

WATER SCARCITY CONFERENCE

CYPRUS

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**THE REUSE OF TREATED URBAN WASTEWATER :
CASE STUDIES IN SOUTHERN ITALY**

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Sogesid: who we are

Sogesid – fully controlled by the Ministry of Economy and Finance – represents one of the instruments of *technical support established in favour of the regional and local governments* of Southern Italy for policies of industrialisation in the water sector, and to contribute to the implementation of the major reforms introduced under the Galli Act (Integrated Water Services), Legislative Decree no. 152/99 and the EU Water Framework Directive (2000/60/EC).

In this context *Sogesid* is presently cooperating with most of the *local institutions in Southern Italy* in different strategic activities, ranging from the *design of important infrastructures*, to the support in *tender processes for the Integrated Water Services* and in the implementation of *Water Quality Restoration Plans*.

The study on the treated wastewater reuse

Sogesid has carried out the study for the *“definition of technical, economic and operational optimisation of wastewater treatment finalised to its reuse in Apulia Region”*.

The study, commissioned by the Italian *Ministry of Environment and Territory*, has the ultimate objective of promoting the conservation of water resources in quantity and quality and to reduce water consumption in regions that have a water scarcity emergency.

The necessity of optimising the reuse of treated wastewater is mandatory in Apulia Region, affected by cyclical water shortage and serious problem of stress of the ground water resources, due to low rainfall and high water abstraction for agricultural and industrial activities.

Apulia water supply system depends largely from water transfer from other regions, particularly from Basilicata, region with mountainous morphologic characteristics and rich of water resources.

Territorial Context

Basilicata

Area: 9.992 sq km

Population: 610.330

Average precipitation:
500÷2000 mm/year

Rivers: Bradano, Agri,
Basento, Cavone, Noce,
Sinni, e Ofanto.

Water Export to Apulia:
240 - 290 M cubic Metres
(mainly households)

Water Service Provider:
Acquedotto Lucano

Main water users:
Agriculture (3 land
reclamation consortiums)



Figure 1. The territorial context

Apulia

Area: 19.357 sq km

Population: 4.090.068

Average precipitation:
400 mm/year

Rivers: Ofanto e Fortore

Water Import from:
Basilicata, Campania e
Molise 490-540 M cubic
Metres (mainly
households)

Water Service Provider:
Acquedotto Pugliese

Main water users:
Agriculture (6 land
reclamation consortiums)

Water resources transfer to Apulia

The recent infrastructure projects, together with initiatives of water demand management, are important to assure long-term prospects for sustainable development. This need is felt particularly in the following sectors:

Agriculture: the sector will become more competitive, especially as the elimination of duties in the Mediterranean basin draws nearer (2010) very important that the real impact of the “Common Agricultural Policy”, linked to the implementation of decoupling (shift funds from product to producer support)

Tourism: the number of structures, and the demand for water services, are forecasted to increase notably;



Figure 2. Water transfer to Apulia

Apulia imports approximately 500 Mcm/year of water from Basilicata, Campania and Molise regions.

The two areas in Apulia suffering particularly from water stress are the “**Tavoliere**” plain and “**Salento**”.

