The River Po: a natural precious resource of water for the City of Turin

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Abstract

Turin, the city where we live, lies on the river Po that not only constitutes a characteristic element of the city landscape, but is also a real primary source for what is one of the most precious natural resources, water.

From the Po, in fact, a meaningful (17%) percentage of the water that is purified and converted into drinkable water originates, distributed to the city population by the SMAT (Società Metropolitana dell'Acqua di Torino - Metropolitan Company of Waters Turin) through the net of the town aqueduct. Furthermore, the Po furnishes a relevant quantity of water for industrial and agricultural uses in the upstream and downstream areas of the city; to the Po, after appropriate treatment, the wastewaters (grey and black) return, used by the same city and by different industries.

Finally, in the city stretch, the water of the Po is used for sporting activities and relaxation (canoeing, fishing, tourist navigation on the boats Valentino and Valentina).

These are the reasons why one research team (Water in&for Turin) will be looking into the necessary treatments to obtain drinkable water, into the engineering and technology of SMAT's (Società Metropolitana Acque Torino/ Metropolitan Company of Waters in Turin) plant and its research laboratories.

This team will focus on theme of Engineering and Technology ET (Water quality, treatment, monitoring, water waste management) and partially on theme of Communities WC (Service learning, community involvement projects, water & recreation, integrated urban-water designs).

Keywords

Drinkable water, treatment, River Po, city

1 Introduction

The city of Turin, in the North-West of Italy, is crossed by the river Po. This river is not just a characteristic element of our urban landscape, but it is also a source of water for industrial and agricultural activities and for the city.
The Metropolitan Society of the Waters of Turin (SMAT) manages the water networks of the city and the system that processes drinkable water and wastewaters. SMAT directs one of the biggest and best systems of all Europe [1].

FIGURE 1 SMAT'S BUILDINGS IN TURIN, SMAT

SMAT is the first society that uses superficial water as a source of the production of drinkable water. Indeed the 17% of the drinkable water delivered to the city of Turin has as its source the river Po. The remaining part of the water that SMAT delivers to the city comes for the 75% from wells and for the 8% from the springs of Pian della Mussa and Sangano.

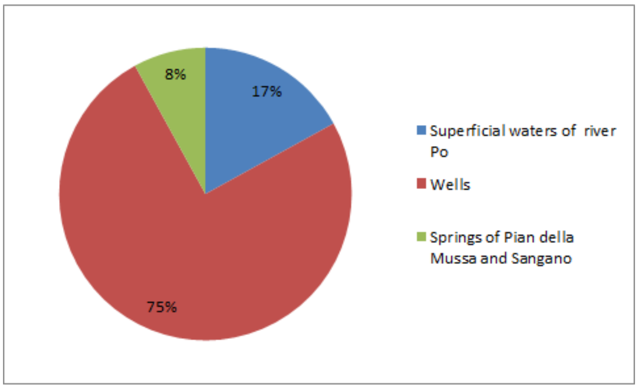

FIGURE 2 SOURCES OF WATER THAT SMAT USES TO PRODUCE DRINKABLE WATER

More than 250.000 laboratory analysis guarantee the good quality of water distributed by the company. SMAT has more than 160 establishments of various dimensions. It purifies more than 270 million cubic meters of wastewater per year.
The distribution network is about 7.000 kilometres long and the average daily delivery, in the day of highest consume, is of 7.037 litres per second. This amount of water produced is enough to satisfy the water needs of more than 2 million people. Furthermore, SMAT takes and purifies the wastewaters with a plumbing system of 6.000 kilometres.
Another important side of the process of purification is the biological and chemical monitoring of the qualities of water. This is the task of the biologists of the Regional Environmental Protection Agency (ARPA). This agency's biologists collet samples of water in order to determinate its biological and chemical qualities. The researchers study and analyse the samples from a chemical and biological point of view. We took care of the biological analysis, as explained in the other work about Water keepers project. These consist in analysis of macro-benthos, macro-phytes and diatoms. From a biological point of view, the quality of water depends on the species and amount of organisms that are found in that sample of water. The combination of all the analysis (chemical, macro-benthos, macro-phytes and diatoms) gives us the rate of quality of water.
As we said before, the river Po is also a characteristic element of our urban landscape. Indeed, it is necessary for the correct functioning of most of the fountains that we can find around Turin. In our city, we have lots of fountains, called "Torèt", and they are the symbol of our city. In fact, in the dialect of Piedmont, the word 'toro' means 'bull' and Turin's name in Italian means 'little bull', so, in Turin, fountains look like a bull's face.

