<u>RESPONSE TO REFEREE 2</u> :

I would like to thank you for your comments. I feel that the modifications made to the paper have truly contributed to its improvement. In order to take account of your comments, the following changes (which appear in red in the manuscript) have been made to the paper:

General comments

Though presenting an interesting topic, I find this article rather disappointing. Whereas the presented case could be interesting to enter into a more general debate on aquifer overexploitation, the motivation for it to be studied (stated to be the most heavily overexploited in Spain without linking it to the production model) is not well developed and generally lacks analysis in its presentation. For it to be considered of scientific added value the article would need a more thorough analysis and considerable editing.

As the referee suggests, a rigorous revision of the article has been made, taking account of all the comments made by the referees, with the aim that this paper is of a good scientific level and, above all, is of use to the scientific community in other places with similar issues.

Specific comments

Detail in presentation should be balanced: the author seems to have studied the biophysical aspects of the aquifer well over time and presents an interesting set of hydrogeological and chemical data. However data on management of the water resources are poor and not analyzed. Although announced as a prime example of poor management, the management of the aquifer is not documented and doesn't allow understanding the causes or impacts of overexploitation. It is therefore impossible to link the bad status of the aquifer to poor management practices in a meaningful way and even less to project actions that could lead to sustainable management.

Although section 6 makes reference to the cause of the poor management of the aquifer, the reasons for this overexploitation, which are legal and administrative, have now been specified and enlarged upon in section 4.1 of the paper .:

> All of the water abstractions are pumped and are exclusively destined for irrigation of the nearly 15,000 ha of irrigated fruit orchards, since the poor chemical quality of the water means that it is not possible to use it for human consumption.
>
> The reason that the aquifer has reached such a severe degree of overexploitation and degradation results from the lack, over a period of many years, of adequate legislation to regulate abstractions. In effect, until August 8, 1985, when the new Law of Public Waters was passed, groundwater was governed by the old Water Law (which had been in effect for a hundred years), which considered waters to be in the private domain; anybody could construct a well, with the sole condition that the new well should lie more than 100 m from the nearest neighboring well. Based on the New Water Law, this aquifer was declared provisionally overexploited in 1987, but another ten years passed until this declaration was made definitive. All these legal conditions contributed to the

fact that the aquifer became the most heavily overexploited in Spain and perhaps in Europe.

For example: in section 4.2 on 'Excision' (?) of the aquifer it is not clear why the author wants to enter in the flow details of the different created sub-aquifers. A link of location of boreholes (refer to maps) and pumping rates in these areas to the production model (what is the water used for, what is the sustainability of the production model?) would be desirable.

The term "excision" has been replaced by "division". It was considered appropriate to go into detail about the subdivisions of the aquifer to demonstrate that there are already large differences between them, characteristics that serve to detect and confirm that there is no longer a single aquifer but several. All the boreholes cites are located on the attached figures. In terms of the list of boreholes the referee refers to, in my opinion, it is not necessary to attach a map showing what the water is used for, since all of them are used for crop irrigation.

Likewise the analysis of table I (now table II) *in section 4.3 is rather poor and lacks a clear argument. Conductivity, salinity and temperature are interlinked and increase with depth. There is however no link to pumping rates and the link between cause and impact of the apparently logical depth profile is not (clearly) presented.*

In this case, the author humbly considers that between Table II and figure 13 (the two illustrations need to be observed) the relationships that exist between depth, conductivity and temperature are clearly shown, both for free and confined aquifers. The pumping rates are also given and the relationship between the cause and the impact of the depth profile.:

BORING WELL	DATE	PERM. ROCK (m)	CONDUCT. (µS/cm)	Cl^- (mg/L)	Na^+ (mg/L)	TEMP. (ºC)	TYPE OF AQUIFER	
							Free	**Conf.**
CA0709002	6-10-08	0-250	2,250	444	275	-	x	
Fonseca I	7-01-08	306-329	1,415	335	211	-		x
Fonseca II	5-06-08	306-438	2,610	680	304	22.9		x
S.L. 3	8-12-06	500-520	3,000	-	-	-		x
S.L. 1	6-08-08	265-344	3,920	-	-	28.6		x
Jesús II	1-03-08	0-304	2,140	600	600	26.6	x	
Judío I	9-04-09	495-508	2,470	-	-	28		x
Judío II	3-12-09	495-691	8,110	2,344	1,456	35.5		x

Table II. Thermal and chemical characteristics of certain boreholes situated in the subaquifers of Ascoy and Sierra Larga, in recent times.

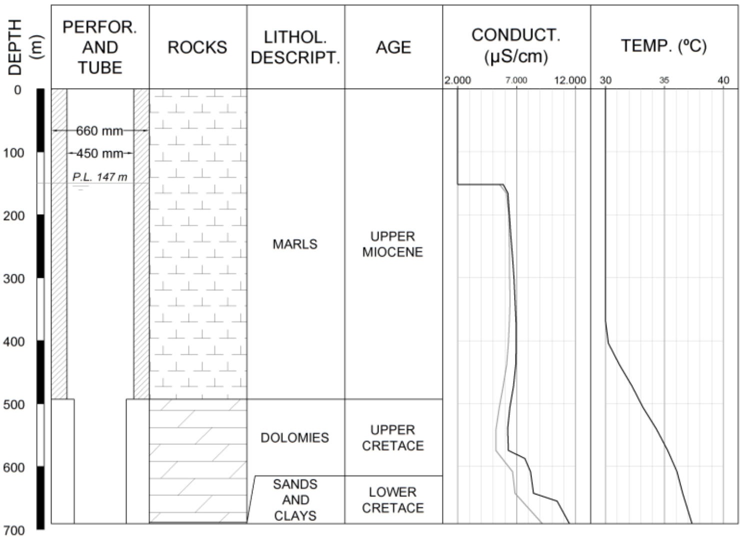

Fig. 13. Log of temperature and conductivity in Judío II boring.