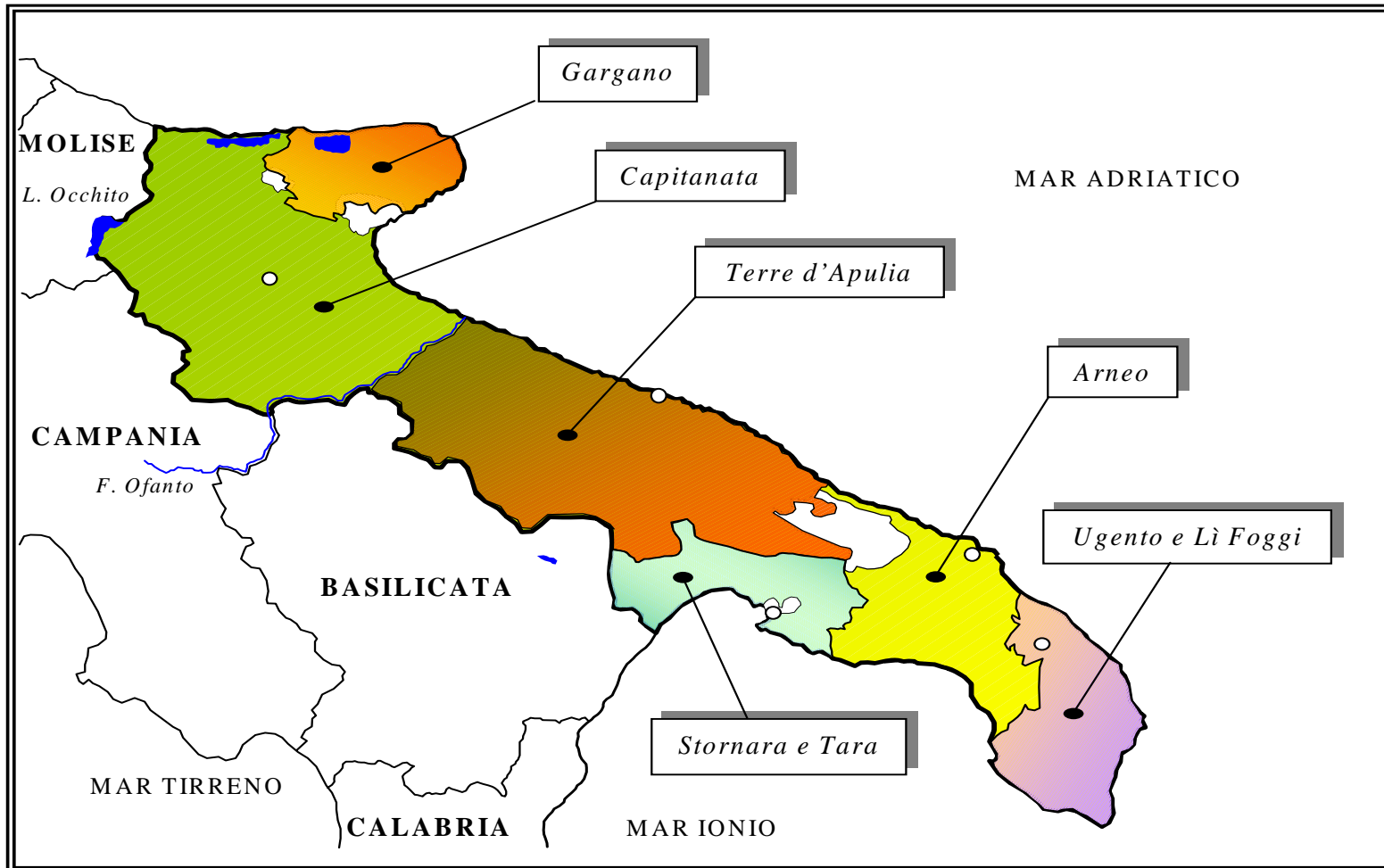
The Study components

The study has been subdivided in different phases, interconnected between them, as follows:

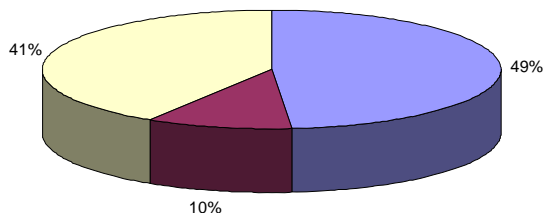
- Identification of non conventional water demand areas and treated wastewater sources;
- Analysis of best treatment technologies available for the reuse of wastewater
- Economic analysis of additional treatment costs
- Evaluation of case studies

The definition of non conventional water demand was carried out for the whole region, giving priority to the areas with already stressed water resources, identifying the water treatment plants as well as the potential users and other possible benefits (environmental, social, etc...) deriving from the reuse. Twenty-two case studies were identified and studied, providing a preliminary planning of required advanced and treatment techniques, operational costs, water conveyance pipelines and distribution infrastructures, social and environmental benefits and any other element interesting the feasibility of the project.

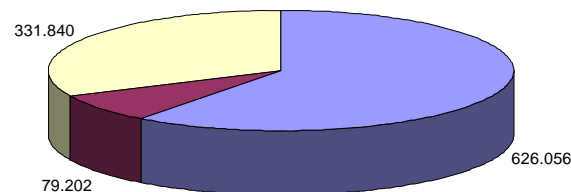
Identification of nonconventional water demand areas



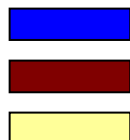
Apulia: treated wastewater



Number of plants: 185



Treated volumes (m³/day)



