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WP3

Deliverable 3.3.2 - 3.3.3

Irrigation Audits at Consorzio per la Bonifica della Capitanata: Chemical characterization of purified, refined, conventional and ground waters

Interreg V- A Greece-Italy Programme 2014 2020

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IR2MA
Large Scale Irrigation Management Tools for Sustainable Water Management in Rural Areas and Protection of Receiving Aquatic Ecosystems

Subsidy Contract No: I1/2.3/27

Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

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Partners

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Associated partners

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Project co-funded by European Union, European Regional Development Funds (E.R.D.F.) and by National Funds of Greece and Italy

Notes

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Irrigation Audits at Consorzio per la Bonifica della Capitanata: Chemical characterization of purified, refined, conventional and ground waters

Involved partners:

Institute of Sciences of Food Production (ISPA) National Council of Research (CNR).

Consorzio per la Bonifica della Capitanata (CBC)

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Project Summary

The main objectives of the Interreg IR2MA project are the implementation of advanced smart decision support systems (DSS) for irrigation management, the definition of optimal strategies for the reuse of treated wastewaters for the production of safe and high-quality horticultural products, as well as the dissemination of technological solutions suitable for optimizing water resource uses.

The project involves for the Italian side the Institute of Sciences of Food Production, National Council of Research (CNR-ISPA), Consorzio di Bonifica della Capitanata (CBC), the Mediterranean Agronomic Institute of Bari (CIHEAMB) and Puglia Region as Associate partner, while on the Greek side the University of Ioannina and the Region of Epirus.

Among the several ways to use water, irrigation represents the largest quantity (even up to 70% of the total used volume). Therefore, considering the problem of the climate changes and their effects on the future scenarios in agriculture, it is essential to put in place suitable strategies for optimizing the irrigation practice, avoiding water reservoir pollution and contamination and, where possible, taking advantage of unconventional water usage, for example by reusing wastewater.

Foreword

This report contains a description of the activities carried out by CNR-ISPA with the collaboration of Consorzio di Bonifica della Capitanata (CBC) in the framework of WP 3 - Specialized research actions, Deliverable 3.3.2 – 3.3.3 “Irrigation Audits at Consorzio per la Bonifica della Capitanata: Chemical characterization of purified, refined, conventional and ground waters”. The activities focused on chemical analysis of different waters (purified, refined, conventional and ground), collected from July to October 2020, in different sites of CBC area in Apulia region.

Beside an introductive examination of the state of the art and of the concepts at the base of the carried out activities, a description of chemical analysis performed and the results is included in this report. The present document contains an overview of the findings of the project activities. All the publications that will arise from the activities carried out in the project will clearly refer to the IR2MA project as source of funding for the conducted research.

Introduction

The increase in world population suggests that higher food demand will be expected in the future, in fact, over the past few years, the major challenge of agriculture was to produce “more with less” in order to obtain crops with high nutritional values and with low environmental impact. In addition, the transition to sustainable food systems also represents a huge economic opportunity for farmers (European Commission 2020). However, the increasing population causes intensification of resources used to produce foods, such as soil and water. In this context, the Green Deal Farm to Fork strategy points to a new system of production, in general more sustainable (European Commission 2020).

Water scarcity is seen as a major constraint to intensify agriculture in a sustainable manner as an attempt to meet the food requirements of a rapidly growing human population. The ever increasing human population, climate change due to increased emissions of greenhouse gases, and intensification of agriculture, are putting severe pressure on the world’s two major non-renewable resources of soil and water, and thus pose a big challenge to produce sufficient food to meet the current food demand. In general the quality of different waters (human and livestock drinking, irrigation of crops, etc.) are related with concentration and composition of soluble salts present in it. The quality of water is, thus, an important component with regard to sustainable use of water for irrigated agriculture, especially when salinity development is expected to be a problem in an irrigated agricultural area. There are different criteria for evaluating water quality for irrigation purposes, such as: electrical conductivity (EC), total content of soluble salts, relative proportion of Na to Mg and Ca, excessive concentrations of elements that cause an ionic imbalance in plants or plant toxicity (boron, chlorine, sodium), pH (acid or basic) and alkalinity - carbonate and bicarbonate.

Table 1. General guidelines for salinity hazard of irrigation water based upon conductivity.

Limitations for Electrical use	**Conductivity (dS/m)**
None	≤ 0.75
Some	0.76 - 1.5
Moderate*	1.51 - 3.00
Severe**	≥ 3.00
dS/m at 25° C = mmhos/cm	

* Leaching required at higher range.

