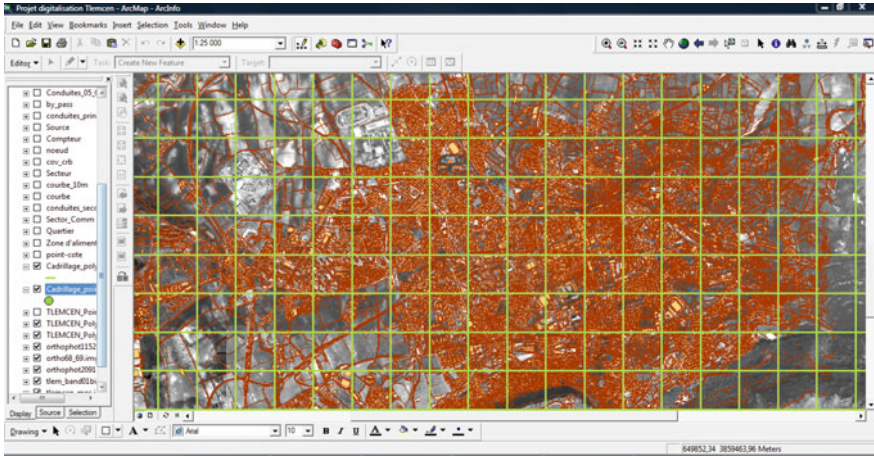


Fig. 7.1 Preparing the base map to trace the water distribution network

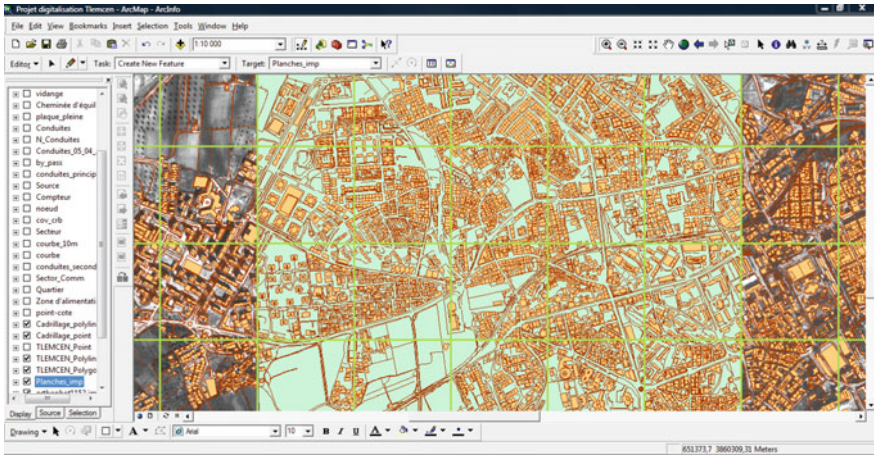


Fig. 7.2 Extract of plans to print

with CAD software such as AUTOCAD; and existence of extended SQL language for managing descriptive data.

Key features include also effectiveness in database management, graphics, powerful query language to mix graphic and non-graphical inputs, independence with regard to the choice of material, and ability to integrate external data and export data to other systems. Furthermore, after processing, useful information is obtained for the design of the database. The associated data is organized as tables. The attributed names are entered field by field according to their types (e.g., character, integer, floating point, fixed point, date, etc.). Each geometric entity (conduct) is related to

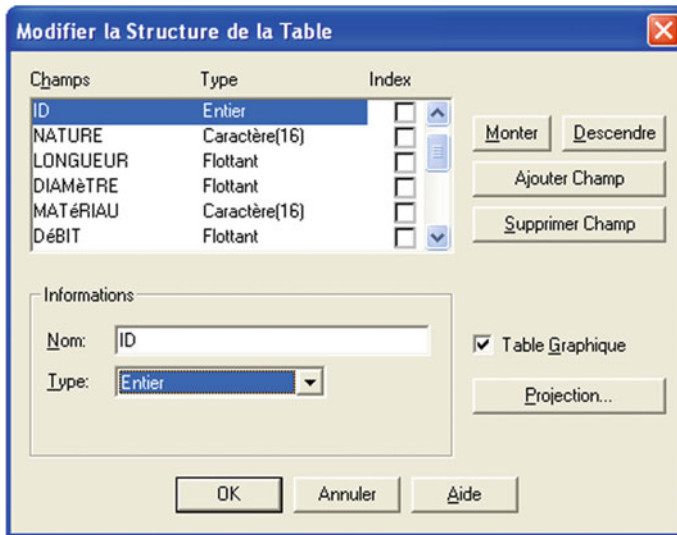


Fig. 7.3 Definition of structure of “pipelines” table

ID	NATURE	LONGUEUR	DIAMÈTRE	MATÉRIAU	DÉBIT
<input type="checkbox"/>	39	Distribution	56.1087	80	Fonte ductile
<input type="checkbox"/>	40	Distribution	305.532	250	Fonte ductile
<input type="checkbox"/>	41	Adduction	662.23	400	Fonte ductile
<input type="checkbox"/>	42	Distribution	268.238	300	Fonte Grise
<input type="checkbox"/>	43	Distribution	8.74465	250	Fonte Grise
<input type="checkbox"/>	44	Distribution	58.9454	400	Fonte Grise
<input type="checkbox"/>	45	Distribution	151.011	250	Fonte grise
<input type="checkbox"/>	46	Distribution	445.96	150	Fonte grise
<input type="checkbox"/>	47	Distribution	129.937	50	Acier Galvanisé
<input type="checkbox"/>	48	Distribution	15.5383	200	Fonte grise
<input type="checkbox"/>	49	Distribution	123.173	150	Fonte grise
<input type="checkbox"/>	50	Distribution	216.616	80	Acier Galvanisé
<input type="checkbox"/>	51	Distribution	84.5719	60	Fonte grise
<input type="checkbox"/>	52	Distribution	198.604	40	Fonte grise

Fig. 7.4 Structure of “pipelines” table

its description; this link is done by means of an internal identifier. Figures 7.3 and 7.4 show the definition and structure of the pipelines table.

All spatial features and their descriptive data may be subject to errors or inaccuracies. The operation consists of establishing the link between spatial and descriptive data in order to verify the following errors: Space entities are sometimes poorly positioned or have wrong forms such as a large number of duplicate pipes or nodes. Figure 7.5 illustrates an extract from the GIS of the water distribution network of the Tlemcen urban cluster.