FIGURE 3 TORÈT

The park of Valentino, that is the most beautiful in Turin, is crossed by the river Po. This river is a spectacular and scenographic feature to the park.
The Po has an important touristic role because the touristic boats Valentino e Valentina sail on that river. From these two boats tourists can watch the shores of the river as well as Turin's hill.
Finally, on the river it is possible to practice sports, like sportive fishing and canoeing: along its shores, we can find some historical societies of rowing clubs, like Cerea, Armida, Amici del fiume (River's friends).

FIGURE 4 SIGHT OF CASTLE, VALENTINO PARK FROM R. PO

2 Content

We deepened in how the whole purification process works through a visit to SMAT's plant, made in January 2016. During this visit, we were guided by Mr.Tocci, an engineer who works in SMAT: he explained us the different components of drinking water plant and their specific treatments.
We also met a researcher who works at the SMAT research laboratory: he explained us some recent research in which SMAT is involved. Unfortunately, we could not visit that research laboratory because of safety reasons. The same reasons did not allow us to visit the bigger wastewater plant of Castiglione Torinese, which could have given us a more complete idea about the overall water cycle, from natural source, the River Po, through the human usage until the purification and its return into the Po.

2.1 The purpose of the investigation

The water of river Po is not pure enough to be used in our houses and to be drinkable.
Considering the easy and continuous availability of drinkable water, we wanted to know in details the process that makes the water drinkable, visiting the SMAT plant and personally observing the different steps occurring during the process.

2.2 Method of the investigation

After the guided visit mentioned before, we tried to get some other information on the Internet as well as walking around Turin, to consider and explain in our project the big importance of drinkable water availability, its link with the River Po and the multiple role played by it in our city.

3. Results of the project

3.1 Drinkable process

Now, we are able to describe the main steps that occur in the Po 3 plant starting from fluvial waters to be transformed into the drinkable ones [2].

FIGURE 5 PRE-SETTLER AND ACTIVE CARBON DOSAGE, SMAT

SMAT's main buildings are situated on the left side of the river Po, in an area called Millefonti, and in the south part of Turin where the Sangone creek is.
The whole plant is made up of three stations, Po1, Po2 and Po3. Po1 and Po2, built between 1959 and 1964 and modified during the 1970s, have a total production of 86.400 cubic meters per day, while Po3 is a fair new structure and has a total production of 130.000 cubic meters per day.

FIGURE 6 PO2, PO2 AND PO3 PLANTS, SMAT

The purification process is divided into different phases. Each phase takes place in only one of the three structures. The result of this work is the regular flow of drinkable water also in case of emergency, as in dry periods.
The main part of the purification process takes place in the building of Po3:

1) The water is taken **from the river** with the process of impoundment. The machine that carries out this work has the shape of a hexagonal tower, built on the riverbed, a little before the confluence of Sangone creek. This machine starts purifying water with a system of **metallic belt filters** that take away the biggest solid impurities. When it is necessary, a mechanic washing is provided to remove impurities inverting the filters movement and splashing water jets under pressure. The water passes from this machine to the first raising station by two underground galleries. The first raising station, common for Po1, Po2 and Po3, is made of five different electric pumps: two for 1 m^3/s, two for 0.5 m^3/s and one for 0.6 m^3/s. From these pumps, water passes to four pipes made of steel that are connected to the pre-settler.
2) The **pre-settler** is a big circular tank, with a diameter of 33 m; it is equipped with a scraper that removes all the mud form the bottom of the tank. This scraper's function is to take a big part of the solid residues from the water, in particular during the big floods. The pre-settling can be helped by the addition of chemicals like iron or aluminium salts.

