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Article

# The Tajo-Segura water transfer (1979-2017). Actions for the future in Spain

# El trasvase Tajo-Segura (1979-2017). Actuaciones para su futuro en España

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## Abstract

The southeastern portion of the Iberian Peninsula is the driest area in Europe, where since water demands exceed internal resources, water transfers have been projected ever since ancient times. The origin of the Tajo-Segura water transfer dates back to the 14th century with the requests of the city of Lorca to obtain water from the Archivel and Caravaca and Castril and Guardal rivers. It wasn't until 1933 when, in the National Plan of Hydraulic Works, Lorenzo Pardo expressed the idea of transferring water from the headwaters of the Tagus River to the southeast (Lorenzo, 1933). In November 1967, the "Anteproyecto General de Aprovechamiento Conjunto de los Recursos Hidráulicos del Centro y Sureste de España: Complejo Tajo-Segura" was presented, written by engineers J. Ma. Martín and J. Ma. Pliego (DGOH, 1967). In 1979, when the construction of the Tajo-Segura was completed, the waters from the Tagus started to arrive to the Segura Basin to supply 2.5 million people and irrigate 150 000 ha. This research's

object is the analysis of more than 35 years of water transfer operations, with water policies related to resource supply and demand management. The research involves a diachronic study of the regional history and geography, along with a review of sources in historical archives (such as the ACHS) and field work along the path of the aqueduct and in southeast Spain. This included interviews of customers and water managers, which enabled the development of proposals with the aim of securing the continuity of the ATS as a national and multifunctional hydraulic infrastructure, and the "Postrasvase" as an essential structure for the territorial model in Southeastern Spain.

**Keywords**: Tajo-Segura water transfer, water infrastructure, water supply, irrigated landscapes, Southeast Spain.

## Resumen

El sureste de la península Ibérica es el espacio más seco de Europa. Las demandas de agua sobrepasan a los recursos propios, por lo que desde antiguo se han proyectado trasvases de agua. El origen del trasvase Tajo-Segura (TTS) se remonta al siglo XIV, con las peticiones de la ciudad de Lorca para traer agua de las Fuentes de Archivel y Caravaca, y de los ríos Castril y Guardal, pero será en el Plan Nacional de Obras Hidráulicas de 1933 cuando Lorenzo Pardo expresa la idea del trasvase de aguas al sureste desde la cabecera del río Tajo (Lorenzo, 1933). En noviembre de 1967 se presenta el *Anteproyecto General de Aprovechamiento Conjunto de los Recursos Hidráulicos del Centro y Sureste de España: Complejo Tajo-Segura*, redactado por los ingenieros J. Ma. Martín y J. Ma. Pliego (DGOH, 1967). En 1979, finalizadas las obras del acueducto Tajo-Segura, llegan las aguas del Tajo a la cuenca del Segura para el abastecimiento de dos millones y medio de personas y el riego de 140 000 hectáreas. El objeto de la investigación es el análisis de los 50 años transcurridos desde el Anteproyecto General, incluidos los más de 35 años de funcionamiento del trasvase entre las políticas hidráulicas de oferta del recurso y las de gestión de la demanda, que permite tomar una posición en favor de su continuidad en la amplia polémica entre detractores y defensores del trasvase Tajo-Segura (TTS). Para ello, se llevó a cabo un estudio diacrónico, de geografía histórica y regional, con acceso a las fuentes en archivos (como ACHS), con trabajo de campo en la cabecera del Tajo, a lo largo del trayecto del acueducto y en el sureste de España, y con entrevistas a usuarios y expertos gestores del agua, que han permitido elaborar una serie de propuestas, con objeto de asegurar la continuidad del ATS como una infraestructura hidráulica de dimensión nacional y

multifuncional, y el postrasvase como elemento vertebrador del modelo territorial del sureste de España.

**Palabras clave**: trasvase Tajo-Segura, postrasvase, infraestructuras hidráulicas, abastecimiento de agua, paisajes regados, tarifas de agua, Sureste de España.

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# Introduction

## Background on the change in the origins of the transfer (TTS)

Many initiatives, projects and works have occurred throughout history in order to transfer water to the driest region, the Iberian Peninsula, in southeast Spain. Water scarcity forces its residents to bring water to these lands from those places where there is a surplus of water flows. Since ancient times, the people of Vinalopó have turned to the waters of Segura and Júcar. Water from the Guadalentín and Almanzora basins were initially diverted to the Caravaca springs (Segura River Basin), and then to other rivers such as Castril and Guardal (tributaries of the Guadiana Menor in the Guadalquivir Basin). Kings and governments of all times have worried about these water transfers, to which they have dedicated money and the energies of their best trained men (ACHS, 1942).