On the other hand the list of indirect impacts in section 3.2.2 is not documented at all and poorly edited. The same occurs in section 5, where a list of internal actions is given without any further analysis.

Both in section 3.2.2 and section 5 the original manuscript included only the titles of the areas were listed, without further development, in order to avoid making the paper too long. However, given the misgiving of Referee 2, these two sections have now been adequately documented.:

"3.1 Positive effects of intensive exploitation

- *Progressive economic development*. The district of Mazarrón (4 in Fig. 1) suffered economic depression between 1900 and 1950. In 1989, thanks to intensive exploitation of its aquifers (the Tagus-Segura water transfer scheme had not yet arrived), it achieved an agricultural production worth 102 M €, with a reported value of 67 M € (Aragón *et al*. 1992).

The real problem of overexploitation arises from the uncertainty of maintaining the socio-economic development in the long-term, especially if there is no prospect of external water resources being supplied to a particular area.

- *Infrastructure benefits* (water pipes, roads, electricity supplies, etc.).
- *Re-infiltration of excess irrigation water with recharge of the aquifer* when the abstracted water is applied to the same permeable terrain. In Vegas del Segura (5 in Fig. 1), the irrigation excess amounts to 25–35% of the water applied if the irrigation system is gravity-fed.
- *Recovery of saline soils* (as there is more water, there is greater solution).
- *Increase in vegetation cover*, which improves rainfall infiltration.
- *Change from a non-irrigated to an irrigated regime*, with all the related economic benefits.

3.2 Negative impacts of overexploitation

This section will differentiate between the direct and indirect impacts. Direct impacts are considered to be those whose effects are relatively rapid and which produce as a result certain serious consequences, fundamentally economic; in contrast, indirect impacts are considered to be those whose effects are more spread over time and more diffuse, and whose consequences are not only economic but also environmental, social, and political.

3.2.1 Direct

- *Continuous fall in piezometric levels*. This can be up to 10 m/y, as in the aquifer of Don Gonzalo-La Umbría (6 in Fig. 2); the sulfate content increased (Fig. 3) due to the action of the gypsum present at the aquifer limit (Andreu *et al*. 2004).

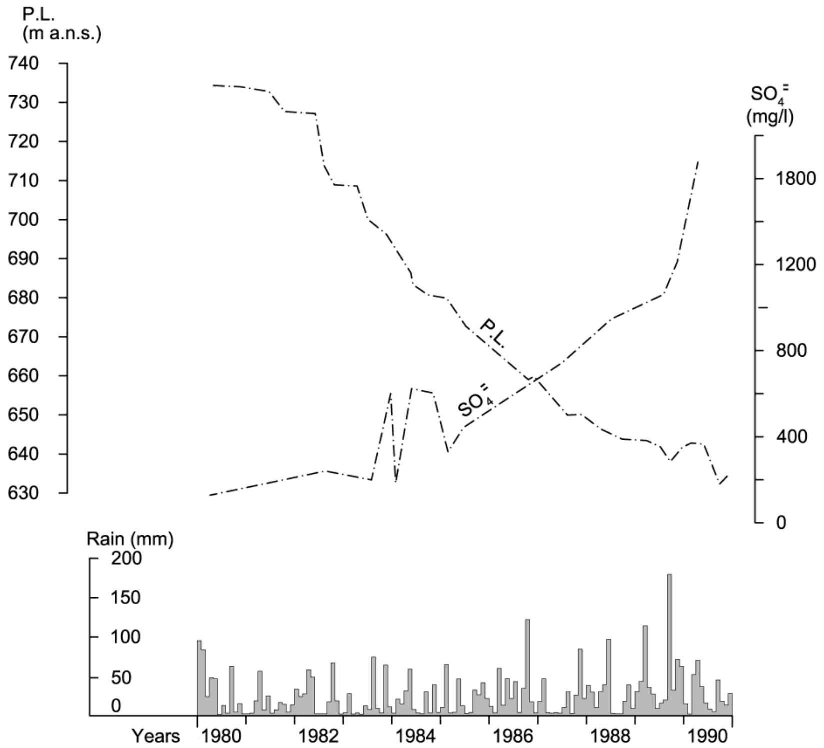

Fig. 3. Piezometrical Level and Sulphates Evolution in the Don Gonzalo-La Umbría Overexploited Aquifer.

- *Increase in the economic cost of pumping*. This has occurred in the Triassic aquifer Las Victorias ("7" in Fig. 2) and the aquifer of the Cabezón del Oro (province of Alicante), where the piezometric level now lies below 500 m (Fig. 4).