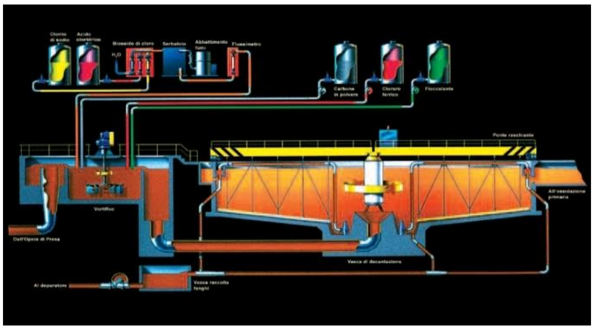

FIGURE 7 FIRST SEDIMENTATION, SMAT

3) To remove all the molecules that make water taste and smell bad it is necessary to remove all the organic micro-polluting substances. SMAT uses **active carbon** in order to do this. This substance is an absorbent powder with a high porosity that assures good result in this technological process.
4) By adding **ozone** in the water, $[O_3]$ = 1-2 mg/l for 5-10 minutes of contact, the oxidation is achieved. This process has a lot of functions, like: disinfection as an effective protection from viruses and bacteria, iron and manganese removal from well water, pesticides, phenols and detergents demolition. There are four generators of ozone, composed by 558 dielectric tubes, with 8 kg/h of production. The air, taken from the atmosphere, is dried and then circulated through metal electrodes under alternating current with apparent power of 15 kW. The air enriched of ozone is blown into the water. The exceeding air enriched of ozone is recycled. In alternative, the oxidation can be done with ClO_2, chlorine dioxide, produced with the reaction between $NaClO_2$ (sodium hypochlorite) and HCl (chloridric acid).

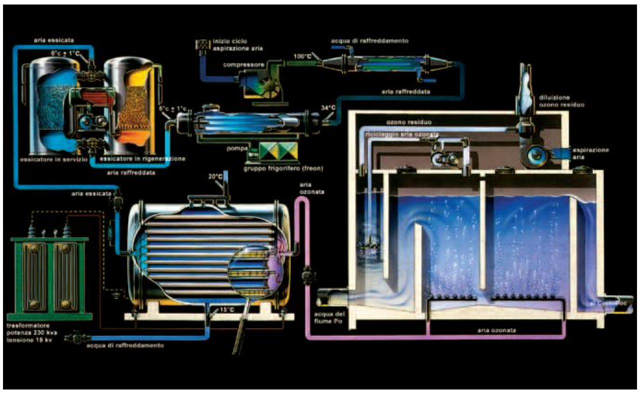

FIGURE 8 OZONE PRODUCTION, SMAT

5) Clarifying with "**Cyclofloc**". There five clarifying tanks, today only three in action each one with a flow of 700 l/s, disposed as a star around a central dispenser. In each clarifying tank aluminium poli-chloride (20-300 mg/l according with water flow), and eventually the oxidant agent, is introduced. Tanks are upside down, truncate cone shaped, with maximum diameter of 24 m and retention time of 1 hour. Micro-sand is introduced to increase weigh of aluminium hydroxide flocs that precipitate on the bottom. There is a system made of metallic rotating scrapers with four arms that remove all muds definitively. Muds are pushed into conic devices, called hydro-ciclons, which, by centrifugal force, divide
6) muds from heavier sand that is recycled. Muds are sent to the waste treatment plant of Castiglione Torinese. Sodium hypochlorite could be used as a disinfectant. However, this is not commonly used because of the production of other products. The cyclofloc's process is highly efficient: water comes out very clear and by constant quality.