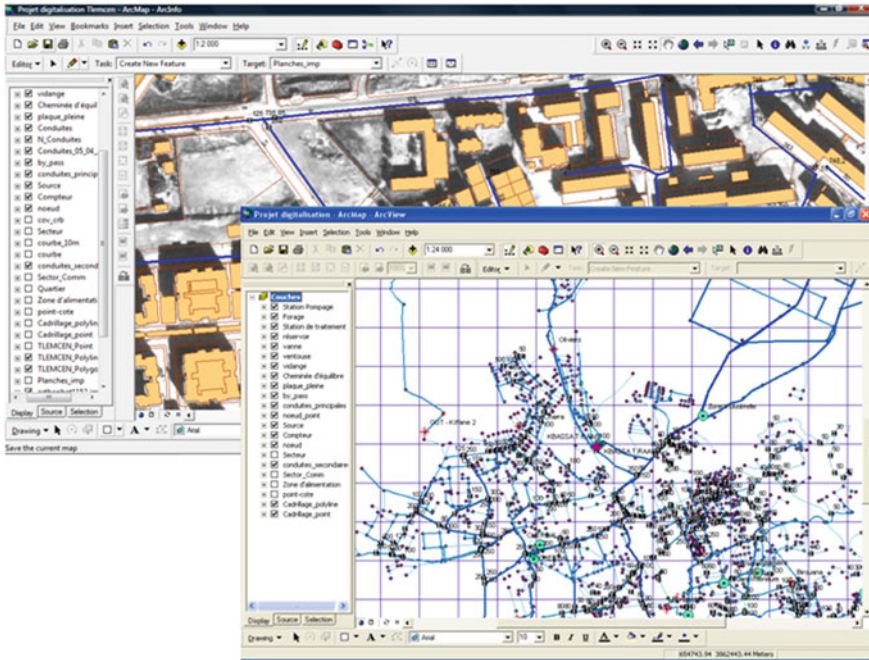


Fig. 7.5 Extracts from Tlemcen urban cluster water distribution network (Center City part, Kiffane) under GIS

7.3 Structure Query Language (SQL) Request and Thematic Analysis

Due to relational algebra and its set operators, it is possible to search for all the information that satisfies a set of criteria. These are alphanumeric or attribute requests. Structured Query Language (SQL) is used to formulate database queries based on relational algebra operators. The most important and semantically rich SQL command is the SELECT statement whose simplest form includes the clauses: SELECT, FROM, and WHERE. The SELECT clause makes it possible to express the projection on the list of attributes that one wishes to keep, the FROM clause makes it possible to quote the list of tables concerned by the SQL query and the WHERE clause groups together a set of conditions and also expresses the purpose of the restriction (Laurini 1993).

The implementation of the distribution network made it possible to analyze the network according to various criteria: diameter, construction materials, nature, and age of the pipes. Figure 7.6 shows a selection of pipes according to the construction material “galvanized steel (GS)”. Figure 7.7 shows the result of the query concerning the classification of the pipes according to the “Discharge” function. Figure 7.8 shows pipelines with a problem of under sizing (diameter less than 80 mm). The results of

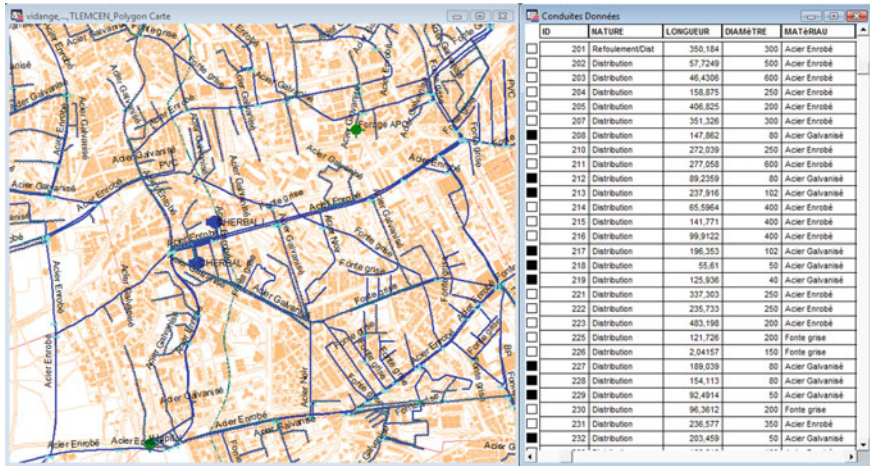


Fig. 7.6 Query result for galvanized steel pipe display

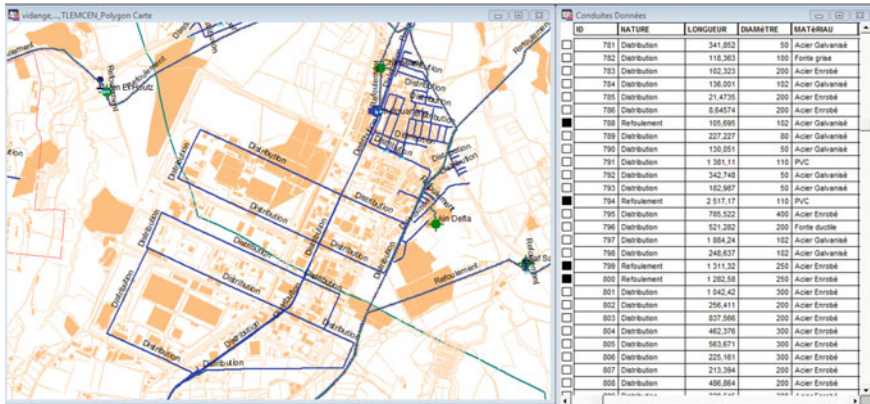


Fig. 7.7 Result of queries showing the discharge pipes

the queries obtained constitute the first form of diagnosis. By identifying the points of malfunction, the operator can first identify problematic areas of the network and make decisions to improve the state of the network (Blindu 2004).

