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Pilot Arno Water Accounts

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1 Introduction

The Arno river basin has a surface of 8228 km² and it is located in Central Italy (**Figure 1**). It belongs to the Region of Tuscany (Central Italy) for 98% of its territory and to the Region of Umbria for the remaining 2%. The basin comprises 171 municipalities and the provinces of Arezzo, Florence, Pistoia, Pisa, Siena, Lucca, Livorno (in Tuscany) and Perugia (in Umbria).

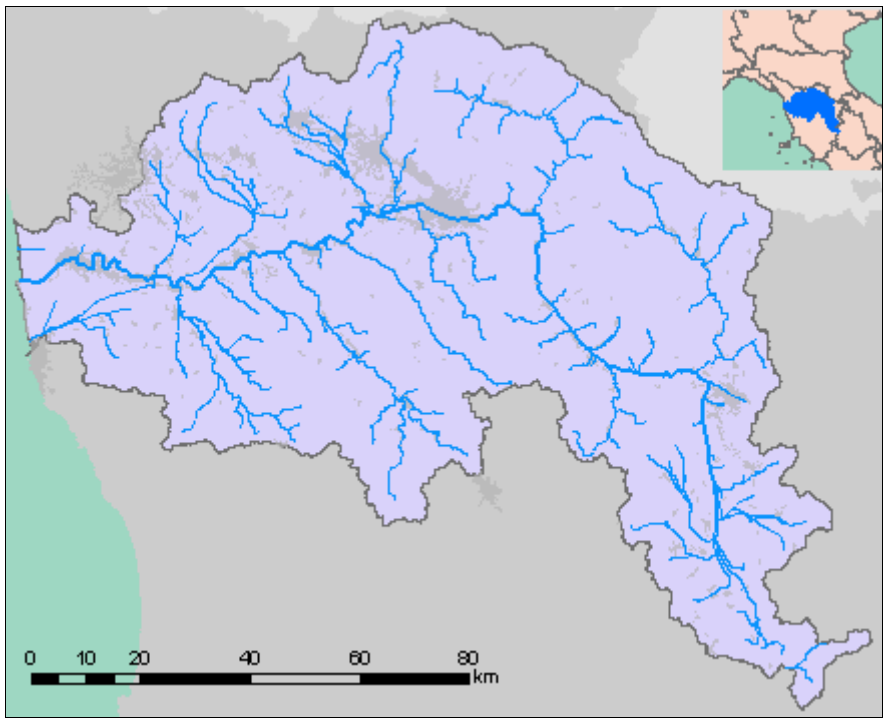

Figure 1 – Map and shape of the Arno river basin.

The Arno River rises from the southern slope of the Falterona Mountain, 1385 meters above sea level. After flowing upstream, through the mountainous area, it leaves the Casentino valley at S. Mama and flows into the Arezzo plain. Sixty kilometres away from its springs, near the plain's western border, it receives the Chiana main channel. Then, it runs through the upper Valdarno where it opens designing a vast arch that reaches the town of Pontassieve, flowing to the mouth of its main right-bank affluent, the Sieve. Afterwards, the Arno river meanders westwards maintaining the same direction to its mouth. Its main left bank and right bank tributaries flow into the Arno in this stretch.

The river is 241 km long whereas the valley is 18 km shorter, a difference that is mainly due to the many meanders that the Arno forms especially in its final tract.

Geological formations among which clays, marls, marly limestones, clay shales, compact sandstone are mainly impermeable. The permeable part of the basin does not exceed 5% of its total surface. The alluvial sediment covers 23% of its surface. On the whole, rocks that form the Arno basin are easily erodible. Yet, the yellowish colour of the water flow indicates a high percentage of sediment transport that causes an intense basin denudation, even if Tuscany is one of the woodiest regions in relation to the total forest and agricultural area.

The basin is mainly impermeable therefore water runoff follows rainfall patterns. Runoff peak is reached from December to March and an absolute minimum rate is usually recorded in August. The variation between rainfall and runoff depends from the soil's seasonal conditions and from base flows. Total average runoff in the whole basin is around 3 Million cubic meters with an average discharge registered at San Giovanni della Vena of 100 cubic meters per second. Discharge trends are characterized by quick flows comparable to those of streams. Discharge during summer months and dry times (that may even occur in winter) can reach very low rates lower than 10 cubic meters per second in the final sections of the basin. On the basis of this geological characteristics flow peaks are sudden and fast and mainly occur in autumn or spring. Water recharge from springs is scarce both for the main river and its affluents. Snowpack recharge is not relevant.