In the modern era, in the time of Charles V and Philip II, wars did not allow the development of projects to bring water from Castril and Guardal, as part of the large projects of hydraulic interconnection of the rivers of the Iberian Peninsula. Works were started, but they were interrupted, such as in 1540 because of the wars with the Protestants, in 1566 due to the Moorish Rebellion, and in 1573 with the expedition to England (the Invincible Armada).

In 1568, Hernán Pérez de Herrera sent a letter to Felipe II in which he pointed out that the solution to the water shortage would be to bring water to Lorca from Archivel, Venablón, Singla, Barranda, Caneja, Naviales and the Eyes of Archivel, places near Caravaca. In 1574, Álvaro Rodríguez de Maderuela proposed to the king a more ambitious project, the transfer from the Castril and Guardal, tributaries of the Guadiana Menor (Mula, Hernández, & Gris, 1986:35).

The Royal Certificate by Felipe IV on October 15, 1733 put Don Gregorio Lopez Madera in charge of the management of the infrastructure to bring water to the area. Technical errors and a shortage of flows forced the suspension of the works as they reached Sierra de Almorox. In the times of Felipe V, the Document of January 15, 1742 gave the responsibility for the study of the conduction to Lorca from the Castril and Guardal rivers to Lieutenant Colonel Don Sebastián Ferignan y Cortés. He took the first measurements of the Castril and Guardal in June 1742, finding a flow of 2.2 $m^3/s$ and 1.4 $m^3/s$, respectively. He levelled over 400 km and explained the project "in more than one *'arroba'* of paper." Many years later, in 1928, geological studies, measurement campaigns, etc. were carried out to beat Ferignán's study (Bautista & Muñoz, 1986:48).

**Figure 1**. Old Murcia Channel excavation (1776-1785).

The attempted works on the channel to Lorca and the financial failure of the Prádez and Company led to Carlos III cancelling the concession to Prádez on September4 September, 1776 (Royal Document decreed in San Idelfonso). By means of that Royal Certificate, another company was formed under royal auspices, the Royal Murcia Channel Company. The new company kept Boizot as the director of the works, the cost of which was borne by post office rents and also by the prices of alcohol, and barrel taxes, soda and esparto. The works were finally started and, until 1780, a lot of activity was accomplished, with

the opening of roughly 27 km of the channel, with some interruptions (Figure 1). High costs led to the Royal Order of March 24, 1778, which eliminated navigation and restricted the channel to irrigation uses. The Royal Decree of February, 11 1785 dissolved the Royal Murcia Channel Company and ordered the construction of the Puentes and Valdeinfierno dams (Gil, 2017:53).

In October 1932, Martín Navarro Flores returned to the province of Almería and, accompanied by engineers Manuel Lorenzo Pardo and Clemente Sáenz García, moved to the Hijate slope, where they considered it feasible to transport the flows to the Almanzora basin (Fernández, 2006:294). On this trip, it seems that these engineers also thought of supplying these lands with water from other basins, such as the Guadiana and Tajo (Flores, 2004:191-192). The trip by Lorenzo Pardo and Clemente Saenz through southeast Spain allowed them to get in touch with the people of the Bajo Almanzora, Lorca and Cartagena fields, and to understand the urgent need to bring waters from other basins to these parched lands to avoid misery and stop emigration. "An invitation led Lorenzo, on October 24, 1932 through the lands of Cartagena and Almanzora, we accompanied him ... Three or four days later, back in Madrid on Alicante roads and inside the car, we commented on what we had contemplated with pain" (Sáenz, 1971:239-247). That made Lorenzo Pardo design a new hydraulic policy that would take better care of the southeast. He criticized the Hydraulic Works Plan of 1902 and designed the Hydraulic Works Plan of 1933, which included a study of the country's hydrological imbalance and measures to correct it, such as the Plan for the Improvement and Extension of Irrigation of Levante.