Tab. 1: effluent disposal in water courses

Tab. 1 & 2: effluent disposal in sensible areas

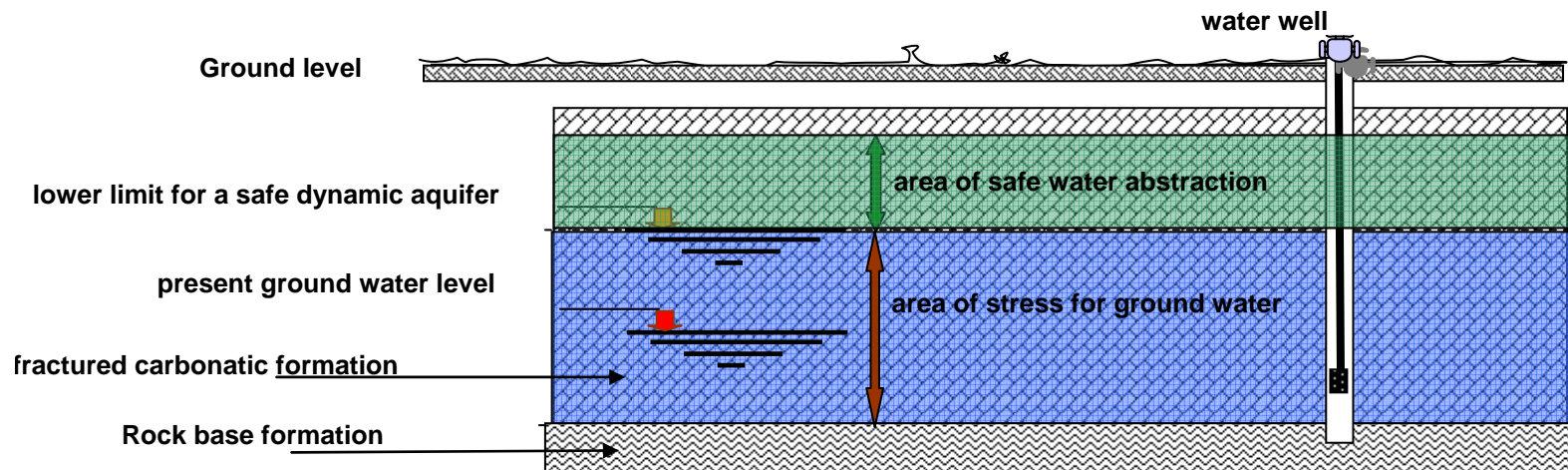
Tab. 4: effluent disposal over natural soil

Reuse in Apulia	n°	Treated volumes Mcm/year	Reuseable volumes Mcm/year	% of reuse
Plant eligible for reuse	20	109	62,5	57%
Plants to be adapted or/ restored	11	37	18,4	50%
Plants already financed	18	76	41,1	54%
Plants identified with Sogesid study	20	54	27,9	52%
<i>Total</i>	<i>69</i>	<i>276</i>	<i>149,9</i>	<i>54%</i>

over-abstraction of ground water

The evaluation of total water demand in agriculture and industry using ground water resources, compared with the total water tables capacity and recharge - evaluated in a recent modelling of the aquifers utilising data over the last 15 years (Sogesid, 2004) - gives an estimated deficit of some **300 million m³/year**, a clear indicator of the magnitude of stress condition of the groundwater resources in critical areas.

The over-abstraction of aquifers in stressed areas, have lowered the dynamic level of the groundwater table below the safe limit. The reconstruction of safe dynamic aquifer volumes requires several years and in coastal areas, this phenomenon has led to salt water intrusion .



National and International Law Reference

International Regulations

- “*Regulation Governing Use of Sewage for Irrigation Purpose*” and “*Wastewater Reclamation Criteria*” edited by the *California State Board of Public Health*,
- “*Guide lines for the reuse of water in agriculture*” edited by the “*World Health Organization*”, the “*Rapport Engelberg*” by the United Nations Environment program, World Health Organization, World Bank and United Nations Development Program,
- Regulation of some states of U.S.A and Canada.