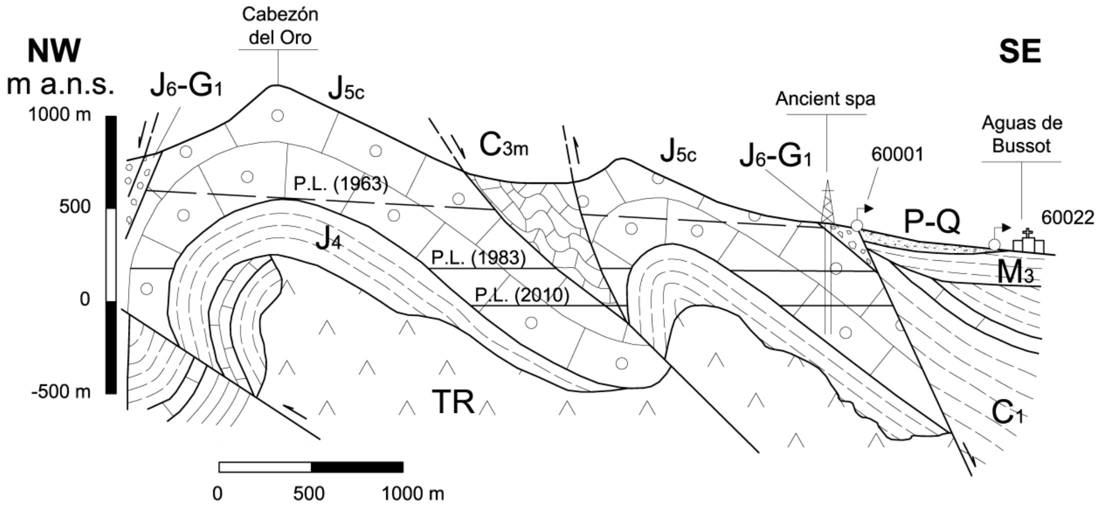

Fig. 4. Hydrogeological Section of the Cabezón del Oro Overexploited Aquifer. TR: Clay and gypsum. Triassic. J_4: Marly limestone. Middle Jurassic. J_{5c}: Oölitic limestone. Upper Jurassic. J_6-G_1: Sandstone. Upper Jurassic-Lower Cretace. C1: Marls. Lower Cretace. C_{3m}: Marly limestone. Upper Cretace. M_3: Marls. Upper Miocene. P-Q: Conglomerates. Pliocene-Quaternary.

- *Abandonment of wells*. In 1971 in the Ascoy-Sopalmo aquifer (the focus of this article), there were 146 production wells; by 1987, only 60 were still active, and now (2010) there are fewer than 20.
- *Diminishing groundwater reserves*. Between 1975 and 1981, 210 Mm^3 were taken from the reserves held in the Alto Guadalentín aquifer (Puerto Lumbreras and Lorca).
- *Induced compaction of the land surface* and appearance or accentuation of endorheic or semi-endorheic areas. Subsidence is occurring in the semi-arid zone -(Guadalentín), as evidenced by the collapse caused by "piping".
- *Compartmentalization of aquifers*. In 1973, the Quibas aquifer (8 in Fig. 2; Murcia and Alicante provinces) extended over 317 km^2 and was drained by the Chícamo spring (Fig. 5).