The choice of diameters is based on the suppliers' catalogs. Given the high flows that the distribution pipes must convey, they are rarely of a diameter less than 0,060 m or even 0,080 m (Bonin 1986; Dupont 1979). The different extensions made at the Tlemcen urban cluster level are dictated by urgency and not based on a studied design (Abdelbaki et al. 2012, 2014). This is why 38% of the so-called main pipes have a diameter of less than 80 mm. Furthermore, given the high flows that the main pipes must carry, they are rarely less than 150 mm in diameter (Valiron 1994). The distribution of the pipes according to the diameters shows that 67% have a diameter

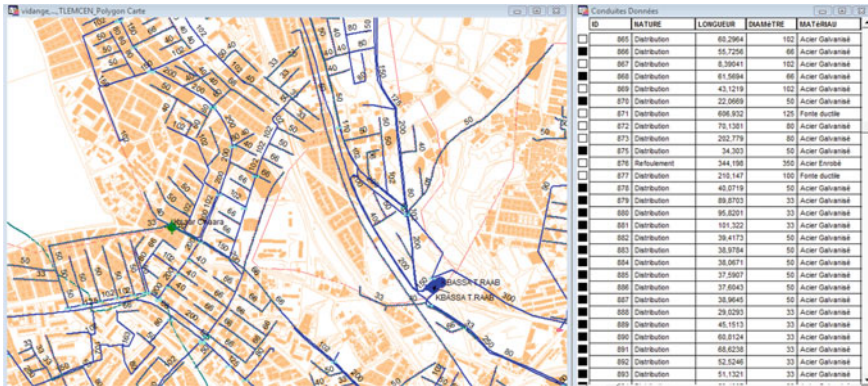


Fig. 7.8 Result of queries showing pipes with a diameter less than 80 mm

of less than 150 mm and only 31% have a diameter greater than 150 mm (Abdelbaki et al. 2012, 2014).

The choice of pipes used is a function of the pressure and nature of the ground, the costs of supply, and implementation, but also the ease of making connections, connections, repairs in the event of a leak (Bonin 1986; Valiron 1994). 15% of the pipelines are cast iron, these pipelines date from the 1950s. 47% of the pipelines are galvanized steel; they have a diameter of less than 100 mm, causing problems in the distribution of pressures in the distribution network. 38% of the remaining pipelines are of different materials [ductile iron for the renovated part (5%) prestressed concrete (24%), PVC (4%), and coated steel (3%)]. It can be noted that a significant portion of the pipes is in an advanced state of deterioration due to the discontinuous operation of the distribution (frequent draining of the pipes, etc.). And the poor condition of the installations (Abdelbaki et al. 2012, 2014).

The storage capacity supplying the Tlemcen urban cluster is 35 (ADE 2011) with a total storage capacity of 50,600 m³. 81% of the storage capacities represent supply tanks and 19% remaining are the capacities which play buffer roles (Breeze Charge, dispatcher, etc.).

In the field of GIS, thematic analysis makes it possible to build thematic cartographies. These are geographical maps illustrating, by the use of various graphic parameters (color, symbolic, size, etc.), the behavior of a phenomenon in relation to its spatial location. An example of the Tlemcen urban cluster network is shown in Fig. 7.9. This example shows the distribution of diameters at the Tlemcen urban cluster’s water distribution network.



Fig. 7.9 Thematic analysis of Tlemcen urban cluster's network according to distribution of diameters

7.4 Creation of a Digital Model Elevation of the Tlemcen Urban Cluster

The Vertical Mapper tool was chosen for the creation of the digital elevation model (DEM) of the Tlemcen urban cluster. The interpolation method used was the irregular triangulation interpolation (TIN) for the construction of the DEM. Irregular triangulation uses an array of triangles as equilateral as possible that will connect the points in the data set. This triangulation is called Delaunay and is very useful for working on lots of data of any spatial distribution (Barbier 2002). The Tlemcen urban cluster’s DEM was created from contour lines of 10 m equidistance and digitized coast points on the same maps. These curves were digitized from several topographic maps of Tlemcen urban cluster given at different scales (1/25,000, 1/50,000, 1/200,000); maps were obtained from the National Institute of Cartography and Remote Sensing. Figure 7.10 shows the different steps in creating the DEM. The result of the interpolation results in the DEM of the Tlemcen urban cluster, the superposition of the DEM, and the water distribution network is given in Fig. 7.11.