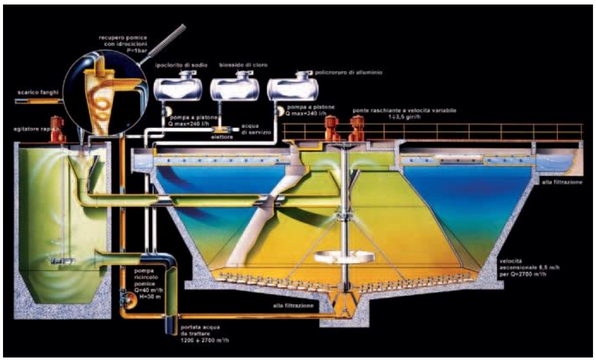

FIGURE 9 CYCLOFLOC, SMAT

7) During the clarifying and flocculation process, another **sodium hypochlorite addiction** eliminates ammonia and derived nitrogen compounds. Recently, a biological process is preferred, allowing less use of chemical compounds.
8) **Filtration,** with two overlapped batteries of active granular carbon filtering bed. It has the same characteristics of powder active carbon, but with different functions. Granular active carbon filters complete the clarifying of water. This process eliminates the bad taste, smell and organic micro-polluting substances and the colouring too. Every 24 hours the superior filter is washed upstream with air and water for 15 minutes. The inferior filter is washed every 6 days in the same way.
9) Water is collected in a **compensation tank**, where the last disinfection is done with $ClO_{2,}$ to obtain water with a content in active chlorine between 0.2 and 0.3 mg/l. This disinfection is necessary to prevent the formation of bacterial colonies in the distribution network.
10) **Second lifting station**: it uplifts water with two electrical pumps that assure a supply of 2500 l/s through two steel pipes (diameter of 1200 mm) linked to the urban network distribution.

FIGURE 10 DOUBLE FILTRATION ON ACTIVE CARBON BEDS, SMAT

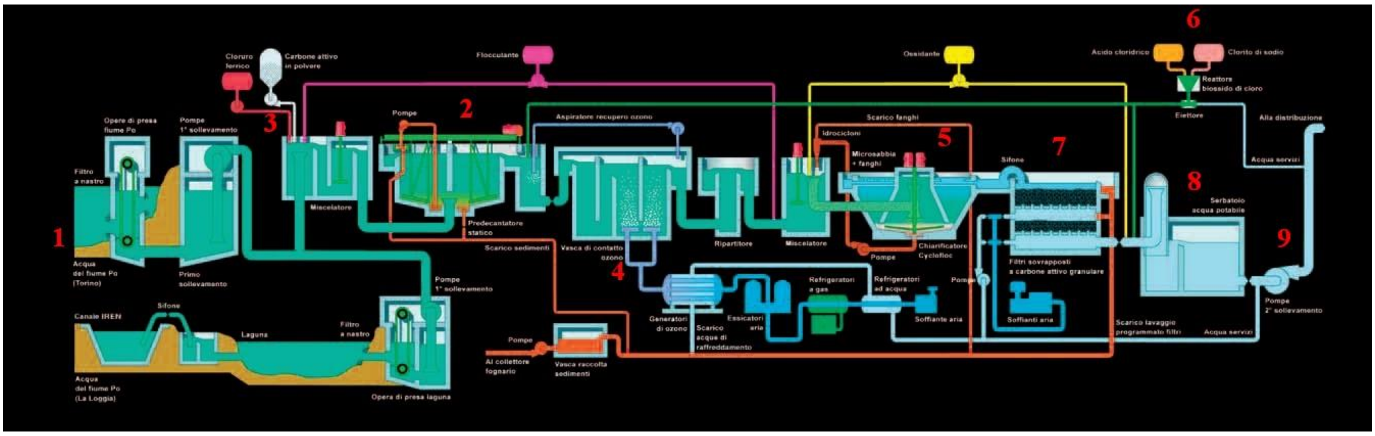

FIGURE 11 PO3 PLANT, SMAT

Legend:
1 Taking from river
2 Pre-settler
3 Active carbon dosage
4 Ozone treatment
5 Cyclofloc
6 Disinfection with ClO_2
7 Double-filtration with carbon
8 Compensation and second disinfection
9 Second lifting station

FIGURE 12 LEGEND FIGURE 11

There is a computer centre to supervise and monitor the quality of water taken from the River Po and of the drinkable water, to control the chemical reactants' optimal dosage, to collect data for statistic researches. The continuous monitoring is sited in the SMAT Research Centre, while the other one is in the lagooning basin of La Loggia (TO), where general parameters (pH, temperature, conductibility, ammonia and nitrates concentration, as well as biological activity of some organisms (rainbow trout or a specific mollusc, sentry organism) and pollutants' presence are identified.