** Good drainage needed and sensitive plants may have difficulty at germination. Zaman et al., 2014.

The most influential water quality guideline on crop productivity is the water salinity hazard as measured by EC. The primary effect of high EC water on crop productivity is the inability of the plant to compete with ions in the soil solution for water (physiological drought). The higher the EC, the less water is available to plants, even though the soil may appear wet. Because plants can only transpire “pure” water, usable plant water in the soil solution decreases dramatically as EC increases.

The USSL Staff (1954) water classification diagram does not present an EC over 2250 µS/cm. However, most of the water used for irrigation purposes possesses salinity levels which are higher than 2250 µS/cm. Therefore, in order to accommodate higher water salinity levels, Shahid and Mahmoudi (2014) have modified the USSL Staff (1954) water classification diagram by extending water salinity up to 30,000 µS/cm (Figure 1).

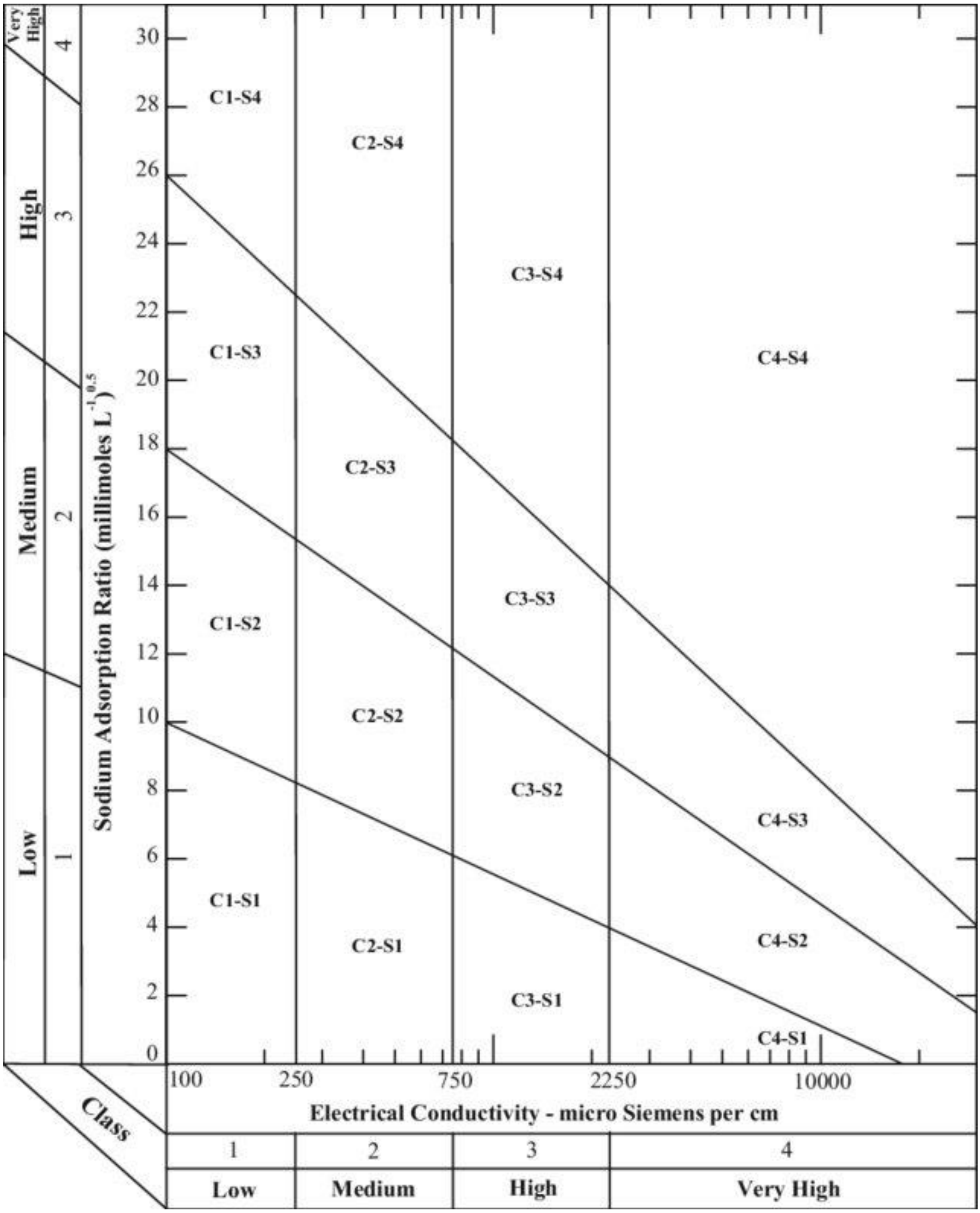

Figure 1. Diagram for the classification of irrigation water (USSL Staff 1954; modified by Shahid and Mahmoudi 2014).