The solution of a transfer to the southeast had its origins at the headwaters of the Tajo, crossing the headwaters of the Guadiana, and with the possibility of connecting with the Júcar through the Alarcón reservoir, to get the waters of these three basins to the Talave reservoir in the Segura Basin (Torres, 1961: 37-38). The Plan for the Improvement and Extension of Irrigation in Levante planned to transfer water from the headwaters of the Tajo and the Guadiana, together with surpluses from Mijares, Turia, Júcar and Segura, in order to reach a total volume of 2297.160 $hm^3$/year to irrigate the 338 000 ha in the provinces of Almeria, Murcia, Alicante, Valencia, Albacete and Cuenca (Flores, 2004:192).

Another proposal came from Félix de Los Ríos in 1933, when reporting on the Hydraulic Works Plan, who had already indicated the possibility of transferring waters to Levante from the Ebro River. This proposal was made in 1937, and was composed of two separate parts: one, to transfer waters from the Ebro to the Turia and, the other one, transfer and successive compensation until reaching the fields of Cartagena and Almanzora (Torres, 1961:40-41).

The General Plan of Public Works of 1940 introduced three basic concepts or guidelines for water resources planning at the national level: 1. integral regulation of own resources in the deficit basins prior to the planning of the water transfers; 2. improvement of the management of the hydraulic availabilities in the deficit areas to reduce contributions from the abundant basins as much as possible; 3. use only surplus flows from the abundant basins in deficit basins. The Plan mentions "maximum interest" in the resumption of the studies on the transfer from the Castril and Guardal rivers for the purpose of improving irrigation in Lorca and Almanzora, in order to finally decide if it is an acceptable solution or reject it.

A Ministerial Order on September 25, 1941 appointed the engineers who were to give an opinion on this work to carry out the following tasks: a) compilation of all the projects and pre-projects drafted for the aforementioned purpose, as well as measurement data of the Castril and Guardal rivers; b) study of the hydraulic needs for irrigation in the basins of the rivers mentioned, and as a consequence, the amount of water that could be transferred; c) in view of the results of the previous sections, proposal for the drafting of a suitable project.

The Study Commission for the Use of the Castril and Guardal rivers presented some solutions that were considered to be suitable for the users of the different river basins (Guadalquivir, Almanzora, Segura), including: in the Almanzora, water is a need; in Lorca, help; and in the Guadalquivir, promise of expansion. The Commission started with evidence that the transfer from Castril and Guardal was feasible, that there were winter flows without a current use concession; and that Lorca and Almanzora had reasons to be examined and perhaps served the national interest (ACHS, 1942:49).

In fact, this proposal to transfer water from Castril and Guardal to the Almanzora was not a reality until 2003, through the Negratín-Almanzora Connection (Gómez, 2017:159). However, part of the Bajo Almanzora, Lorca and Cartagena saw the idea of transferring water renewed in the General Draft of the Joint Use of hydraulic resources for the central and southeast Spain □the Tajo-Segura Complex, November 1967, by the engineers José María Martín Mendiluce and José María Pliego Gutiérrez. After the construction of the aqueduct, the waters reached the Segura basin in 1979, and through the Postravase network, they also reached the Cartagena, Lorca and Almanzora fields. The report drafted in 1967 by the Commission of Hydraulic Resources of the II Plan for Economic and Social Development (II PDES) and its proposal to initiate the correction of the national hydraulic imbalance by means of the Tajo-Segura Transfer was decisive for initiating the work. The fundamental conditions considered in the 1967 Draft to determine the volumes to

be transferred meant that the Tajo-Segura Transfer proposal was supported by the criteria for the use of surplus and the economy of transfer schemes, both in its construction aspect and in the exploitation.

The preliminary draft clarified that the volume of the transfers would be determined by the unmet needs in the deficit area, by the availability of surpluses in the feeder basin, or by the technical-economic characteristics of the works that enable the transfer. Large transfers had to be planned in such a way that the flow captured and transported would be as uniform as possible throughout the year, to achieve a lower cost per cubic meter transported, lower installed power per cubic meter at the pumping outlets and advantages in the scheduling of the supply.

The total surpluses calculated in the Tajo basin, measured at the border with Portugal, were 5 502 $hm^3$/year, reflecting the full satisfaction of the Tajo's total demands in the future, and since Bolarque was the suitable point of capture for the origin of the aqueduct, the transferrable volume would be fixed by the surplus in section I in the future, estimated at 1 118 $hm^3$/year. In terms of transfers to the southeast over time, availability would be determined by the stocks for each year. The maximum resources that could be assigned to transfer to the southeast without any damage to the Tajo were 1 000 $hm^3$/year.