3.2 SMAT Research Centre

Before starting our visit around the SMAT plant, we met a young researcher, who explained us the main role of the Research Centre, giving us some examples of different actual researches in which SMAT is involved.
Firstly, the Research Centre has as a main goal, the improvement of the actual technologies, paying attention not to miss the technological news from the world. The researchers try to improve the efficiency in terms of costs, energetic consumption and the choice of better chemical reagents.
For example, the SOFCOM project [3] is a European project, in cooperation with Politecnico di Torino, whose goal is to test a method that permits to store energy from sewage sludge deriving from depuration of the waters, Thanks to the biogas full of methane coming from sludge anaerobic fermentation, it is possible produce electrical energy. Until now, the energy production occurs in a classical electric engine, but in the future, fuel cells will be used: in this way only CO_2 will be the waste product, and it can be fixed from some seaweeds in a photo-bioreactor to avoid the increasing of greenhouse and to obtain the plant's growth. The result of this project is DEMOSOFC plant with 2KW in power: the next step will be the installation of an industrial plant at the purification plant of Collegno, the second one for dimension. This new system will have a 174 KW power.
Another interesting field of research is about some micro seaweeds, very useful in many different ways: as a source of energy, cosmetics, micronutrients, food for livestock. The LAPIS project takes advantage of seaweed in the anaerobic digestion to produce biogas for fuel cell, or production of hydrogen by pyrolysis. A similar project, called RAINBOW SEAWEED, concerns the use of seaweed to improve the biogas quality and remove from it the 40% of CO_2.
In this plant, there is the application of Fe (VI), which is very unstable but at the same time a very strong oxidising towards organic compounds. It is difficult to be obtained, due to its instability. It is useful to decant certain pollutants: in this way, just one dosage produces simultaneously oxidation and flocculation.

FIGURE 123 SOFCOM DEMO PLANT, POLITO

3.3 Water for Turin

The drinkable water is available not only with the distribution network that arrives in every citizen’s home, but also through two further ways: the characteristic “**torèt**” and 140 **water points** in Turin and Municipalities in Turin’s province.
The **water point** is a hexagonal kiosk about two meters high, designed and produced by SMAT Research Centre.
In this structure, there are three dispensing points: one for plain water, one for the chilled natural water and one for carbonated chilled water.
The delivery can vary from 0.2 l to 1.5 l of micro-filtered drinkable water; the average flow rate of chilled water deliverable is 180 liters per hour.
For the carbonated water, the supply is provided by means of a saturator appropriate, a carbon dioxide dose that varies from 5 to 10 grams per liter. The cooling takes place by means of a cooling circuit.
Plain water, at room temperature or chilled, is distributed free while the sparkling water costs 5 cents per one and a half liter.
The valve is equipped with a coin mechanism, which accepts coins of various sizes and is also set to accept a prepaid card.

FIGURE 14 WATER POINT, SMAT

From June 2009, the city of Turin and SMAT started the water supply network in school canteens. The project involves the distribution in school canteens of water in jugs, taken directly from the tap to replace the bottle. Replace the water in the bottle with that of the tap will avoid the disposal of 2.5 million plastic bottles per year: it will be economical, cheaper and ecologically safer than the current use of drinkable water.

FIGURE 15 WATER POINT IN CHIRONI PLACE, (TO), P. SPERONE

The distribution of water points into Turin’s places has mainly an educative goal: to increase the people’s consciousness about the good quality of the water, which reaches our houses every day and to encourage people to reflect on the economic and polluting waste in consuming large quantities of bottled water.

What are “torèt”?

FIGURE 16 UMBERTO IS DRINKING AT ONE OF TYPICAL TORÈT FOUNTAIN, U. VECE

For us, people of Torino, it is easy to be disoriented if we visit another city and we are thirsty, because we are used to find Torèt everywhere. It is a symbol of Turin. Torèts are fountains from which the head of a bull stands and out of his mouth fresh water runs 24 hours a day. The continuous flow of water may seems like a waste and you would think that the water quality is not good. On the contrary, the continuous flow involves the removal of residual parts and a better cleaning of the fountain: in this way the water has a higher quality, guaranteed by SMAT service. In recent years, an application for I-phone and I-pad was created: it allows using GPS to find the closest Torèt [4].