Table 2. Potential yield reduction from saline water for selected irrigated crops.

	Yield reduction (%)			
Crop	0%	10%	25%	50%
	Electrical conductivity of the irrigation water (dS/m) at 25°C			
Wheat	4	4.9	6.4	8.7
Potato	1.1	1.7	2.5	3.9
Corn (grain)	1.1	1.7	2.5	3.9
Onion	0.8	1.2	1.8	2.9
Sugarbeet	4.7	5.8	7.5	10

Adapted from T.A. Bauder, Colorado State University Extension water quality specialist; R.M. Waskom, director, Colorado Water Institute; P.L. Sutherland, USDA/ NRCS area resource conservationist; and J.G. Davis, Extension soils specialist and professor, soil and crop sciences. 10/2014.

The Bonifica Capitanata Consortium

The consortium is a public legal entity with an associative structure, administered by its farmers. It implements public actions to protect soil, to protect and use water resources and to safeguard environment. It designs and makes the reclamation works and it provides for their maintenance and management. Bonifica Capitanata Consortium was established with Republic President Decree issued on 10th May 1965, through the merger of pre-existing nine reclamation consortia, and it currently operates on the basis of the Regional Law and of the rules contained in its Statute Due to the vastness of the catchment areas and the unhealthy conditions of the land, Consortium has carried out important reclamation and hydraulic defense projects since the beginning of its establishment. In a long and patient work it has made large territories cultivable at an altitude below sea level, proceeding to reclamation of large swamps, first filling them with soil, and then, in consideration of the long time necessary, removal excess waters through draining machines. At the same time, works were carried out to regulate rivers and streams, aimed to balance of geomorphological structure, reduction the flooding and reclamation of lands that lacks drainage; activities that have been the main occupation of the Consortium until the sixties. Currently the scheme of the large hydraulic network under maintenance is delimited to the north by Fortore river and its tributaries and to the south by Ofanto river, and includes: n. 55 public streams and rivers under maintenance – length serviced 1,201.76 km; n. 177 reclamation channels – length serviced 966.32 km; n. 72 mechanical and river equipment. To understand how dense the hydraulic network is, just an examination of the sections subjected to hydraulic maintenance by the Consortium for each municipality falling in the reclamation territory indicated in the table below.