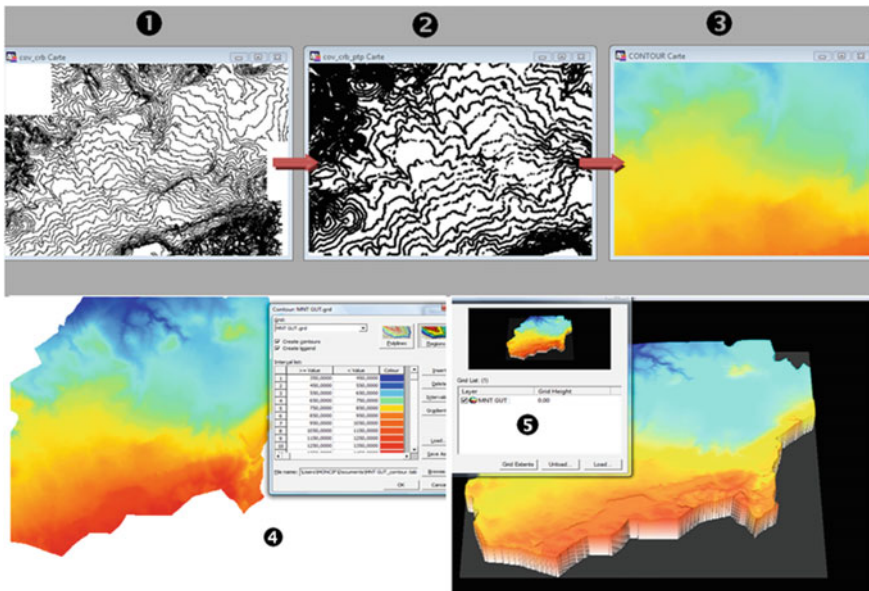


Fig. 7.10 Creation of the Tlemcen urban cluster’s DEM

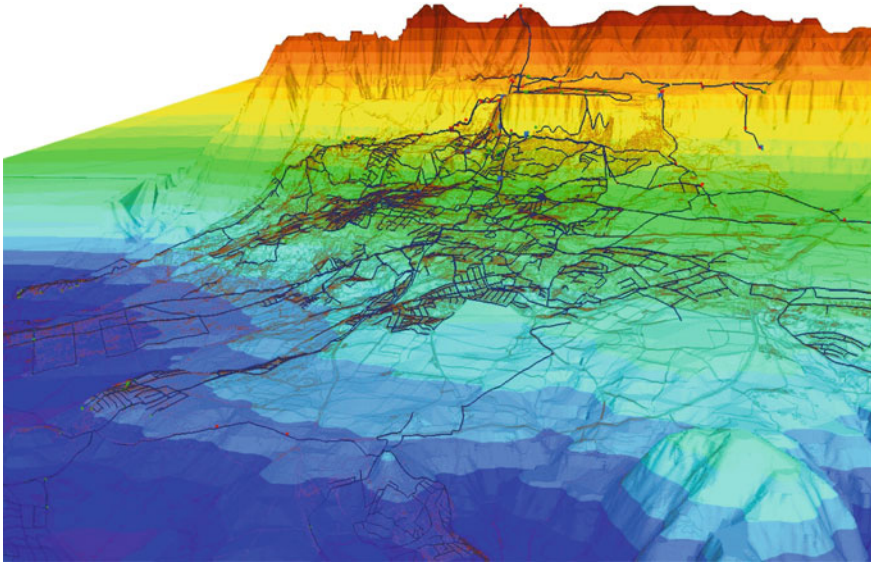


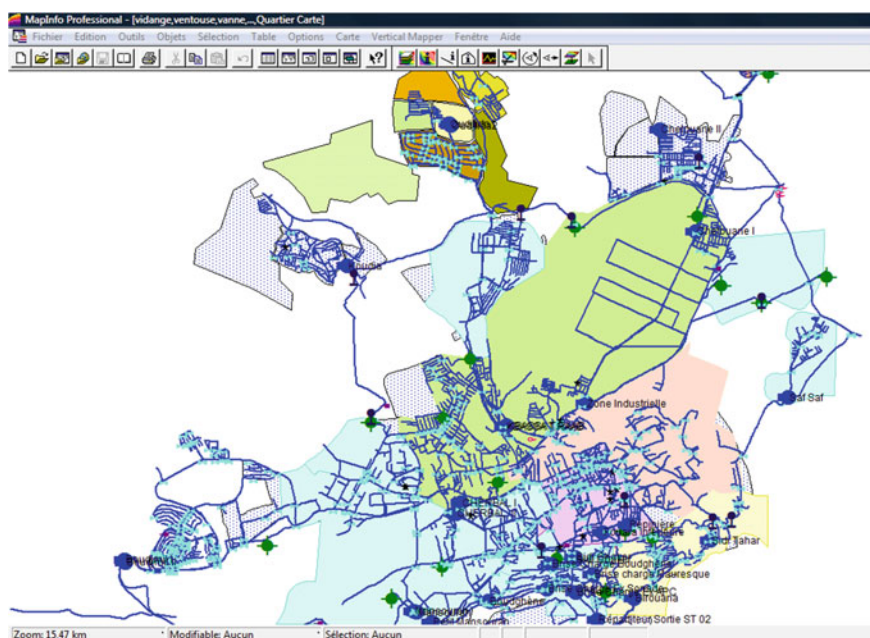
Fig. 7.11 Superposition of water distribution network and DEM of the Tlemcen urban cluster

7.5 Sectorization of the Tlemcen Urban Cluster's Network

Sectorization is the basis of any policy aimed at improving network knowledge about its functioning. This approach consists of breaking a network down into one or more subassemblies to make easy the global monitoring of distributed volumes and also incidents occurring. By making it easier to locate breakages or malfunctions, it makes it possible to prioritize repair or maintenance interventions by acting primarily on the most important leaks first. For example, the sectorization of the Tlemcen urban cluster's network was made by choosing two subassemblies, one with 24 zones and another with 18 zones. These distribution zones were created by manipulating valves (i.e., open/closed) on the network (Table 7.1). Figure 7.12 presents an extract from the sectorization scheme of the Tlemcen urban cluster's network. This operation is of great importance for network modeling. For each tank, the details of the valves, the arrival of the adduction, the departure to the distribution, the overflow, and the emptying are schematized. Figure 7.13 shows an example for the tank of SidiTahar.

Table 7.1 Network distribution sectors for Tlemcen urban cluster

No.	Sector
1	Sidi Chaker
2	Cherbal
3	Tombeau du Raab
4	Boudjmil
5	Sidi Tahar
6	Birouana 1
7	Birouana 2
8	Lalasetti
9	Boudhghène
10	Petit Mansourah
11	Koudia
12	Safsaf
13	Aindefla
14	Ain El Houtz
15	Oudjlida
16	Zone Industrielle
17	Chetouane
18	Ouzidane

**Fig. 7.12** Extract from sectorization of the Tlemcen urban cluster's network

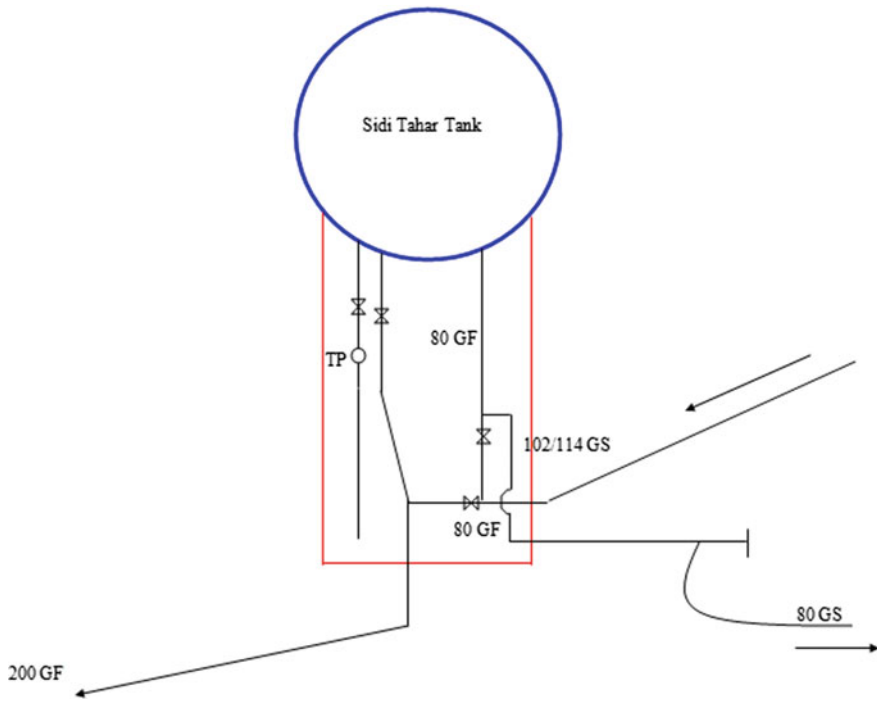


Fig. 7.13 Example of details of the valve chamber of the tank of Sidi Tahar

7.6 Coupling of GIS with Epanet and Analysis of Urban Cluster Network Operation

The scientific community is increasingly recognizing the usefulness of geographic information systems (GIS) coupling and behavioral models because it allows, among other things, the introduction of three-dimensional or spatial differentiation (via localized data) in the description of the processes studied in Pouliot 1999). GIS provides a flexible environment for localized data management (e.g., acquisition, structuring, storage, visualization, and dissemination), and it has very advantageous spatial analysis capabilities. The model contributes to the dynamic representation of the phenomena observed.