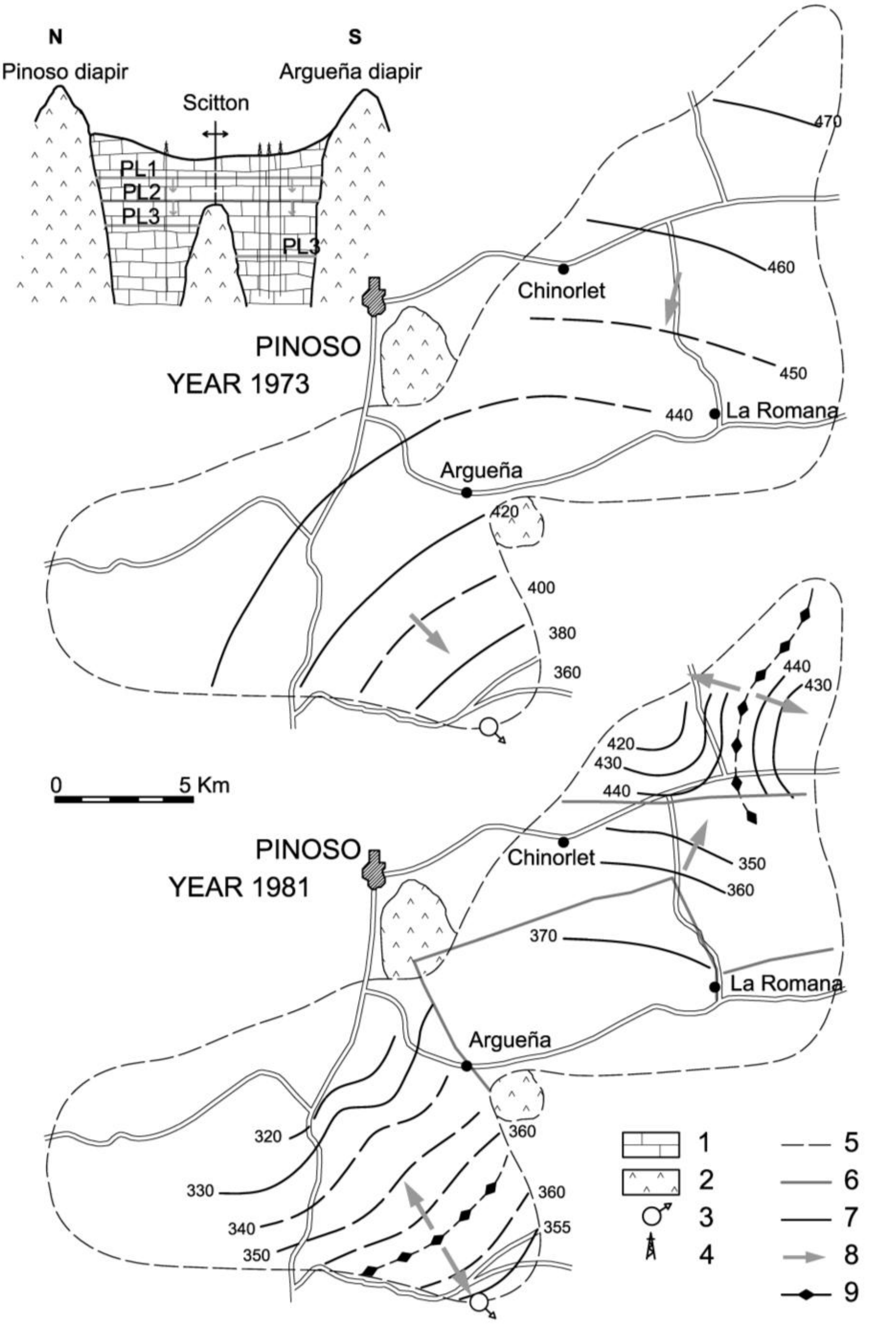

Fig. 5. Water-level contour maps and hydrogeological scheme of the Quibas aquifer. 1: Limestone. Eocene. 2: Clay and gypsum .Triassic. 3: Chícamo spring. 4: Boring. 5: Limit of aquifer. 6: Limit of subaquifer. 7: Water-level contour (m a.s.l.). 8: Groundwater flow. 9: Groundwater dividing.

In 1980, it split into seven distinct subaquifers, as the falling piezometric level sank below the top of the Triassic diapiric sub-outcrops (Rodríguez-Estrella 1979). The same thing has happened in the Ascoy-Sopalmo aquifer.

- *Change in the physical and chemical characteristics of the groundwater*. Of these, the following are considered:

A) NON-THERMAL AQUIFERS

A-1. CHEMICAL CHANGES

- *From a bicarbonate to a sulfate or chloride facies*: through lixiviation of continental evaporites, for example, Don Gonzalo-La Umbría aquifer; through marine intrusion, for example, Cabo Roig (Alicante province).
- *From a sulfate to a bicarbonate facies*: through the influence of endogenic CO_2, for example, Alto Guadalentín (Fig. 6). Highly mineralized waters, situated at depths, are propelled upwards by the action of the CO_2 and by the decrease in the hydrostatic pressure, and also as a consequence of the decrease in the piezometric levels (Rodríguez-Estrella *et al*. 1987).

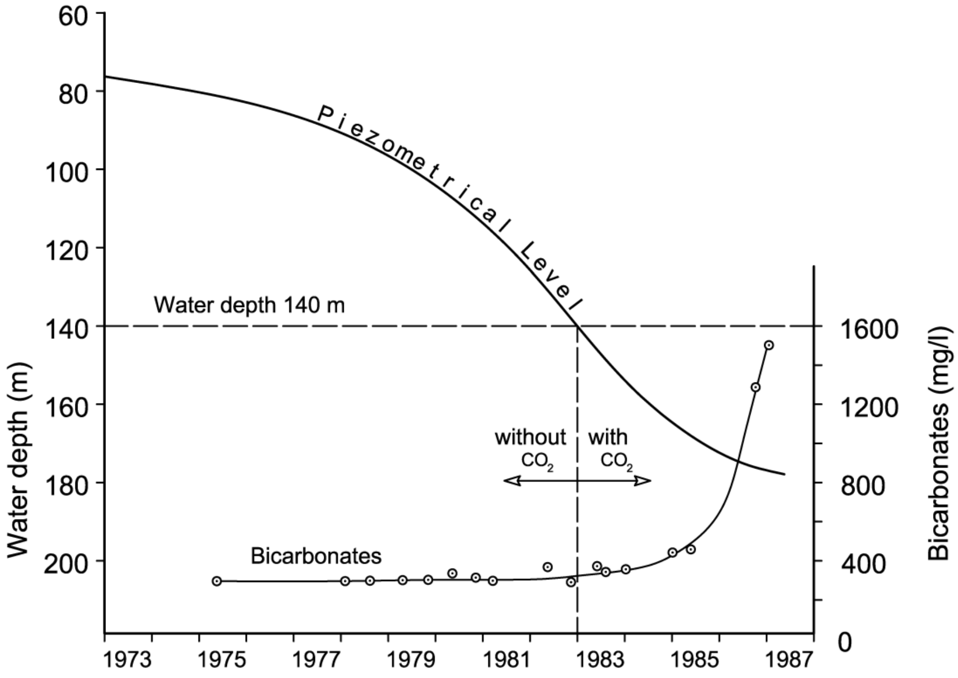

Fig. 6. Piezometrical Level and Bicarbonates Evolution in the Alto Guadalentín Overexploited Aquifer.