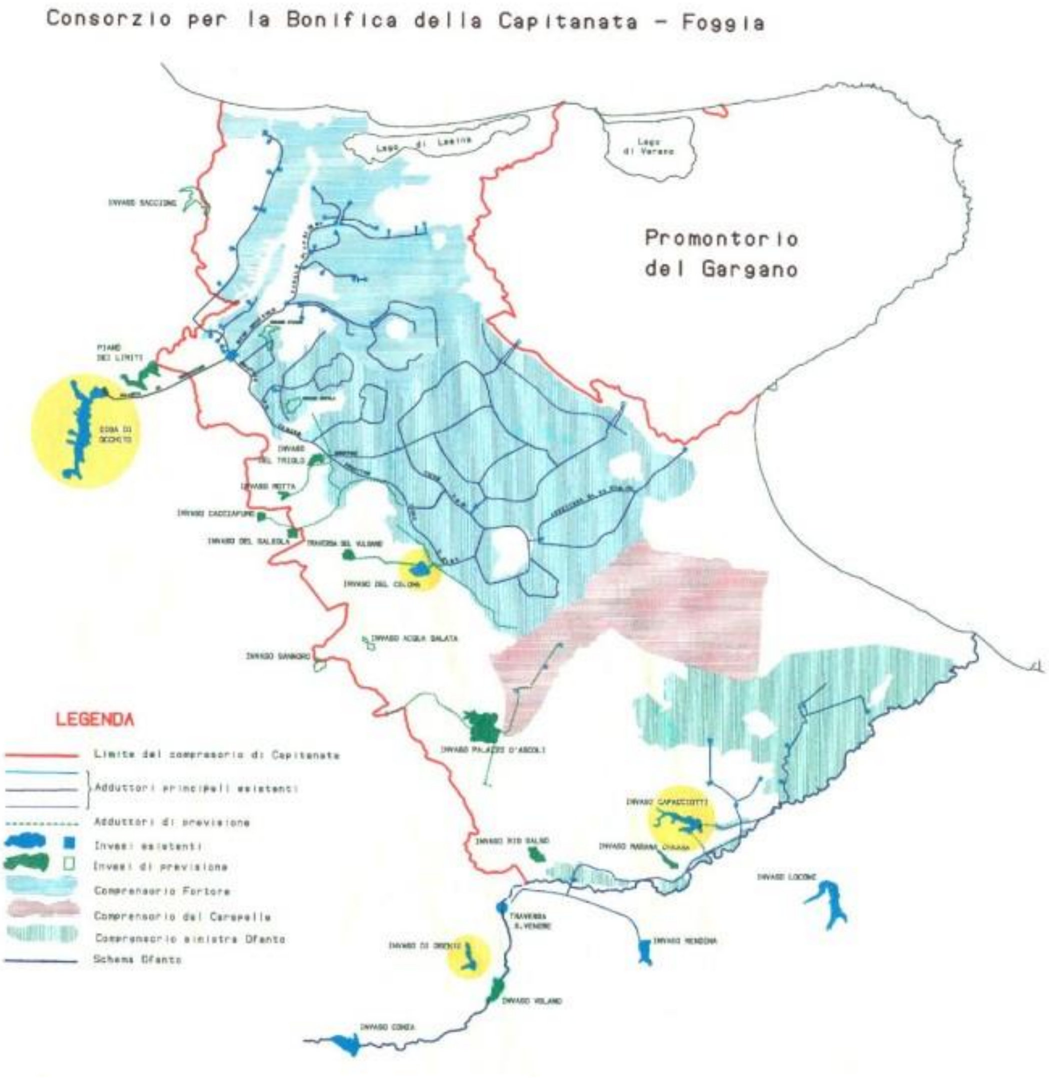

Figure 2. **hydraulic scheme of Capitanata district in north of Apulia region.**

The distribution of water to farms is carried out through a network of pipes and pressure pipes, with a diameter between 90 and 350 millimeters. The pipelines are completely underground, the visible part is represented by about 49,000 hydrant columns on which delivery groups or other irrigation equipment stand. Each delivery group is placed at the service of about 4 hectares and can also be assigned to several consortium users, in relation to the company surface and the division of the property. The water is supplied with a minimum pressure of 2.5 atmospheres, exploiting, on over 90% of the equipped surface, the natural piezometric gradient of the share of the storage tanks. The irrigation season, as a rule, begins on March 1 and ends on November 30 of each year, with a supply of 2,050 cubic meters per hectare and a water supply system for users of the “on demand” type. In the late 1990s, the Consortium started a modernization process of the irrigation network with the introduction of electronic card for delivery groups, to rationalize the use of the modest water resource and to improve its management, guaranteeing an equitable distribution of water and of consequent contributions.

The IR2MA case-study: chemical analysis of different types of waters

The aim of this activity was to analyze different types of waters (purified, refined, conventional and ground), collected from July to October 2020, in sites of Apulia region. The activity was carried at Institute of Science and food Production (ISPA-CNR) and the Consorzio di Bonifica della Capitanata. Major information about water samples were reported in table 3.

Table 3. **Water sample information.**

Water samples	Info	Coordinates Google maps
Purified	Water collected from the wastewater treatment plant of the Municipality of Trinitapoli (FG) managed by Acquedotto Pugliese (AQP).	41.366575 16.056642
Refined	Water collected from the refining system of the Municipality of Trinitapoli (FG) managed by AQP.	41.366575 16.056642
Conventional	Water distributed through the irrigation network (Consorzio di Bonifica) in different districts (6, 7 and 8) of the left Ofanto district, collected from the Pignatella plant.	41.2433776 15.9408785
Ground	Groundwater collected from local farm in Municipality of Trinitapoli (FG).	41.334571 15.966677

Water collecting and analysis

After collecting, the water samples were filtered using a 0.45 µm filter and pH and EC parameters were measured by using pH (WTW InoLab) and conductivity meter (WTW InoLab). Regarding the ammonium ion NH^{4+} content was measured by using the protocol of Kjeldahl modified by Eastin (1976). After mineralization, the samples were cooled, quantitatively transferred in volumetric flask, diluted, filtered using a 0.45 µm and analyzed with ion specific electrode (Thermo Scientific Orion Star A210 Series). The standards for NH_4 analysis ranged from 0 to 90.2 mg/L. The quantification of NH_4 in the samples was determined by interpolation with a calibration standard curve (R^2 = 0,9999).
For F, Cl, NO_2, NO_3, PO_4 and SO_4, determinations, ion exchange chromatography (Dionex DX120, Dionex Corporation, Sunnyvale, CA, USA) with a conductivity detector was used as reported by D'Imperio et al., (2020). Briefly, the samples were diluted with 3.5 mM (Na_2CO_3) and 1 mM ($NaHCO_3$) and filtered by using 0.45 µm followed by Dionex OnGuard IIP (ThermoScientific). The resulting solutions were analyzed by ion chromatography (IC-Dionex DX120, Dionex Corporation) with a conductivity detector by using an IonPac AG14 precolumn and an IonPac AS14 separation column (Dionex Corporation).

Figure 3. Ion exchange chromatography used for chemical analysis of treated wastewater.