The basin main aquifers are shown in **Figure 2**. Aquifers supply most of the existing aqueducts and also provide water for agricultural and industrial uses. Actually, on the basis of the water balance assessments performed by ARBA in 2008, only one of the main aquifers is highly depleted and shows a negative accumulation trend. Other aquifers on the basis of present abstractions and recharge trends are in balance.

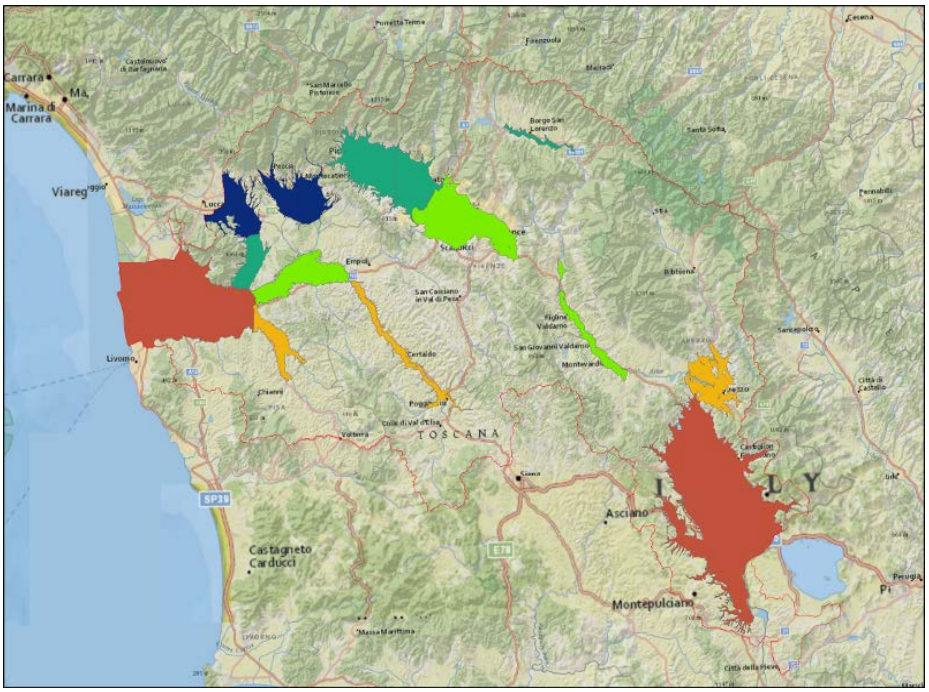

Figure 2 – Main aquifers in the Arno river basin.

Hydrological data such as climate and hydropluviometric historical time series datasets, in particular air temperature, are available for a high number of gauges. Therefore, detailed basin evaluations can be carried out for many time series.

In the Arno basin, public supply is the main water use both as regards to surface and groundwater abstractions. Therefore, reliable estimates, often derived from detailed measures, are available. Assessments of withdrawals for agricultural and industrial uses are more complex because only a cumulated datum for the whole year is available and the monthly variation is obtained by using models that take into consideration seasonal uses. Moreover, the basin is characterized by a high

number of abstraction points because of the presence of an elevated number of small medium enterprises in the basin production districts. There are 22,000 abstraction points from surface waters and to 26,000 from groundwater bodies.

Since the beginning of the project it has been decided to focus the analysis within the larger Arno watershed on three specific sub-basins, namely *Chiana valley*, *Bisenzio valley and Prato plain*, and *Pisa area*, so that the System of Environmental-Economic Accounting for Water (SEEA-Water)[1] could be thoroughly investigated by testing its application on areas characterized by different water exploitation issues (see **Figure 3**). These sub-basins have been identified using as criteria: vulnerability to drought and water scarcity; data availability; and operational governance structure. Nonetheless, data collection and modelling tools will take the whole Arno river basin as reference area.