A-2. PHYSICAL CHANGES

- *Increase in temperature*, for example, Alto Guadalentín and Ascoy Sopalmo; in the latter, the confined nature of the aquifer combined with its depth means that below a certain depth the groundwater temperature increases, as do the degrees of dissolution and salinity.
- *Increase in turbidity and color, and change in smell and taste,* for example, Ventós (Alicante province).
- *Increase in conductivity.*

B) GEOTHERMAL AQUIFERS

B-1. CHEMICAL CHANGES

- *Confined metamorphic aquifer with CO_2.* Increases in sulfate, dry solids, and chlorides, and decreases in calcium and bicarbonates, for example, the Saladillo borehole (9 in Fig. 2), which consists of a thermal and emergent borehole (confined aquifer), of 535 m depth, which, with the passage of time, has gradually decreased in volume, remaining unaltered by pumping. This is because the emergent volume exceeds the renewable resources, since the main permeable rock does not come to the surface. In addition, between 1985 and 2003, the sulfates rose from 3093 to

3579 mg/l, the dissolved solids from 9340 to 9794 mg/l, and the chlorides from 1191 to 1269 mg/l; calcium fell from 713 to 344 mg/l and bicarbonates from 2068 to 1989 mg/l. This situation is "natural" overexploitation, not induced by people through pumping, but caused initially by people by the drilling of the borehole, leading to a slow emptying process of a semi-fossil aquifer.

- *Free carbonate aquifer without CO_2*. Increase in all parameters. For example, Baños de Alhama (10 in Fig. 2).

B-2. PHYSICAL CHANGES

- *Reduction in temperature*, for example, Saladillo borehole; between 1985 and 2003 the temperature decreased from 51 ºC to 49 ºC.
- *Increase in conductivity*, for example, the Baños de Alhama (10 in Fig. 2) borehole.
- *Modification induced in the river flow regime*. The Albacete hydrogeological unit is in a hydraulic connection with the Júcar River. As a result of overexploitation, the flow of the Júcar River fell from more than 11 m^3/s in 1975 to 5.2 m^3/s in 1989.
- *Impact or desiccation of wetlands and springs*. Numerous wetlands and an even greater number of springs have dried out as a consequence of overexploitation, both in the Albacete and Murcia provinces (López Bermúdez *et al*. 1988; Navarro *et al*. 1988).
- *Changes in groundwater extraction systems*. Examples include changes from ordinary wells (sometimes powered using the natural energy of windmills, as in the Campo de Cartagena) to boreholes; from springs to galleries; from boreholes to galleries, such as the well-known 2500 m Galería de los Suizos (Fig. 7) in the Crevillente aquifer (Alicante); and also from boreholes within a gallery (Solís *et al*. 1983).

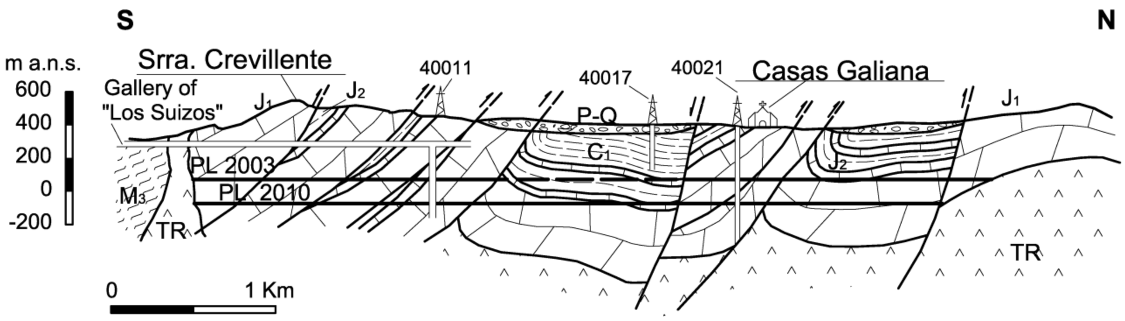

Fig. 7. Hydrogeological Section in the Sierra de Crevillente Overexploited Aquifer. TR: Clay and gypsum. Triassic. J_1: Dolomites. Lower Jurassic. J_2: Marls and limestones. Upper Jurassic. C_1: Marls. Lower Cretace. M_3: Marls. Upper Miocene. P-Q.: Conglomerates. Pliocene-Quaternary.

3.2.2 Indirect

- *Land subsidence and collapse*, giving rise to geotechnical impacts in dwellings (Cooper 1998). During the 1994 drought, numerous emergency wells were brought into operation in the Quaternary Vega Media aquifer in Murcia province. The consequence was a drop in piezometric levels of up to 7 m and land subsidence and ground collapse of up to 0.7 m, causing cracks to appear in buildings in the city of Murcia.
- *Pipeline breakages and deterioration of road surfaces.* Such damage is common in the Guadalentín Valley.
- *Salinization of soils*, for example, the Guadalentín Valley.