For Al, B, Ba, Fe, Mn, Ca, K, Mg, Na, Mo, Sr, Co, Cu and Zn determination, the samples were diluted with ultrapure H_2O:HNO_3 (95:5 as v/v) (Milli-Q Millipore 18 M Ω/cm) and filtered using a 0.45 µm filter. Samples were analyzed with a Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES; 5100 VDV, Agilent Technologies, Santa Clara, CA, USA) to measure Ca, K, Mg, and Na in radial mode and Al, B, Ba, Fe, Mn, Mo, Sr, Co, Cu and Zn in axial mode as reported by D'Imperio et al., 2020.

Figure 4. **Inductively coupled plasma - optical emission spectrometer (ICP-OES) .**

In addition, accuracy and precision of chemical analysis (NO_3, Ca, K, Mg, Na, Al, B, Cr, Mn, Zn and Fe) were evaluated by using two different certified reference materials. The limits of detection (LOD) and the limit of quantification (LOQ) of the methods were calculated with standard deviation (sd) of the blank (n=10), LOD (sd x 10) and LOQ (sd x 10).

Table 4. Concentrations obtained for minerals and NO_3 determination in NIST-1573a and NRC/SPIN-1 (certified reference material).

	LOD	LOQ	Certified value and uncertainty	Experimental value and uncertainty
	µg/l		mg/kg of DW	
NIST-1573a				
Al	0.03289	0.0996	598±7.10	575±19.6
B	0.59262	1.7958	33.1±0.42	32±6.1
Ca	0.20223	0.6128	50,450±550	50.051±2049
Cr	0.20801	0.6302	1.988±0.034	2.075±0.2913
Fe	0.81112	2.4579	367±4.37	355±27
K	15.9942	46.467	26,760±480	25,611±1100
Mg	0.34969	1.0596	12.000	12,758±2949
Na	0.07113	0.2155	136±3.70	140±19
Mn	0.74266	2.2504	246±7.11	231±1.6
Zn	1.45585	4.4116	30.9±0.55	29.9±4.9
NRC-SPIN-1			mg/g of DM	
NO_3			22.5±0.43	22.9±0.50

Mg: Non-Certified Value. Insufficient information is available to assess the uncertainty associated with the value, and therefore no uncertainty is provided (NIST).

Results

Table 5. pH and electrical conductivity of different water samples collected in different site (Trinitapoli and Cerignola) and day of collecting.

Water	Site of collecting	Day of collecting	pH	EC (µS/cm)
Purified	Trinitapoli	13/07/2020	7.99	1223
Refined			8.85	1149
Conventional	Cerignola		8.31	532
Ground			8.16	1864
Purified	Trinitapoli	28/07/2020	9.02	1319
Refined			7.7	2300
Conventional	Cerignola		8.4	603
Ground			8.33	2203
Purified	Trinitapoli	10/08/2020	7.62	828
Refined			8.2	930
Conventional	Cerignola		8.17	530
Ground			7.95	1690
Purified	Trinitapoli	24/08/2020	7.4	1096
Refined			7.61	1691
Conventional	Cerignola		7.62	724
Ground			7.56	2351
Purified	Trinitapoli	09/09/2020	8.18	1173
Refined			7.8	937
Conventional	Cerignola		8.66	509
Ground			7.9	1690
Purified	Trinitapoli	21/09/2020	7.6	938
Refined			7.96	1020
Conventional	Cerignola		8.1	536
Ground			7.4	2207
Purified	Trinitapoli	05/10/2020	7.9	951
Refined			7.7	1037
Conventional	Cerignola		8.14	620
Ground			7.25	2220

Data are expressed as mean of three independent analysis.

Table 6. **Principal ions (NH_4, NO_3, SO_4 and Cl) content in different samples of water collected in different site (Trinitapoli and Cerignola) and day of collecting.**