The EPANET computing model which was chosen for the current study is a simulation code for the hydraulic and qualitative behavior of water in water distribution systems (Rossman 2000). It aims to better understand the flow and use of water in distribution systems and can be used for different types of applications in the analysis of distribution systems. A water distribution network is defined by pipes (i.e., sections on the software), nodes (e.g., intersection of two pipes and end of an antenna) but also other components (e.g., tanks, pumps, valves, different types of valves). The models allow for calculating the flow through each pipe, the pressure at each node,

and also the water level at any time of the day. The integrated hydraulic calculation engine makes it possible to process networks of unlimited size. It has several formulas for calculating pressure losses and includes the various individual pressure losses and models for fixed and variable speed pumps (Générale des eaux 2003). In summary, EPANET has the necessary tools to regulate pressures in the network, to detect deficit operating areas, allows for network dimensioning, and improves management of water equipment. The model has the same functionalities and possibilities as the other codes for drinking water networks such as Porteau or Piccolo. It has a user-friendly interface that makes it easy to access (Générale des Eaux 2003). EPANET has been used in various fields of research combined with GIS. The most recent work has been reported by Stefan et al. (2000); Burrows et al. (2000), Bell et al. (2000), Bartolin et al. (2001), Bahadur et al. (2001), Brown and Affum (2002), Daene and Ximing (2002), Gumbo et al. (2003), Alonso et al. (2004), Biagioni (2004), Ardeshir et al. (2006), Marunga et al. (2006), Zhang (2006), Zheng et al. (2006), Martinez et al. (2007), Yong et al. (2007), Vairavamoorthy et al. (2007), Jia et al. (2008), Jun et al. (2008), Bartolín et al. (2008), Tabesh et al. (2009), Kenneth and James (2009), Torres et al. (2009), Daoyi et al. (2010), Franchini and Alvisi (2010), Guidolin et al. (2010), Tabesh et al. (2010), Yu et al. (2010), Worm et al. (2010), Tabesh and Jamasb (2011), Zhou et al. (2011), Benson Andrew et al. (2012), Karadirek et al. (2012), Ramesh and Jagadeesh (2012), Tabesh and Saber (2012), Panagopoulos et al. (2012), Fattoruso et al. (2014), Furnass et al. (2013), Janke et al. (2013), Lynn (2013), Kurek and Ostfeld (2013), Nilufar et al. (2013), Padilla and Davila (2013), Roozbahani et al. (2013), Shafiqul et al. (2013), Sitzenfrei et al. (2013), Bach et al. (2014), Diao et al. (2014), Kanakoudis et al. (2014), Abdelbaki (2014), Choi and Koo (2015), Abdelbaki et al. (2017).

Coupling allows GIS to leverage the analytic capabilities of models with the models taking on the graphical and data management capabilities of GIS (Nyerges 1992). The aim for the network of the Tlemcen urban cluster was to facilitate access to the data of different databases, to ensure communication between the computer code and the user in the various tasks to be performed such as data loading, launch of calculation, modification, and display of results. It is necessary to control the network topology before starting geoprocessing. The GIS-EPANET passage (Fig. 7.14) was performed using the DXF2EPA tool (Salomons 2005). It is a program that converts all line and polyline elements (in DXF format layers) into a set of pipes and fittings under EPANET (Rossman 2000). Additional elements must be added manually to the model (Worm et al. 2010) such as tanks, pumps, and valves. The conversion program can calculate pipe lengths. Other network data such as node elevations, pipe demands, and pipe diameters must be manually entered into EPANET (Rossman 2000) after the converted file is loaded (Fig. 7.15). After the conversion of the different layers under EPANET (Rossman 2000), network data are entered, such as pipe diameters and roughness, elevations, and basic node demands as well as tanks and valves. Figures 7.16, 7.17 and 7.18 illustrate the loading of data for the different components of the Tlemcen urban cluster's network.

Network consumptions are defined at the nodes. The advantage of this step is to be able to establish a consumption profile specific to each part of the network from the demand of the nodes at its peak flow. Once the simulation options are defined,