- *Progressive desertification*. In the Guadalentín Valley, erosion gullies and "soil piping" are common, indicating an advanced stage of desertification (Martínez-Mena *et al*. 2001).
- *Modification or suppression of flora*. Change from phreatophytes to xerophytes.
- *Disappearance of a particular fauna and substitution by another*. Substitution of the lacustrine avifauna by steppe birds in the Guadalentín Valley (Rodríguez-Estrella and López Bermúdez 1992).
- *Abandonment of agriculture and emigration from towns and villages*, for example, Yecla (Murcia).
- *Decline or disappearance of sheep herds*, for example, Yecla (Murcia).
- *Decline of hunting and angling*. With the disappearance of surface water, hunting and fishing also disappear.
- *Cessation of wetlands resources exploitation*, linked to the salt, clay, and mineral water spa industries.
- *Change in landscape and lack of correlation with ancient place names*, for example, the villages of Fuente Álamo or Fuente del Pino (Jumilla) no longer have *fuentes* (springs).
- *Alteration of the physical properties of the aquifer water* (water mixing, acceleration of karstification, reduced storage coefficient, etc.).
- *Creation of depression cones* that mobilize pollutants from remote areas.
- *Modification of the local climate* (the moderate climate of wetland areas).
- *Rise in the sea level of the Mediterranean:* the majority of the groundwater abstracted from coastal aquifers is destined for agriculture within the boundaries of either the same aquifer or adjacent ones. If the aquifer is overexploited, this necessarily means that part of the water extracted (precisely the part corresponding to the overexploitation) is never returned to these aquifers (hence the continual decline in reserves). This water must go somewhere and, given the coastal location, it is logical to suppose that it goes to the nearby Mediterranean Sea. Significant evaporation from the irrigated land (due to high temperatures) and plant transpiration means that the evaporated water vapor condenses and falls as rain over the sea. In other words, a large part of the "below ground" water is extracted and "donated" to the adjacent sea. In 1985, this author calculated the rise in sea level that could be produced by this means in the Mediterranean (which covers 1,000,000 km^2). The conclusion was that in the eastern third of the Mediterranean, the rise in sea level could amount to 0.5 mm/y, based on the fact that, in a year, overexploitation of the aquifers within 50 km of the Levante coast of Spain was 500 Mm^3. This issue is addressed here only as a working hypothesis, since, in order to confirm this effect, more detailed research would have to be carried out in relation to climate change as the main cause of sea level rise.
- *Legal problems* from impacts on water abstraction points.
- *Negative social, economic, and political impacts*. The Murcia Region has seen serious altercations, including a number of deaths related to water resource issues.
- *Disappearance or deterioration of landscape features or hydrological and hydrogeological features that formed part of the national heritage* (Rodríguez-Estrella 1999), including: old springs with associated archeological remains that have disappeared; unique ecosystems dependent on springs that have disappeared; ancient lakes with paleontological remains that have dried out; wetlands that have disappeared permanently and which have become dry saline areas; wetlands that have disappeared permanently, being transformed into agricultural areas; wetlands that have disappeared temporarily inside Natural Parks; unusual boreholes of scientific,

touristic, or educational interest (artesian and thermal wells) whose flow and temperature have decreased."

5 Proposal of internal actions to alleviate the water deficit of the Segura basin

There is no doubt that the high deficit in the Segura Basin can only be resolved by using water from the Ebro River (i.e., the water flowing into the sea, which amounts to more than 10,000 Mm^3/y). However, until the transfer becomes reality, a series of internal actions are suggested (Rodríguez-Estrella 2004; Molina *et al*. 2009), including:

- *Combined use of groundwater and surface waters*. This has been done since 1991 by the Segura Hydrographic Confederation in the karstic aquifer of the Calasparra Syncline (11 in Fig. 2) by taking advantage of its hydraulic connection with the Segura River (Rodríguez-Estrella 1979; Rodríguez-Estrella *et al*. 2005). Volumes of up to 50 Mm^3/y were extracted in six to eight months (20 boreholes with flows of 100 to 150 l/s, which were designated by the author), and the piezometric level was recovered once pumping stopped (in winter), due to river flows that feed the aquifer (Fig. 14).

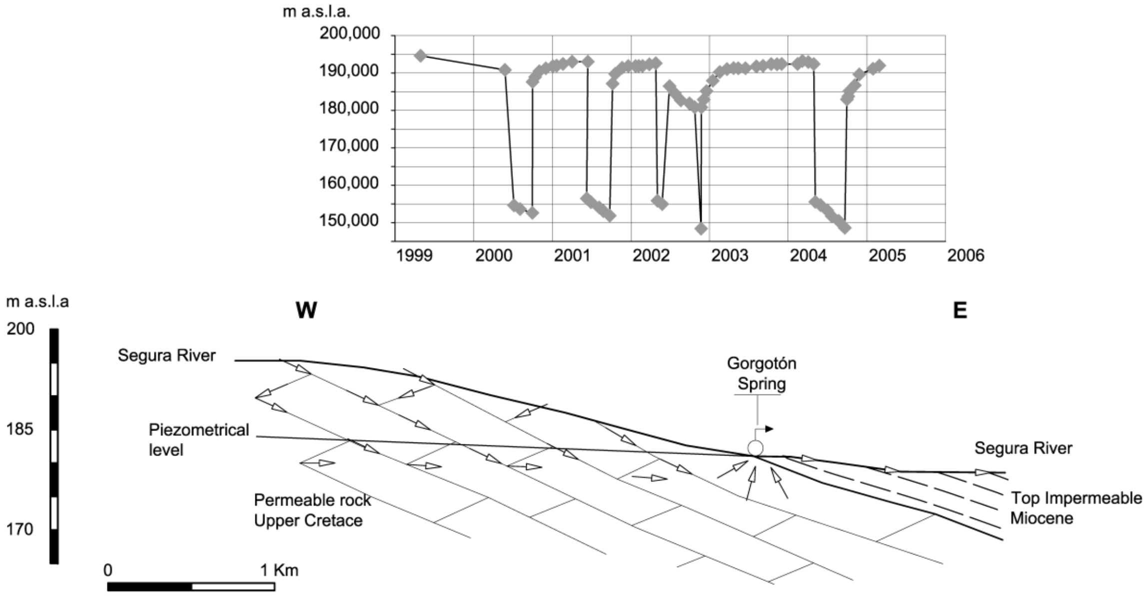

Figure 14. Piezometric Evolution and Hydrogeological Scheme of a Borehole of the Sinclinal de Calasparra Aquifer, which has Suffered Intensive Controlled Exploitation.