Water	Site of colleting	Day of collecting	NH_4	NO_3	SO_4	Cl
				mg/l		
Purified	Trinitapoli	13/07/2020	1.170±0.169	44.32±3.99	114.13±5.93	8.17±0.09
Refined			0.986±0.019	29.34±1.10	89.11±0.68	7.33±0.10
Conventional	Cerignola		0.581±0.041	6.07±1.56	65.95±0.56	3.16±0.07
Ground			0.581±0.038	131±6.74	173±14.28	7.13±0.08
Purified	Trinitapoli	28/07/2020	2.204±0.061	19.56±2.85	96.01±5.17	10.49±0.51
Refined			15.12±0.322	7.45±1.43	32.50±1.23	6.37±0.04
Conventional	Cerignola		0.599±0.053	4.34±0.08	47.06±0.87	2.61±0.05
Ground			0.563±0.023	144±8.37	156±0.67	6.99±0.11
Purified	Trinitapoli	10/08/2020	0.576±0.030	28.40±1.36	55.82±1.19	3.47±0.03
Refined			0.503±0.011	26.02±2.22	76.19±3.43	5.72±0.05
Conventional	Cerignola		0.520±0.022	5.67±1.26	58.06±1.87	3.23±0.06
Ground			0.517±0.024	103±4.16	152±4.57	5.44±0.09
Purified	Trinitapoli	24/08/2020	0.627±0.014	69.21±4.43	75.48±4.09	4.16±0.11
Refined			0.687±0.017	29.22±3.06	56.68±2.11	3.55±0.07
Conventional	Cerignola		0.699±0.003	6.70±0.94	45.60±1.57	2.35±0.04
Ground			0.567±0.008	137±3.47	161±2.47	6.47±0.03
Purified	Trinitapoli	09/09/2020	0.963±0.030	101±2.57	98.28±3.97	7.42±0.07
Refined			0.670±0.028	78.54±1.71	83.83±3.72	5.26±0.09
Conventional	Cerignola		0.997±0.055	3.40±0.54	67.76±0.53	3.40±0.13
Ground			0.983±0.042	80.31±5.15	98.70±5.90	4.73±0.07
Purified	Trinitapoli	21/09/2020	0.668±0.006	57.74±1.30	88.42±3.86	5.10±0.02
Refined			0.989±0.024	58.97±3.30	92.11±4.63	5.91±0.12
Conventional	Cerignola		1.367±0.027	4.95±1.41	68.11±0.57	2.04±0.02
Ground			0.573±0.004	165±7.01	210±3.49	8.10±0.18
Purified	Trinitapoli	05/10/2020	0.753±0.019	64.34±0.31	101.50±2.92	6.00±0.17
Refined			1.054±0.007	62.42±9.02	95.37±0.97	7.84±0.17
Conventional	Cerignola		3.416±0.056	8.02±1.60	73.70±0.48	3.87±0.08
Ground			0.630±0.015	268±52.14	187±54.76	10.20±0.55

Data are expressed as mean and standard deviation of three independent analysis. Fluorine (F) and Nitrite (NO_2) not detected (< limit of quantification).

Table 7. **Principal mineral elements (Ca, Fe, K, Mg and Na) content in different samples of water collected in different site (Trinitapoli and Cerignola) and day of collecting.**

Water	Site of collecting	Day of collecting	Ca	Fe	K	Mg	Na
				mg/l			
Purified	Trinitapoli	13/07/2020	50.69±0.90	0.25±0.01	37.5±0.8	17.6±0.4	168.2±3.6
Refined			55.38±0.61	0.27±0.01	43.3±0.2	17.8±0.2	156±1.5
Conventional	Cerignola		33.93±1.72	0.22±0.01	10.2±0.6	11.8±0.8	52.8±2.7
Ground			105.07±8.72	0.20±0.01	23.7±1.6	39.1±3.5	191±14.3
Purified	Trinitapoli	28/07/2020	38.03±0.70	0.21±0.01	40.4±0.5	17.7±0.3	193±3.2
Refined			39.59±3.52	0.33±0.00	27.3±1.8	12.3±1.1	108±8.5
Conventional	Cerignola		20.25±1.79	0.22±0.01	7.7±0.5	7.7±0.7	36.1±2.1
Ground			121.85±0.98	0.20±0.02	22.7±0.3	34.7±0.3	182±1.5
Purified	Trinitapoli	10/08/2020	32.85±0.58	0.24±0.01	15.0±0.2	10.5±0.1	73.0±1.2
Refined			35.60±5.47	0.25±0.01	20.2±2.7	11.1±1.7	95.8±13.1
Conventional	Cerignola		29.18±6.31	0.22±0.02	10.0±1.4	10.3±2.2	46.1±8.6
Ground			105.62±10.05	0.21±0.02	20.0±1.4	30.1±2.9	152±12.0
Purified	Trinitapoli	24/08/2020	40.56±1.71	0.23±0.02	24.4±0.7	14.1±0.6	89.0±2.7
Refined			35.66±1.83	0.25±0.00	20.3±0.6	11.7±0.6	76.9±1.7
Conventional	Cerignola		21.30±1.80	0.22±0.02	8.1±0.5	7.9±0.5	34.7±2.2
Ground			119.57±6.52	0.21±0.01	20.0±0.6	29.6±1.6	153±6.7
Purified	Trinitapoli	09/09/2020	48.98±0.83	0.23±0.01	32.4±0.7	19.8±0.4	149±2.8
Refined			46.15±1.63	0.23±0.01	25.6±0.5	17.6±0.7	107±3.2
Conventional	Cerignola		25.71±2.60	0.23±0.01	12.8±0.6	12.2±1.1	54.6±4.1
Ground			96.26±0.91	0.24±0.00	19.2±0.1	32.9±0.3	128±1.2
Purified	Trinitapoli	21/09/2020	48.89±0.78	0.20±0.01	24.6±0.2	18.2±0.3	105±1.4
Refined			49.22±0.40	0.21±0.00	28.2±0.3	18.8±0.1	122±0.9
Conventional	Cerignola		31.95±0.32	0.21±0.01	13.7±0.3	13.2±0.2	57.9±0.7
Ground			184.67±2.10	0.22±0.01	27.0±0.3	41.6±0.3	206±1.8
Purified	Trinitapoli	05/10/2020	53.36±0.89	0.21±0.00	23.6±0.3	17.7±0.2	113±1.7
Refined			51.79±0.50	0.22±0.00	23.9±0.4	18.3±0.1	128±0.9
Conventional	Cerignola		32.75±0.51	0.21±0.01	12.8±0.3	13.3±0.2	59.2±0.7
Ground			193.16±2.63	0.19±0.00	26.1±0.3	42.8±0.5	215±2.7