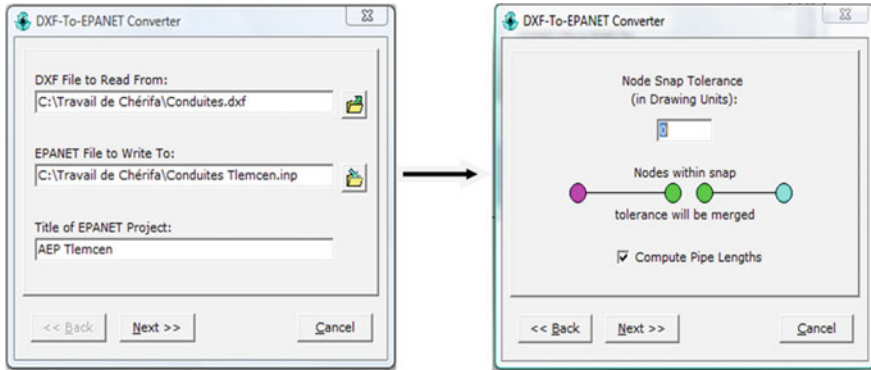


Fig. 7.14 GIS-EPANET conversion

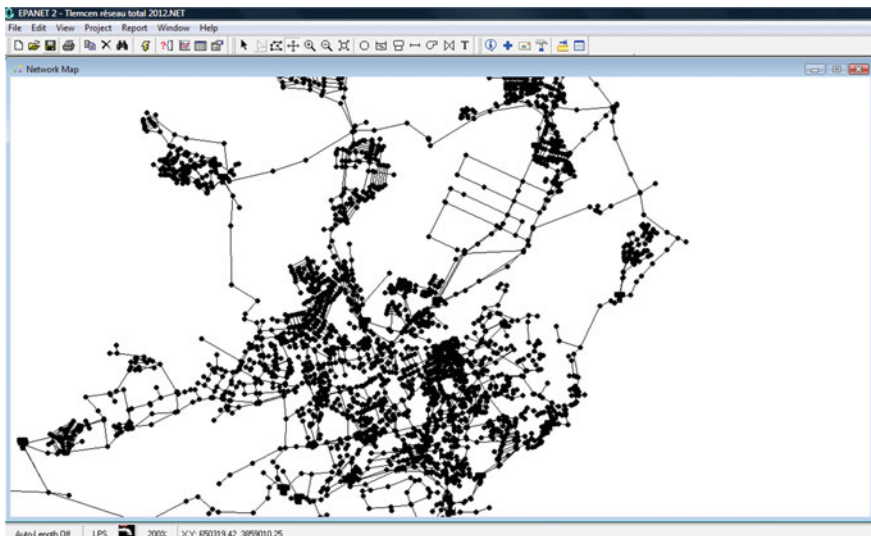


Fig. 7.15 The Tlemcen urban cluster’s network imported under EPANET

the simulation is launched for each sector separately as well as for the entire network (18 sectors). Figures 7.19 and 7.20, respectively, show the start of a simulation and the result of the simulation for the operation of the water distribution network. Figures 7.21 and 7.22, respectively, represent the simulations for the areas of Abu Tachfine and Birouana. The aim of the calibration was to bring the behavior of the model closer to that of the real system. It was about making the model representative of reality. For this, pressure and flow measurements were performed at the tanks of the network. From these measurements made in given situations such as level in the tank, roughnesses values were assigned to the pipes.