- *Combined use of groundwater and surface reservoir waters*. This was suggested (to the Lorca Irrigation Community by the author, in 1995) due to the hydraulic connection that exists between the Valdeinfierno reservoir (which at that time was dry) and its underlying aquifer of Pericay-Luchena (13 in Fig. 2), with 1000 Mm^3 of reserves (Rodríguez-Estrella 2004).
- *Inter-basin water transfer*. When this idea was proposed by the author, it caused discomfort and irritation among inhabitants who felt forced to give water to other regions (with water deficits) within the same basin. This lack of inter-basin solidarity is

difficult to understand, especially in circumstances when the Segura Basin region needs to ask the Ebro Basin for a volume of 1000 Mm3/y and the Catalans and Aragonese are asked to be understanding and generous about inter-basin water transfers.

However, as highlighted in the Introduction, the west of the basin (which has scant demand, since it has a cold climate and lacks a gently undulating landscape and abundant soil where commercially viable agriculture could be developed) presents abundant resources that could be transferred in part to the east of the basin in times of drought (particularly in the light of the multiple urban and agricultural demands). It is therefore proposed that the first thing that needs to be done is to develop global water education.

- *Optimizing natural resources by means of spring regulation*. The regulation of the Mula Fountain is highlighted, which was implemented by sinking the Praillo borehole (designated by the author in 1980 for the Mula Irrigation Community), which had a continuous flow of 125 l/s. The spring has since dried out, but the piezometric level of the borehole remains stable. This spring was the natural discharge point of the Bullas aquifer (15 of Fig. 2), which, due to its karstic nature, presented a very irregular pattern so that in summer (when water demand is highest) the flow was reduced and in winter the opposite occurred.
- *Temporary extraction of part of the reserves from deep unexploited aquifers*. This measure was recommended by the author as a temporary solution until the Ebro River transfer flows arrive, in the Jumilla-Yecla Altiplano, bearing in mind the high overexploitation suffered by the higher aquifers of that area and the great volume of reserves (1750 hm^3) of the lower aquifers. Pumping of test boreholes reached rates of up to 140 l/s, with boreholes extending to depths of between 500 m and 900 m, but with piezometric levels inferior to 200 m (Rodríguez-Estrella 2001), which proved this idea to be a valid alternative.
- *Spatial redistribution of abstractions*. The greatest interest is focused on the overexploited aquifers, since redistribution would obviate the large drawdown cones that originate around clusters of boreholes (these increase the depth in the boreholes and therefore the cost) and that also draw pollutants towards them. This was one of the recommendations of the Jumilla-Villena aquifer Management Plan (16 in Fig. 2).
- *Use of water from groundwater resurgences.* By constructing dams in watercourses that flow through permeable zones, water could be collected at times of resurgence and at other times it can recharge in the same place. Such constructions were proposed to the Hydrographic Confederation of the Segura River for the Quípar sub-catchment of the Segura River).
- *Constitution of the Aquifer Users Communities and design of Management Plans for the overexploited aquifers*. Through these developments, all interests would focus on the aquifer, and it would be managed fairly; at present, only one Users Community in the Ascoy-Sopalmo Aquifer has been created, though recently, the Jumilla-Villena, Sierra de Crevillente, Alto Guadalentín, Bajo Guadalentín, and Cresta del Gallo aquifers have also been declared to be overexploited, and their corresponding Management Plans are being written.
- *Adapting the chemical water quality for its final use*. Excellent water quality must be maintained to cover urban demand; water of good-to-medium quality should be used for irrigation purposes and water of poor quality for industry. To achieve this aim, potable water should come from a different source than water used for industry (currently they have the same source).

- *Installing more efficient irrigation systems*. Although this is already being implemented in the whole area, there are still gravity irrigation systems in the Segura meadows, which should be substituted by spray or sprinkler systems.
- *Agricultural transformation*. This measure consists of replacing traditional crops by others that demand less water, especially in the Segura meadows.
- *Use of purified wastewater for irrigation*. According to the Spanish National Hydrological Plan, 100 Mm^3/y are used in the Segura Basin for irrigation, which come from wastewater-treatment plants. In the Segura basin, 95% of wastewater is treated. However, lack of maintenance impedes the success of this strategy.
- *Desalination of saline groundwater and seawater through coastal aquifers*. In the area of Cartagena there are about 80 private desalination plants, which treat saline water from the Pliocene and Upper Miocene aquifers (more than 4 gr/l of total salinity). In total, the production of water is 5 Mm^3/y. The waste brine is collected through a collection system of brine-conduits, located no more than 10 km from the coast (65 km of net length), which discharge into the Albujón and Miranda watercourses and flow into the Mar Menor.