UE Regulation

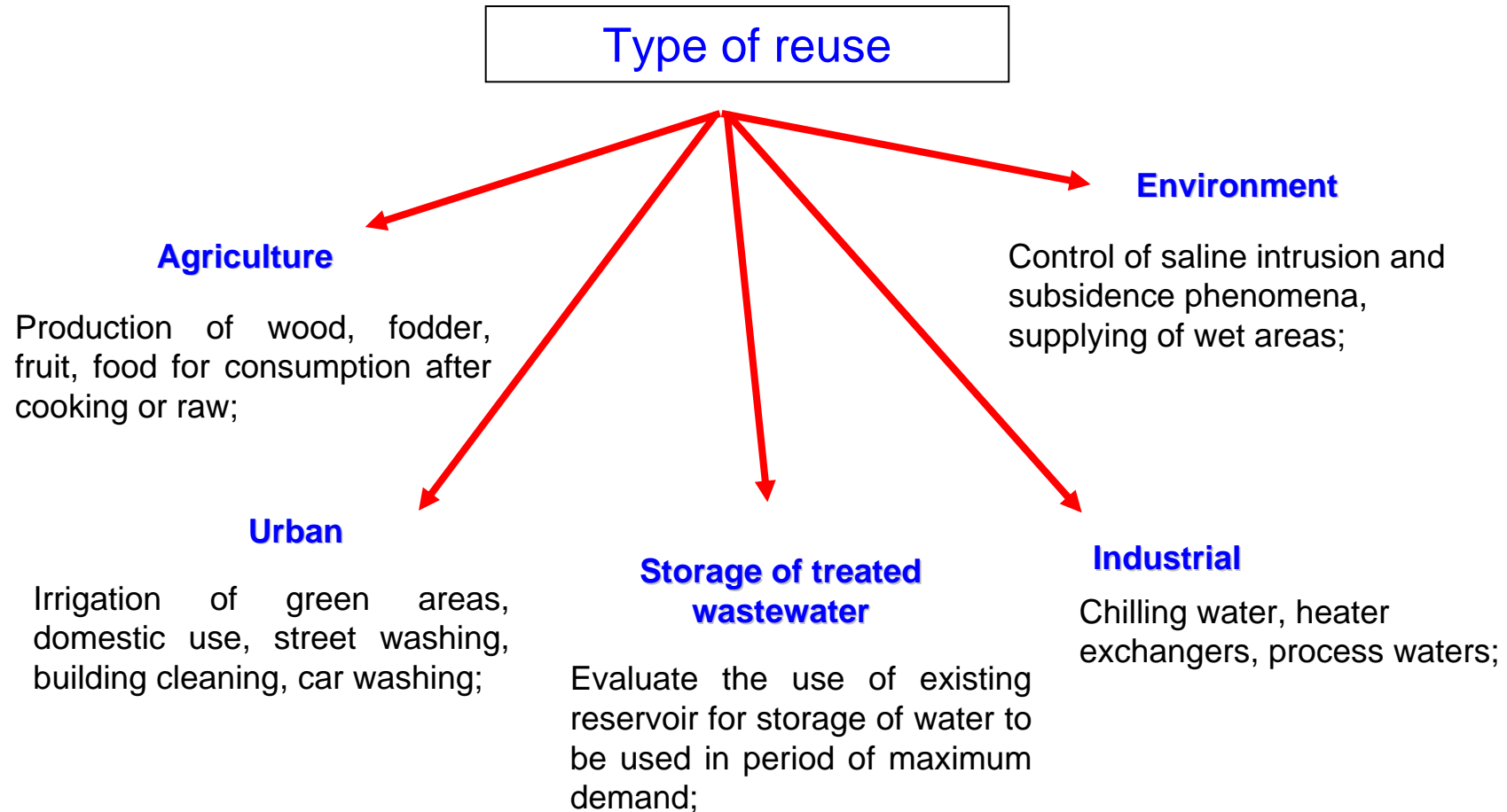
- Framework Directive 2000/60/CE instituting a common implementation strategy in the water sector
- Directive 91/271/CEE concerning the treatment of urban wastewater;

Regulation of some UE states (France, Spain Germany, Cyprus)

Regulation of some mediterranean states (Israel,, Tunes)

Italian legislation

- Law N° 319/76 (L. Merli);
- Resolution of the “ Comitato Interministeriale per la Tutela delle Acque” (CITAI) of 1977;
- Legislative Decree N°152 of 1999
- Ministerial Decree n.185 of 12/06/2003



process parameters: limits according to existing regulations

Class of contaminant	parameter	unit	D.L. 152/1999 e D.L. 258/2000		D.M.A.T.T. 185/2003	
			Table 1	Table 4	Reuse (irrig. & civil)	
			Discharge in surface water bodies	Discharge over soil		
Suspended solids	<i>Total solid suspended</i>	<i>mgSST/l</i>	35	25	10	
Organic Load	<i>Biological Oxygen Demand, BOD₅</i>	<i>mgO₂/l</i>	25	20	20	
	<i>Biochemical Oxygen Demand, COD</i>	<i>mgO₂/l</i>	125	100	100	
Macro Nutrients	Nitrogen	Nitrogen total	<i>mgN/l</i>	---	15	15
		<i>Ammonia-nitrogen</i>	<i>mgN/l</i>	30 % total nitrogen	4,5	1,6
	Phosphorus	Phosphorus <i>total</i>	<i>mgP/l</i>	---	2	2
Microbiologic load	<i>Escherichia Coli</i>	<i>UFC / 100 ml</i>	5.000	5.000	10	