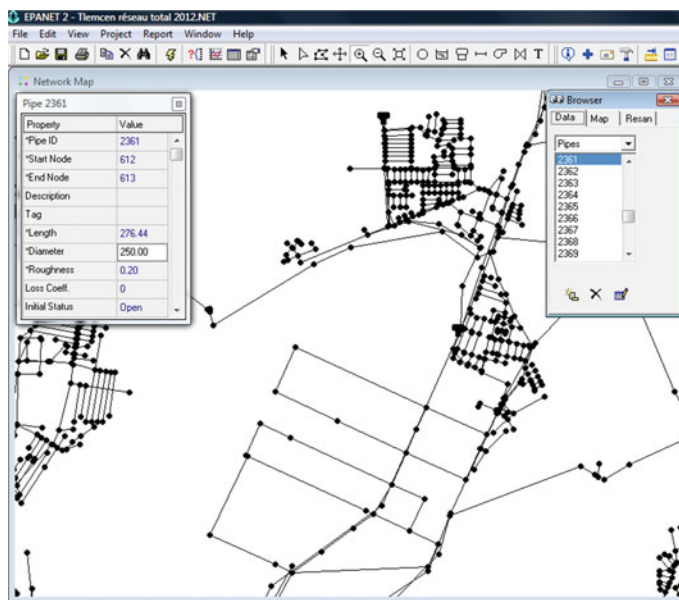


Fig. 7.16 Example of data input of pipelines

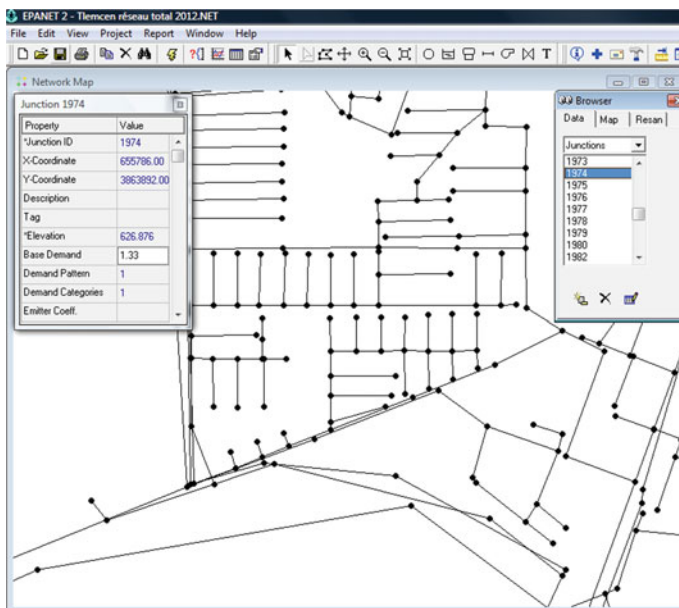


Fig. 7.17 Example of data input of nodes

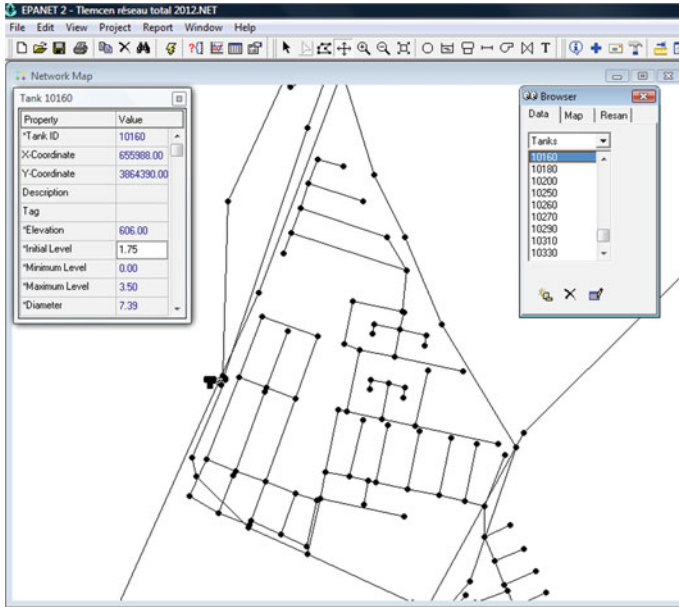


Fig. 7.18 Example of tank data input

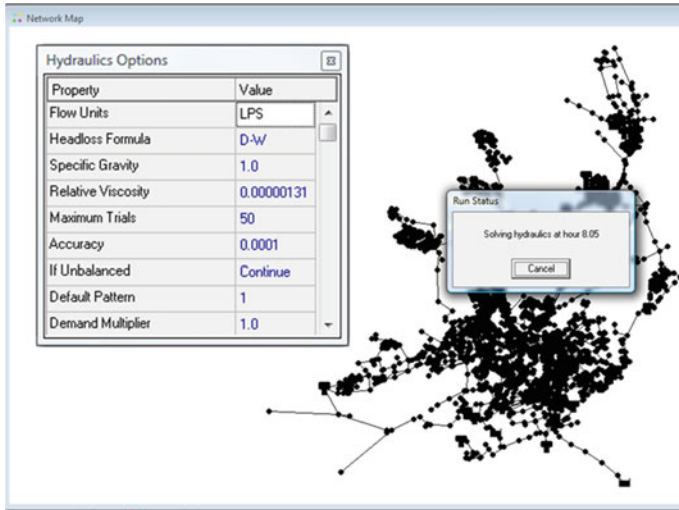


Fig. 7.19 Simulation options of the Tlemcen urban cluster's network

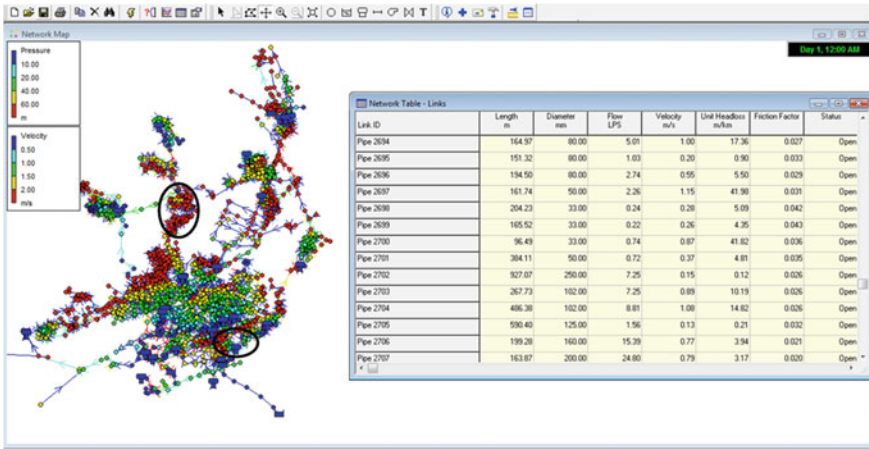


Fig. 7.20 Tlemcen urban cluster’s network simulation results

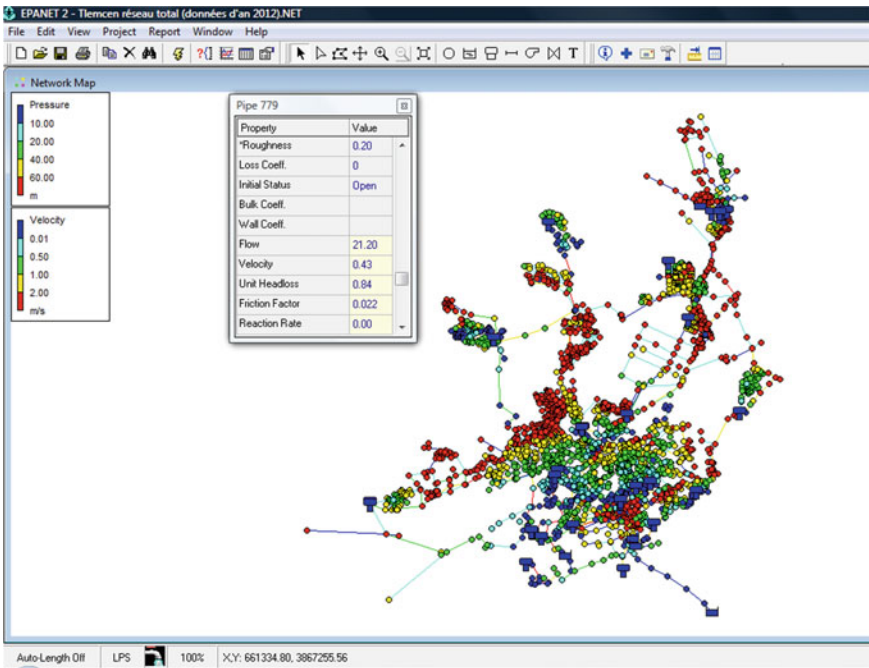


Fig. 7.21 Geometric and hydraulic characteristics of a pipeline

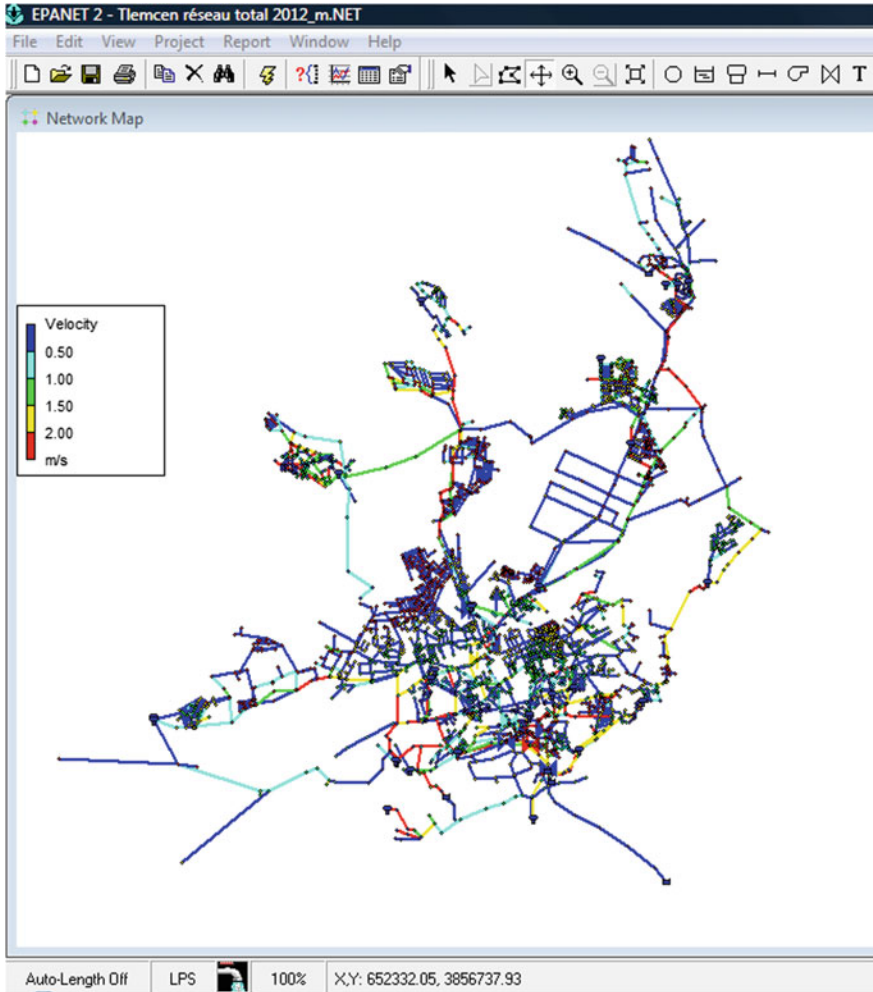


Fig. 7.22 Breakdown of rush hour velocities

7.7 Synthesis and Interpretations of Results

Several scenarios were studied, namely, rush hour network behavior and simulation scenarios during the day. Figure 7.21 shows the geometric and hydraulic characteristics of a pipe after the simulation. The parameters taken for the analysis of the operation of the network were flows, velocities, and pressures. The pipes must be able to transit the highest instantaneous flows, taking into account the peak flow. The velocity of the water in the pipes was of the order of 0.5–1 m/s. Speeds above 1.5 m/s, as well as velocities below 0.5 m/s, should be avoided (Dupont 1979). Low

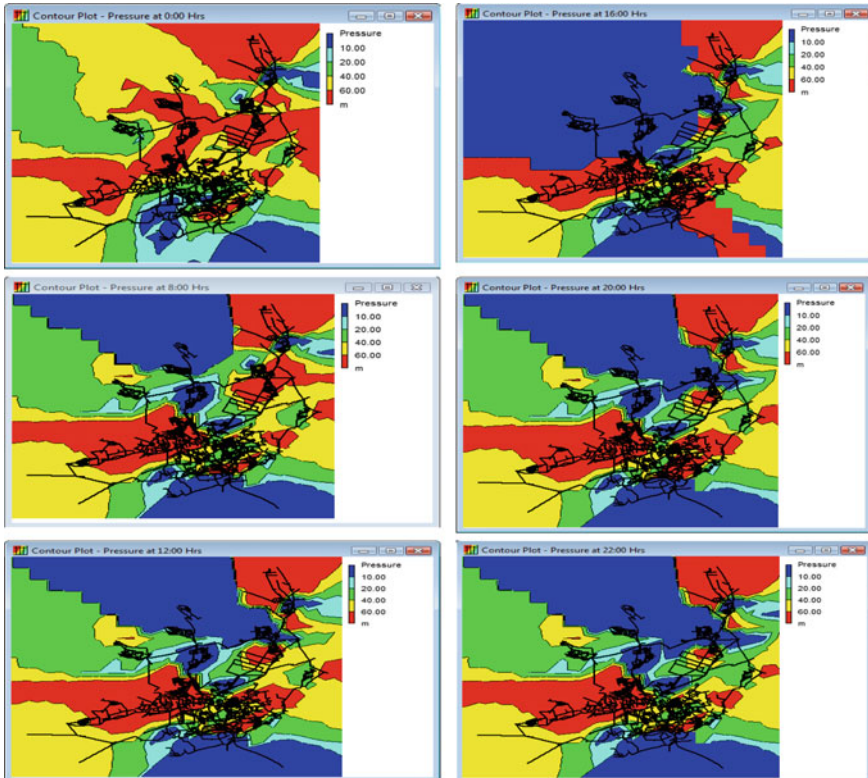


Fig. 7.23 Envelope pressures at the water distribution network for different simulation periods

velocities favor the formation of deposits, which are difficult to remove, and those above 1.5 m/s make it possible to envisage increases in consumption without the user becoming overly sulfurized (Valiron 1994). Figure 7.22 illustrates the distribution of velocities in the water distribution network during peak hours. According to the analysis of the water distribution network based on “rush hour velocity” criterion, 70% of the pipes, i.e., 2639 pipe sections, may have problems with deposits due to the low flow speeds (speed < 0.5 m/s). 17% of the pipelines, i.e., 641 have a velocity between 0.5 and 1.5 m/s (in the norms) and 13% of the pipelines, that is to say, 489 are likely to have the problems of internal erosion following the high velocity ($v > 1.5$ m/s).

In view of the good behavior of the pipes, it is necessary to avoid in city pressures higher than 40 m which are likely to bring disorders (leaks) and some unpleasant noises in the indoor installations of subscribers (Dupont 1979; Gomella 1985; Bonin 1986). The pressure envelope at the Tlemcen urban cluster is given in Fig. 7.23 for different simulation periods. In 31% of the nodes of the water distribution network of the Tlemcen urban cluster, i.e., 1097 nodes, the pressure exceeds 60 m, which