Data are expressed as mean and standard deviation of three independent analysis.

Table 8. Principal mineral elements (Al, B, Ba, Mn, Sr, Tl, V and Zn) content in different samples of water collected in different site collecting (Trinitapoli and Cerignola) and day of collecting.

Water	Site of collecting	Day of collecting	Al	B	Ba	Mn	Sr	Tl	V	Zn
						µg/l				
Purified	Trinitapoli	13/07/2020	15.0±2.6	69.5±5.3	22.0±1.8	6.1±0.5	210±17.4	nd	3.0±0.9	15.7±1.3
Refined			13.7±2.5	66.0±6.8	21.4±1.3	16.6±0.9	213±12.7	nd	2.4±0.2	12.1±1.4
Conventional	Cerignola		10.1±5.5	67.3±2.2	22.0±1.4	3.8±0.2	196±12.1	nd	2.6±0.8	6.1±0.4
Ground			10.7±4.4	129±11.8	26.5±1.4	0.7±0.1	569±30.0	nd	6.0±0.6	nd
Purified	Trinitapoli	28/07/2020	19.7±4.1	77.1±2.7	9.6±0.4	5.5±0.3	177±7.2	17.8±2.0	2.8±0.4	9.3±5.1
Refined			32.9±11.5	37.2±4.5	13.0±1.4	27.2±2.7	158±16.2	nd	1.9±0.6	15.7±9.0
Conventional	Cerignola		13.4±2.6	44.3±4.8	15.1±1.1	9.1±0.7	129±9.0	14.0±10.3	2.7±0.6	1.0±0.3
Ground			14.2±3.4	86.9±9.2	31.2±3.6	3.2±0.3	490±62.0	nd	7.5±1.1	nd
Purified	Trinitapoli	10/08/2020	10.6±1.6	36.0±2.0	12.9±0.2	0.1±0.0	138±1.7	nd	2.8±0.2	49.8±0.7
Refined			nd	57.0±2.5	15.7±0.4	0.1±0.0	182±5.6	nd	2.2±0.2	15.8±0.5
Conventional	Cerignola		14.5±2.3	69.4±0.8	24.2±0.5	0.1±0.0	204±5.0	10.9±7.4	2.4±0.6	6.9±1.9
Ground			10.0±3.6	118±5.2	26.8±1.4	nd	512±24.5	nd	6.9±1.3	nd
Purified	Trinitapoli	24/08/2020	nd	53.2±3.5	12.0±0.2	0.3±0.0	188±3.6	nd	2.8±0.3	38.2±0.5
Refined			11.1±2.5	46.7±0.6	7.6±0.3	0.3±0.0	150±4.7	nd	3.0±0.4	21.6±1.2
Conventional	Cerignola		nd	48.5±1.7	23.3±0.4	0.2±0.1	155±1.8	15.5±3.2	2.4±0.3	62.2±0.8
Ground			11.0±1.2	106±3.0	29.0±0.8	0.7±0.1	515±13.1	nd	5.8±0.5	8.5±2.7
Purified	Trinitapoli	09/09/2020	nd	73.4±5.8	16.4±0.4	1.4±0.0	240±5.3	nd	2.7±0.6	46.7±1.6
Refined			nd	62.8±1.8	18.3±0.2	3.1±0.0	224±2.1	nd	4.0±1.1	27.7±0.6
Conventional	Cerignola		nd	73.3±2.7	46.6±0.5	3.3±0.1	208±2.6	16.4±5.2	2.3±0.2	nd
Ground			nd	117±1.7	23.2±0.5	1.5±0.1	601±10.9	nd	4.8±1.0	1.1±0.4
Purified	Trinitapoli	21/09/2020	25.7±2.0	70.3±5.8	23.3±1.1	2.1±0.1	242±11.6	nd	2.7±0.6	114±5.8
Refined			18.5±4.6	74.0±2.5	19.1±0.5	4.4±0.1	253±5.0	nd	2.4±1.1	50.3±1.5
Conventional	Cerignola		nd	78.5±4.8	39.1±1.3	0.1±0.0	224±8.3	27.5±8.4	2.7±0.4	2.2±0.9
Ground			nd	131±19.4	38.9±4.5	1.3±0.2	673±80.9	nd	7.9±1.2	2.4±1.9
Purified	Trinitapoli	05/10/2020	32.6±3.6	65.2±3.4	24.4±0.1	2.0±0.1	251±2.2	nd	2.8±0.3	27.8±0.3
Refined			21.4±5.8	62.4±7.9	21.7±1.3	3.6±0.2	246±14.8	nd	2.6±0.6	55.0±3.5
Conventional	Cerignola		25.2±3.9	80.9±4.3	33.3±1.1	6.0±0.2	225±7.5	nd	2.5±0.5	nd
Ground			12.2±3.5	140±2.8	43.7±0.3	5.2±0.0	740±7.7	nd	8.9±0.9	1.9±0.1