The technical-economical analysis concerned:

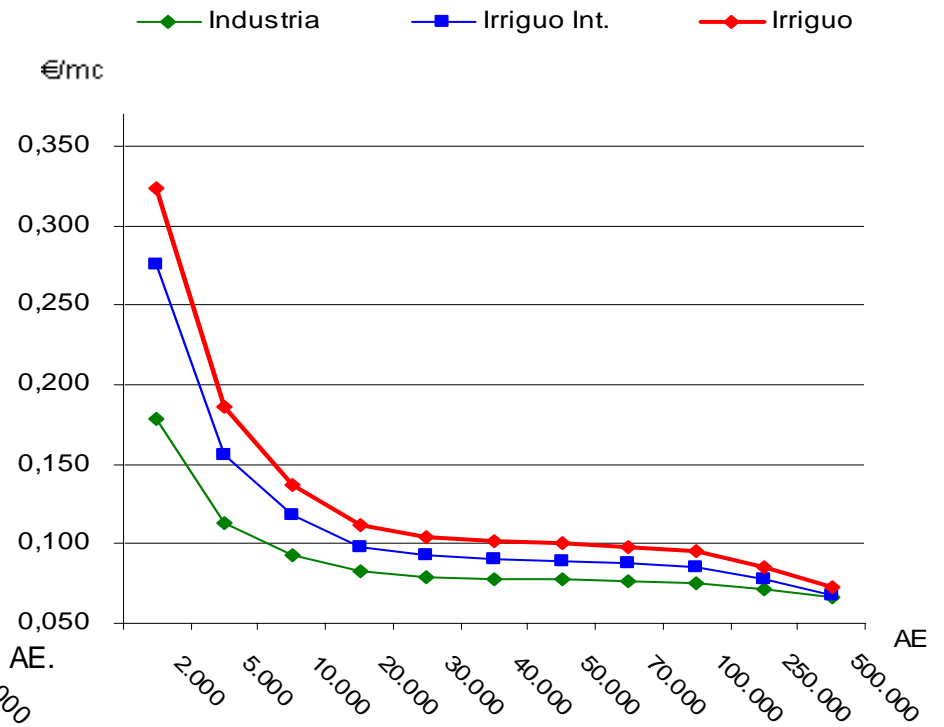
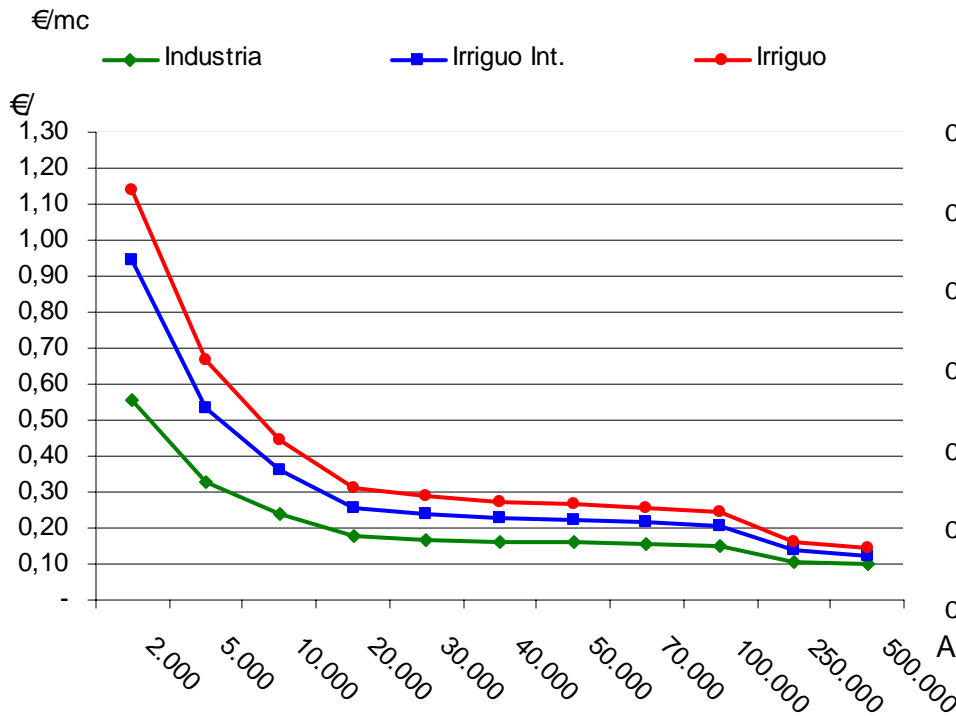
- **Identification and estimate of costs for additional treatment required to adapt the limits prescribed (tab. 1 and tab. 4 of Annex 5 to Decree 152/99), to the new parameters introduced by Decree 185/03 (limit for reuse in agriculture of treated wastewater effluents).**
- **The implication connected with the operation of the system process-reuse plant, as well as with administrative organisation, tariff and political aspects.**