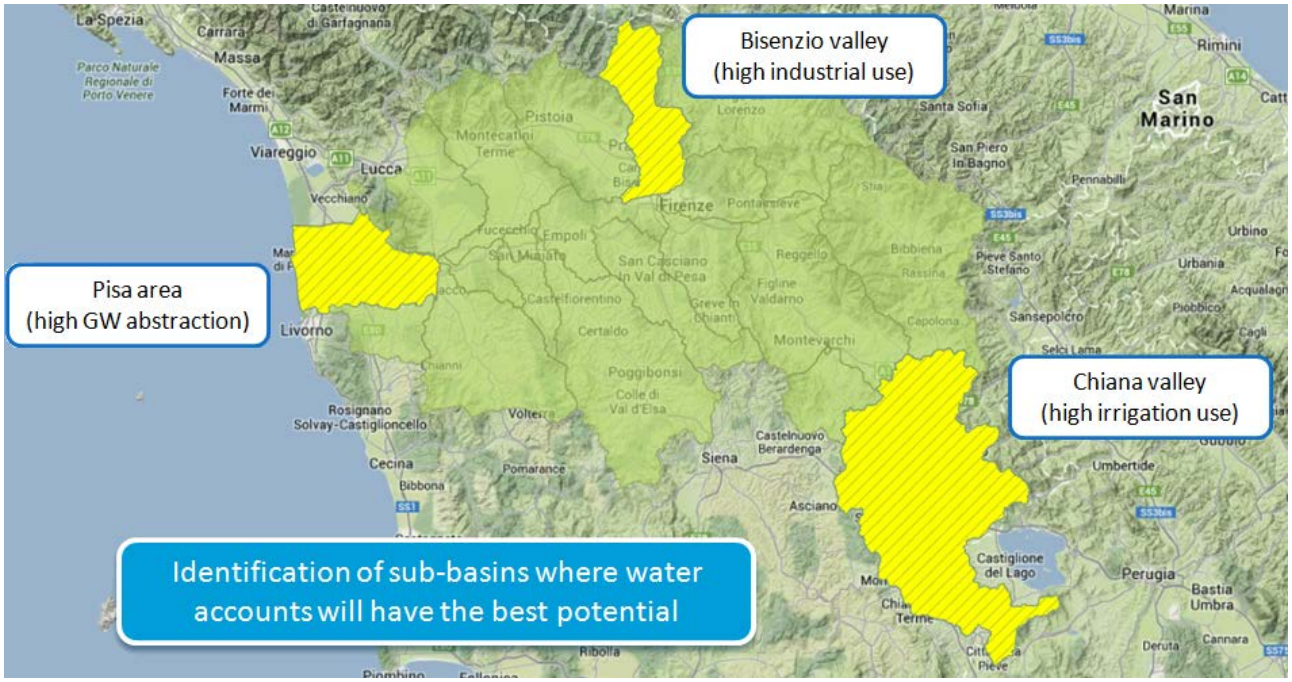

Figure 3 – The Arno river basin with indication of the sub-basins identified for the application and testing of the SEEA-Water system.

2 Synthetic description of the selected sub-basins

2.1 Chiana Valley

The Chiana valley sub-basin comprises the portion of territory where the main Chiana river channel flows draining into the Arno river. It is located in the south-eastern part of the Arno basin and it occupies an area of 1373 km^2.

[1] The SEEA-Water system provides compilers and analysts with agreed concepts, definitions, classifications, tables, and accounts for water and water-related emission accounts. It has been prepared by the United Nations Statistics Division in collaboration with the London Group on Environmental Accounting, and it was firstly approved by the United Nation Statistical Commission in 2007.

Regarding water balances, the basin is characterized by a high exploitation rate, by a significant competition among the different uses among which irrigation is the most significant in terms of abstractions. The first monitoring cycle carried out under the EU Water Framework Directive 2000/60/EC[2] highlighted, generally speaking, environmental quality issues.

Metadata Reference:
http://dati.adbarno.it/geonetwork/srv/ita/metadata.show?uuid=PAWA0094

2.2 Bisenzio valley and Prato plain

One of the main aquifers of the Arno basin is located in the Prato plain.
This groundwater body has been extensively investigated and monitored due to the relevance of the area's main water uses. It occupies an area of 90 square km. Together with public water supply, industrial uses are the most relevant cause of water exploitation and have undergone, mainly because of the economic crisis, significant fluctuations in the last years. Therefore the area can be an interesting test case to examine the correlation between decreases in abstracted volumes and water resources balance. The focus area includes the Bisenzio river catchment until its exit where it joins the Arno river. Thus, both the aquifer recharge dynamics and the surface water and ground water hydrological interactions can be properly taken into account.

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2.3 Pisa valley area

It can be defined as the area associated with the Pisa valley aquifer. It is located in the western part of the basin where the river drains into the sea. It occupies an area of 407 km^2.
The different water abstraction uses (households, industrial and irrigation) mainly affect groundwater resources. In 2011–2012, the severe drought that strokes the area puts the aquifer's water resources to the test. Moreover, due to the abstraction issues the groundwater body is at risk of saline intrusion.

Metadata Reference:
http://dati.adbarno.it/geonetwork/srv/ita/metadata.show?uuid=PAWA0097

[2] **Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for the Community action in the field of water policy**.