explains the considerable losses in distribution exceeding 50% (Abdelbaki et al. 2012, 2014). In 14% of the nodes, i.e., 481, the pressure is less than 10 m, which is at the origin of the limited service of the subscribers. In addition, there are health and hygiene problems resulting from the mode of operation and storage at the household level (Allal et al. 2012; Abdelbaki 2014). As for the remaining 55%, 1906 nodes, the pressures are between 10 and 60 m of water (in the distribution standards).

Based on the results obtained for the Tlemcen urban cluster's network, several recommendations can be made. The geometry of the network should be reviewed. Rehabilitation operations are essential to correct the geometrical characteristics of the network. This is of great importance to have satisfactory hydraulic characteristics for velocities and pressures. The installation of pressure regulating devices such as stabilizing valves for the areas where the pressures are greater than 60 m is essential. New storage capacities should be installed for Chetouane, Ain el Houtz, AbouTachfine, Koudia, and Oudjlida. A consumption model should be developed specifically to the Tlemcen urban cluster, to better represent the population pattern.

7.8 Concluding Remarks

This chapter described the development of a geographical database essential for the management of a water distribution network in an urban environment by coupling Mapinfo GIS and EPANET model. From the various data about the network such as pipe diameters, the network environment, and using GIS, it was possible to obtain an alphanumeric description of the pipes, tanks, and all the accessories constituting the network. Design irregularities in the urban cluster network were identified. The approach adopted contributes to enhanced management of water distribution networks and offers operators of such networks a tool that permits not only for a better understanding how a network functions by knowing, for instance, the state of a particular point or node, but it also allows for analysis of malfunctions and gives the ability to provide an almost instantaneous response for any incident that may occur. The coupling of GIS with a mathematical model thus provides an operating tool that allows managers and operators to diagnose their networks, to study the solutions to the problems encountered and to plan for future situations. While the advantages of such systems are well established, data collection and data entry require a considerable amount of work; however once completed, the stored information proves for effective and improved management of the water distribution network.

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