Type of reuse / pop.	2.000	50.000	500.000
	Table 1		
industry	0,55	0,16	0,10
Irrigation integrated	0,95	0,22	0,12
irrigation	1,14	0,27	0,14
	Table 4		
industry	0,18	0,08	0,07
Irrigation integrated	0,28	0,09	0,07
irrigation	0,32	0,10	0,07

Additional cost/m³ required for type of reuse and class of plant

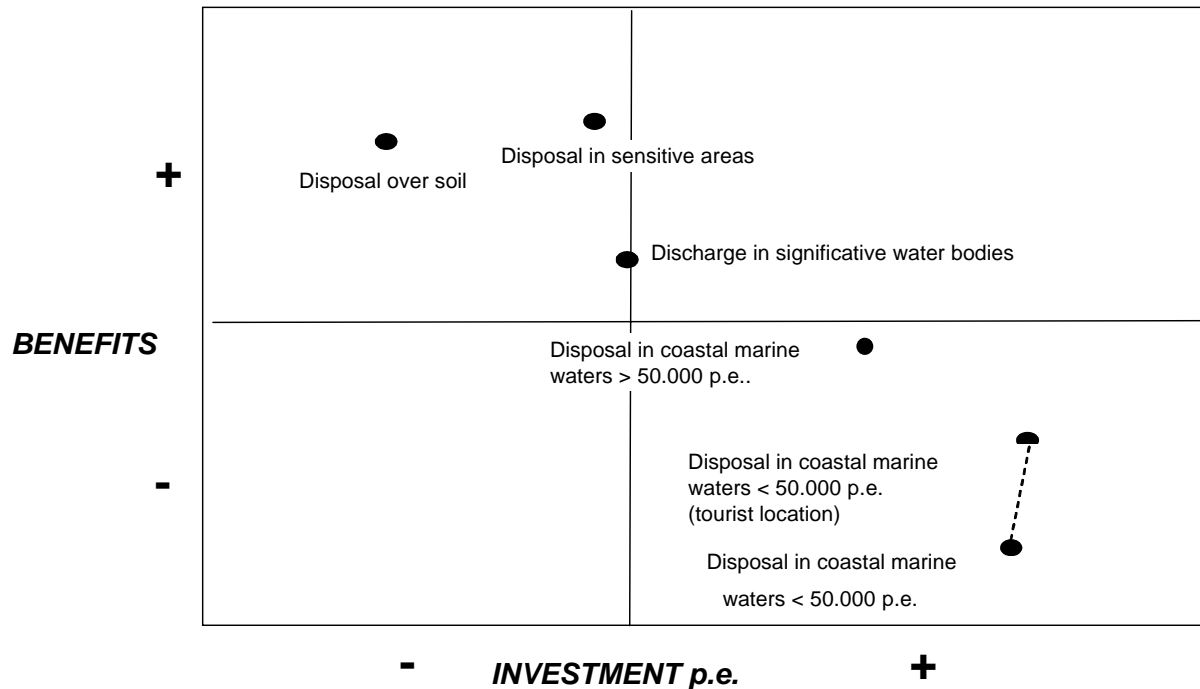
Additional costs required to improve the limits of table 1 (D.L. 152/99) regarding reuse limits in agriculture (DM 185/03)

Additional costs/m³ required to improve the limits of table 4 (Dlgs 152/99) to reuse limits in agriculture (DM 185/03)



- ➡ The costs for advanced wastewater treatment required for improving the plant effluent quality, in order to respect the limits required for disposal in surface water bodies, is ranging from a maximum of 79 €/per capita for plants of 2,000 p.e. to a minimum of 20 €/per capita for plants of 500,000 p.e.
- ➡ The additional costs for improving the effluent quality of the treatment plant, in order to respect the limits required for disposal over soil (in arid regions without defined water courses), are negligible.
- ➡ The difference between the additional costs in the two cases described above is dramatically reduced with the economy of scale obtained in large treatment plants (above 100,000 p.e.)
- ➡ The cost-benefit evaluation depends from the size of the treatment plant and from a well defined tariff policy (incentives and income from additional fresh water made available).
- ➡ Any project in arid or semiarid regions with non conventional water demand (agriculture, industry, environment), presents considerable benefits from the implementation of a wastewater reutilisation policy.