The Irrigation Community of Murcia Sur, in the countryside around Cartagena, has six desalination plants. Because they are 20 km from the coast, construction of a brine-conduit would be very expensive, and so the waste brine is eliminated by means of an injection borehole 748 m deep. The saline waters that come from the Tertiary aquifers of the Campo de Cartagena have a salinity between 4000 and 6000 mg/l, and after desalination the waste brine has a concentration of 15000 mg/l; this is injected into an unexploited aquifer formed by Triassic dolomites, which presents a higher salinity, specifically, 17000 mg/l. Water production of 2.3 Mm^3/y is obtained. All these desalination plants treat saline waters. Next we will deal with seawater desalination plants.

The first desalination plant built in the Region of Murcia was that of the Irrigation Community of Mazarrón, in 1997. Using 13 boreholes (situated 2 km from the sea), they tap seawater via the small Cabezo de los Pájaros aquifer in the south of the area. The water to be treated has a salinity of 30000 mg/l, so 30 Mm^3/y is introduced, yielding 16 Mm^3/y of treated water at a cost of 0.50 €/m^3. This treated water is mixed with other water from saline wells (which have a salinity of 4500 mg/l) to obtain a water quality of 2500 mg/l at a cost of 0.40 €/m^3. The investment was 24 M € (in 1997).

Later the desalination plant of San Pedro del Pinatar (Mar Menor) was built by the Taibilla Water Community; it went into operation in 2006. The plant is located in San Pedro del Pinatar (province of Murcia), but collectors are situated in Pilar de la Horadada (province of Alicante). Due to the fact that a fault exists along the coast (Falla de la Costa) that prevents hydraulic connection between the coastal aquifers and the sea, vertical wells built on land (even on the beach) gave negative results. It was necessary to resort to horizontal directional drilling (HDD) to tap the marine aquifer (5 m of Tyrrhenian oolitic calcarenites) linked to an old dune rock ledge with subvertical fractures. Apart from the already-mentioned hydrogeological problem, there was an environmental one: the waste brine could not be discharged directly into the sea because there is a meadow of *Poseidonia*, a protected species. It was necessary to place an outfall on the seabed, 5 km long, at a topographical elevation of –30 m. The collecting is done using 20 fanned HDDs of up to 500 m in length and pipes with a diameter of 355 mm, 50 m from the coast. The pumped flows oscillate between 100 and 140 l/s per Neodren and the volume of water introduced is 34.3 Mm^3/y; the water yield is 23.7 Mm^3/y (65000 m^3/d), which is 45% of the treated water. There are nine frames of 7220 m^3/d (Rodríguez-Estrella and Pulido 2009).

Other recently built desalination plants with direct connection to the sea include those of Aguilas and Valdelentisco (bordering the municipalities of Cartagena and Mazarrón).

Desalination should be considered as a complementary measure to catchment transfer, since desalination is so costly (0.6 €/m^3, on average), and this means that its use for agriculture, the biggest water demand, is not economically feasible. The main idea of the previous Spanish government for resolving water resource shortages was based on a policy of desalination, yet this proved unsuccessful since the constructed plants provide only a small proportion of the public water supply and a large number of the previously planned plants will not now be built.

- *Computer modeling of irrigation surfaces, conduits, and water applications*. Since the water conduction systems are in perfect condition and are being used effectively (in response to vegetative and climatic season), a great quantity of water is conserved and, as a result, fewer abstractions are made. The Irrigation Communities of Mula and Cartagena are already computerized. Those of Guadalentín Valley and Altiplano of Jumilla-Yecla will follow soon.

In the conclusions (section 7, points 5 and 6) the author highlights the recent government change towards one being more in favor of inter-basin transfers as a possible solution for the overexploitation of the aquifer presented. By presenting surface water transfers as necessary to comply with EU WFD requirements, the author completely omits referring to the debate on inter-basin transfers versus non-conventional resources (regenerated, desalinated), be it on demand management and sustainability of the production model as such. The presentation of a government change as a possible solution to a complex and long lasting groundwater governance problem as final part of the conclusion is rather problematic. There is no analysis whatsoever whether a basin transfer (nor availability of any other additional resources) would effectively alleviate overabstraction of the studied aquifer. Several aquifers in the region suffer similar problems and the provision of additional (alternative) resources has to date not contributed to a recuperation or alleviation of pumping of the aquifers. When making such statements at least the complexity of governing the groundwater resources should be acknowledged. The author touches upon governance issues briefly when mentioning 'legal questions' hindering the execution of Water Use Regulation Plans in section 6, however does not give any further explanation.

In the previous amplified explanations now introduced in section 5 (in response to comments by Referee 2), the analysis of non-conventional resources now appears, including seawater desalination and purification of wastewater. With respect to desalination, a realistic critique has been made, given that desalination here has proved to be a failure, when judged by the fact that its elevated economic cost (0,6 €/m^3) leads to low productivity in all cases.

Finally, and in addition to the comments on correct use of English language by referee# 1: some poor translations make the text difficult to understand, some examples: Use of water from 'rises'(?) (section 5) and use of water from 'swellings' (?) (section 7), referring to use of water from flashfloods; : : :the 'grave' (?) situation of Spain's most overexploited aquifer (section 7).

As the referee suggests, a rigorous revision of the article has been undertaken in terms of English language input, and it has been thoroughly checked by a native professional.

Accordingly, the grammatical and other linguistic errors pointed out by the referee have been considered.