Data are expressed as mean and standard deviation of three independent analysis.. As, Cd, Co, Cu, Cr, Mo, Ni, Pb and Se not detected (< limit of quantification).

Conclusions

This activity was carried out with the aim to investigate the potential use of different types of water (purified, refined, conventional and ground) in agriculture. The conventional waters samples collected in the study area can largely be classified as of excellent or good quality and thus suitable for irrigation. In fact, this water show low EC (579 µS/cm, on average). Regarding the other types of water, thatwith the highest EC was the ground, followed by purified and refined. The chemical analysis reveals that the relative concentrations of the dominant cations constituents of waters are as follows: Na and Ca as reported in table 7. In addition, in all types of water the chemical analysis performed did not show high level of mineral elements potentially toxic for the plant (Boron) and for consumer (Al, Ni, Pb, Cr, As anc Cd).

Synopsis in English language

On the global scale, only 20% of agricultural land is currently irrigated. Nevertheless, it produces more than 40% of the world's food requirements. In the years to come, the demand for water in agriculture will continue to grow to meet the increase in food needs for an ever-growing world population. Moreover, the impact of climate variability and change on agricultural production will be enhanced, which will trigger additional water needs in the agricultural sector and a possible extension of irrigated land. However, fresh water resources are limited (especially in irrigated, usually arid and semiarid, regions), where water requirements of other sectors (domestic, industrial, environment) are expected to increase as well. Therefore, the challenge of irrigated agriculture is to produce more food of better quality with less water and with an optimized use of other resources, like nutrients and energy. The aim of this activity was to analyzed different types of waters (purified, refined, conventional and ground), collected from July to October 2020, in sites of Apulia region. All water samples analyzed showed a moderate quality in terms of chemical composition, pH, and electrical conductivity, these waters source can be used in agriculture with aim to satisfy the triple-R model (reduce, reuse, and recycle).

Sinossi in lingua italiana

L'agricoltura è l'attività produttiva maggiormente coinvolta nel consumo di risorse idriche. A livello mondiale utilizza circa il 70% delle risorse disponibili, percentuale che può arrivare all'85-95% nei paesi non industrializzati. Questa quantità, non sufficienti a soddisfare tutto il fabbisogni delle colture, tenderanno sempre più a contrarsi a causa della crescente competizioni con differenti settori, come civile e industriale, oltre che dei cambiamenti climatici. Occorre quindi valutare la possibilità di utilizzare fonti idriche non convenzionali. Tra le risorse idriche non convenzionali particolare importanza per il settore agricolo rivestono le acque salmastre e le acque reflue depurate. Nell'ambito di questa attività sperimentale sono caratterizzate, da un punto di vista chimico, differenti tipologie d'acqua (falda, convenzionale, depurata e affinata) con l'obiettivo di valutare la qualità chimica e il loro possibile riutilizzo in agricoltura. Tutti i campioni presi in considerazione mostravano differente composizione; tuttavia, nessuna delle quattro presentava elevati livelli di conducibilità elettrica (mai superiore a 2300 µS/cm). Inoltre, in tutti i campioni si sono riscontrati livelli molto bassi, in alcuni casi inferiori al LOD dello strumento, dei principali elementi minerali potenzialmente dannosi per l'uomo (Al, Ni, Pb, Cr, As anc Cd).

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