- ➔ The environmental benefit plays a central role in a comprehensive evaluation of a reuse project, (in our case a value is given to the damages caused by over-abstraction of stressed aquifers).
- ➔ The appropriateness of reuse project varies when compared with treatment plant size and conditions regarding the disposal of the treated effluent.

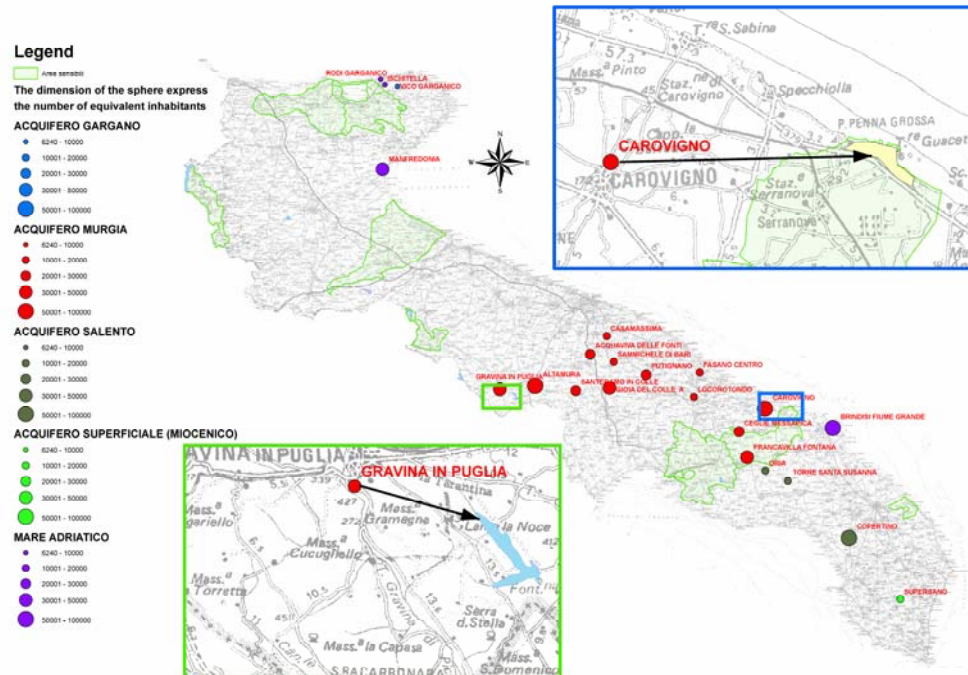


Case projects studied

The treatment plants identified in the Sogesid study are listed below

Paese	Regione	Sistema/Fab			Abilità per condizionare acqua (litri/g)	Sua tipicità ulteriore acqua	Abilità di condizionare l'acqua	Prestazioni
		Nome/tecnologia	Daily intake cubic	Industria (litri/g)				
Italia	EM	Alghero	Table 1	11.000	2,4	Sotto zero	Average High	Impatto
		Grado (in Faglia)	-	22.000				
		Sanremo (in Golfo)	-	22.000				
	EM	Asquero (in Golfo)	Table 1	20.000	2,3	Over zero	High High	Impatto
		Caserta	-	22.000				
		Genova (in Golfo)	-	22.000				
		Reggio	-	22.000				
EM	Genova (in Golfo)	-	22.000					
Italia	EM	Imperia	Table 1	22.000	4,0	-	Good High	Impatto molto alto
		Opitero	Table 1	22.000				
		Sapri	Table 1	22.000				
Italia	EM	EM-1	Table 1	22.000	4,0	Over zero	Low High	Impatto molto alto
		EM-2	Table 1	22.000				
		EM-3	Table 1	22.000				
		EM-4	Table 1	22.000				
		EM-5	Table 1	22.000				
		EM-6	Table 1	22.000				
		EM-7	Table 1	22.000				
Italia	EM	EM-1	Table 1	11.000	4,2	Sotto zero	Low High	Impatto molto alto
		EM-2	Table 1	22.000				
		EM-3	Table 1	22.000				