Here (Fig. 16) is a picture of a Torèt and a map (Fig.17) showing their presence in the territory, near our school (red flag), in the North-West of Turin.

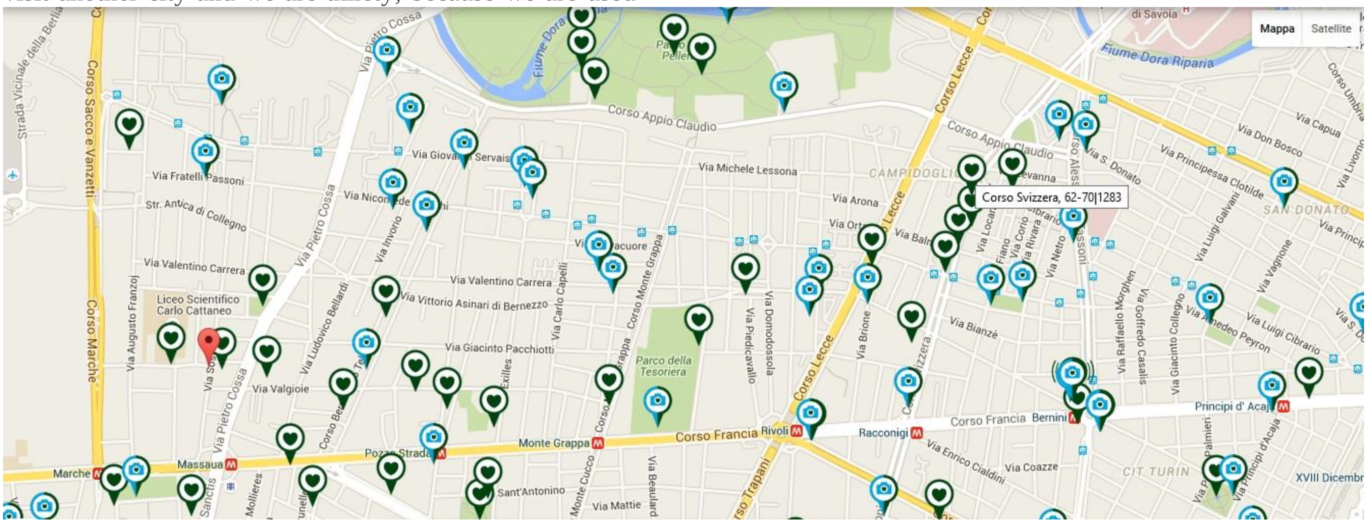

FIGURE 17 MAP OF TORÈTS IN THE NW OF TURIN

Recently, a project has been launched to promote and highlight this cultural and social heritage: “I love torèt” was born in 2012. It possible, for everyone, to adopt for free one of the 800 torèts: the person will take care of it, monitoring its functioning and it will never be damaged. At the same time, a sale of different gadgets has been started with this icon of our city, to collect funds to repair and preserve this symbol.

FIGURE 1138 WATER FOR WASHING OUR HANDS, P. SPERONE

Water for Astronauts

SMAT does not only produce drinkable water for the city of Turin but it also provides water for the ISS, International Space Station (Fig.19).

FIGURE 19 INTERNATIONAL SPACE STATION [6], ESA

FIGURE 20 SMAT ADVERTISING FOR THE WATER PREPARED FOR ISS CREWS [7]

Like written in the advertising above (Fig. 20), on the left **GOOD INTO THE SPACE,** on the right **GOOD AT YOUR OWN HOME**, SMAT was first chosen because of the high quality of the water that it produces and for its high reliability.
After a pact between THALES ALENIA SPACE and SMAT, in April 2008 the first supply of water purified by SMAT was sent to the International Space Station.
Together with THALES ALENIA SPACE, SMAT guarantees the respect of all the required standards.
International Space Station (ISS) is made of different parts that were built by different nations (USA, Russia and European countries) and the crew of ISS is made up of people from different countries, with different needs and preferences. In order to satisfy everyone, SMAT has to produce different kinds of water (Fig. 21) starting from the basic process that are necessary to purify water. In fact, the American crew requires water with a low mineralization and a disinfection process made with iodine, while the Russian crew asks for water with a higher mineralization and a disinfection process made with silver and fluorine.

FIGURE 21 TWO BOTTLES OF WATER ONE FOR THE AMERICAN CREW, THE OTHER ONE FOR THE RUSSIAN ASTRONAUTS, SMAT [8]

A city crossed by the river Po

As we can see in the Google Map below (Fig. 22), Turin developed on the Po left shore, because on the right there are the hills.

FIGURE 22 GOOGLE MAP OF TURIN

The main streets join the River Po, sometimes opening in big squares, like Vittorio Veneto square, visible in the picture below (Fig. 23) and cross it with historical bridges.

FIGURE 23 RIVER PO, VIEW FROM MONTE DEI CAPPUCCINI TURIN, P. SPERONE

Large Streets, like expressways, lie along both Po sides, as we can see in next picture (Fig. 24) with Corso Unità d'Italia, on the Po right side in the south of Turin.

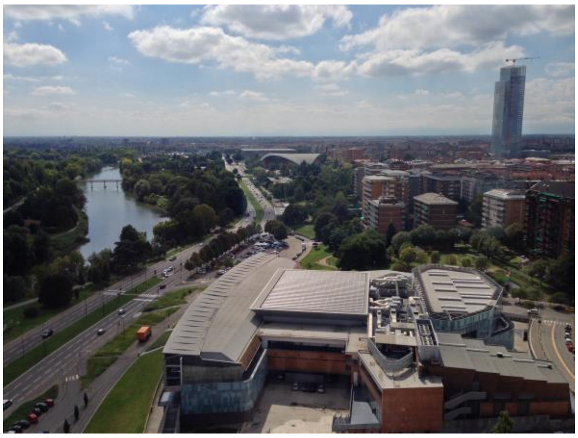

FIGURE 24 RIVER PO, VIEW FROM CTO HOSPITAL, S. GIORGI

Along the left side, in the central part of Turin there are Murazzi, a section with many bars and clubs frequented by young people during weekend evenings, especially in summer evenings; we can see also the wharf where tourists can get onto Valentina or Valentino boats and sailing along a part of the River Po, enjoying beautiful view (Fig.25).

FIGURE 25 TOURISTIC BOATS AND ROWS ON RIVER PO, MURAZZI, TURIN, P. SPERONE

Water joins different parts of our city also with beautiful fountains that are essential features of the green landscape in city parks (Fig.26-27) or monumental fountains in historical centre (Fig. 28).

FIGURE 26 FOUNTAIN IN PARCO DELLA TESORIERA, W TURIN, P. SPERONE

FIGURE 27 VALENTINO'S PARK, S TURIN, P. ANCELLIERO

FIGURE 28 PO AND DORA RIPARIA FOUNTAINS, CLN SQUARE [9]

Two large fountains (Fig.28), sited in the small C.L.N. Square, dedicated to the National, Liberation Committee, which coordinated the activities of Resistance during the Second World War, represent the River Po, on the left, and the River Dora Riparia , on the right side [5]. They were made by the sculptor Umberto Baglioni, in 1937 as a part of the renewal of the second stretch of Via Roma. The stones he used for these sculptures are Serizzo for the basements and Carrara Marble for the statues, two personified rivers, a man (Po) and a woman (Dora Riparia), who, after having ran separated, joins River Po in the South of Turin.

4. Conclusion

At the end of our project, we understood more deeply the importance of water in the environment in which we live. Turin has not any problems in water supplying; moreover, the quality of water available for people, residents and tourists is apparently unlimited. Now, we are more conscious about how precious this resource is, what treatments are needed to obtain drinkable water and we are more attentive to preserve it and avoid every waste.

FIGURE 149 **CLASS 4H: SIMONA, EUGENIO, FRANCESCA, ANDREA. SARA, GIULIA, ELISA, CARLOTTA, LORENZO, SAMUELE, UMBERTO, ALESSANDRO, PAOLO, BESSIM, ALBERTO, DANIELE , STEFANO (ENRICO** WAS ABSENT**) WITH THEIR TEACHERS, MRS. ANGELA AND MRS. PAOLA**

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