Location of Case Projects Studied



- ☞ "Reuse of effluents from the Carovigno Treatment Plant for agricultural purposes and at the same time protecting the "Torre Guaceto Reserve".
- ☞ "Reuse of effluents from the Gravina in Puglia Treatment Plant for agricultural purposes, using the already existing Sagliocchia reservoir for storage of the treated wastewater"

The project area is located along the Adriatic coast of the Brindisi Province and is characterised by the presence of the

Natural Reserve of “Torre Guaceto”

The reserve, has an extension of 1,144 hectares,
is a **wetland of international interest** by the Convention of **Ramsar**,
a **Special Security Zone (Z.P.S.)** as well as a
marine reserve and
Site of Communitarian Interest (S.I.C.).

Moreover the reserve of “Torre Guaceto” has been included in the
"Census of priority habitats", in implementation of the community
directive 92/43/CEE.

The inadequate management of the aquifer, with

over-abstraction from groundwater

and consequent reduction of the safe extraction volumes, is the

principal cause of the present environmental deterioration

affecting the “Wetland” of “Torre Guaceto Reserve”.

The very high concentration of salt in the groundwater

has led to the reduction and even extinction

of some very particular and rare macro-invertebrate species

(Triturus italicus, tree frog, Emys orbicularis, marshland turtle, etc...).

The Project

Non Conventional Water Resource = Carovigno Treatment Plant

Presently under construction, the plant represents a potential source of non conventional water resource that could be utilised in the agriculture zone of “Apani”,

The treated effluent is planned to be disposed into the “Canale Reale” that, according to the Decree 152/99, is a “sensitive water body”. The advanced treatment processes required are therefore designed to fulfil the limits of table 2 of annex 5 to Decree 152/99.



The annual volume of treated wastewater in the Carovigno Treatment Plant is approximately **3.7 million m³/year**, the available volume during the irrigation period is estimated to some **2.8 million m³ /year**.

The total **demand for irrigation** water in the area is estimated to be **0.7 million m³/year**

with a maximum in July (165.000 m³) and a minimum in March (12.000 m³), while the estimated total water

demand for the environmental rehabilitation of the Natural Reserve is estimated to some **2,9 million m³/year**.

The non conventional resources are sufficient to meet both Agriculture and Environmental demand



Works Required

- Additional treatments** (extended removal of suspended solids and reduction of BOD5)
- disinfection of effluent**
- rehabilitation/extension of irrigation network and pumping stations,**
- monitoring system** (The reutilisation of the treated effluent for recharging the water able, must be considered experimental and includes a complex management programme for the whole “Wetland Area”)
- storage tank**
- emergency marine pipeline** (for disposal of untreated effluent in case of plant out of order etc...)
- Conveyance line** to the disposal area with overland flow treatment technique near to the outlet of “Canale Reale”, using vegetative biotypes.

Expected effects of the project:

- reduction of water abstraction from stressed aquifer;
- limitation of the saline contamination of wetland;
- protection of this important habitat, critical for the survival of the existing fauna;
- recharge of the water table of the wetland with a controlled effluent disposal;
- reduction of the supply of nutrients to the “sensitive area”.

The Project

The project is finalised to utilise the treated wastewater, fulfilling the irrigation demand of the area (especially in peak irrigation season) and at the same time providing a proper disposal of the treated effluent.



The effluent of Gravigna Treatment Plant will be conveyed to the existing reservoir of “Tempa Bianca” on the Sagliocchia stream during the non irrigation seasons, optimising the available storage capacity of this reservoir.

Reuse of effluents from the Gravigna Treatment Plant 1/4

Water demand and available resources

	Natural flow (*)	Hypothesis 1 Altamura	Hypothesis 2 Altamura e Gravina	Hypothesis 3 Altamura, Gravina e Santeramo
Available Volumes (m ³)	0.9	4.6	5.8	6.6
Irrigable Agricultural Area (ha)	270	1500	1900	2200



Works Required

- Treatment plant** Construction of a new advanced wastewater treatment plant, tentatively located in the vicinity of the Saglioccia reservoir;
- Conveyance line** Conveying the effluent of existing plants to the Saglioccia advanced treatment plant;
- Conveyance lines** Conveying the effluent of existing plants to the irrigation schemes;
- Minor works** at the Saglioccia Reservoir for the monitoring of water quality;

Expected effects of the project:

- Reduction of water abstraction from stressed aquifer;
- Identification of a proper disposal of effluent;
- Utilisation of complete capacity of Saglioccia reservoir;
- Supply of volumes necessary to meet the peak demand for irrigation water.