Once the preliminary draft was submitted and the information process had occurred, which received 85,000 allegations, it was finally approved by Ministerial Order of August 2, 1968, after agreement by the Council of Ministers. On February 12, 1969 Law 1/1969 was published in the Official State Gazette (BOE), which approved the II Plan for Economic and Social Development (II PDES), whose article 17 provided that "The joint use of the hydraulic system Tajo-Segura (ATS) will be regulated by means of a Law." Decree 102/1969, of May 9, approved the Consolidated Text of the Law of the II PDES, and in its Fourth Final Disposition, reiterated what was ordered in article 17 of Law 1/1969. Law 21/1971 complied with this mandate, and later, Law 52/1980, when the Tajo-Segura Aqueduct (ATS) was in operation, regulated the economic regime related to its exploitation.

# Objectives and methodology

The objective of this research is, considering the water policy paradigm of resource supply for a structurally deficit area such as the southeast of Spain, to highlight the value of the Tajo-Segura transfer (TTS) not only for the southeast (Postrasvase) but also for all the areas covered by the Tajo Segura Aqueduct (ATS). Knowledge about infrastructure and users was acquired through two contracts involving scientific consulting and technological support between the University of Murcia (UMU) and the Central Union of Irrigators of the Tajo-Segura Aqueduct (SCRATS) in the years 2010-2011 and 2014-2015.

The center of the Iberian Peninsula contains both sub-plateaus and is surrounded by mountainous aligned in such a way that only allow for an Atlantic influence. These mountainous systems interfere with the general circulation flow paths from the west, which prevails at our latitudes, so that when rising to cross them, rainfall increases. It is in these mountains where the headwaters of the rivers that are to be traversed are located, along the western slope, in the great spaces of the peninsular interior. Large hydrological organisms have been installed in the tertiary basins, such as the Duero in the northern sub-plateau and the Tajo and Guadiana in the south, which discharge into the Atlantic. Southeast Spain is a region on the peninsular periphery located leeward of those reliefs, and sheltered from the general circulation from the west, making it the driest region in Europe. Its water courses are of the rambla and rio-rambla type, such as Vinalopó and Guadalentín. This territory is delimited by the Mediterranean coastline and characterized by an isohyet of 400 mm of precipitation and an isotherm with an average annual temperature of over 16 ° C. It is a region with certain climatic homogeneity (the coastal steppe would be the most direct response to the SE peninsula, a desert which is an aerological and topographic shelter), where the dry months increase from NE to SW and the precipitations, in addition to being scace, are also characterized by high annual and interannual irregularity (Gómez, López, & Montaner, 2011:33-34). Water transfers are necessary, along with desalination, to meet the consumption needs of a population which exceeds five million people in summer, and to provide irrigation for more than 230 000 ha of commercial agriculture. Regarding the methodology, a diachronic study of the regional geography was carried out, along with consulting bibliography sources (especially the Archive of the Segura Hydrographic Confederation). The ceding and receiving areas were also visited (work of field) and water and irrigation managers were interviewed in order to assess the TTS.

# Discussion

## Management of water transfers in the Tajo-Segura Transfer system

As a result of the elimination of the Ebro transfer, an environment unfavorable to transfers was created in Spain (when Cristina Narbona was the Ministry of Environment). Some researchers of economic history, geography, ecology, etc. associated with the New Culture of Water (Arrojo, P., Del Moral, L., Martinez, J., Esteve, M.A., etc.) published statements opposing networks for those water shipments. Other researchers have defended the contributions of surpluses to the deficit basins (Gil, Morales, Rico, Hernández, Gil, Gómez, Melgarejo, Soto, etc.) based on the analysis of the role played by the water distributed by hydraulic complexes such as the TTS or the Negratín-Almanzora Connection (CNA).

Law 52/1980, of October 16, regulating the Economic Regime of the Exploitation of the Tajo-Segura Aqueduct, in its second article stipulated: "For the purposes of this Law, works of the Tajo-Segura aqueduct will be considered those executed or financed by the State to obtain, regulate, conduct and distribute the transferred water, as well as the complementary works necessary to achieve its perfect functioning".

**Figure 2**. Ojós dam, start of Postrasvase in Segura River Basin

"Pre-transfer" is defined by the set of works carried out in the Tajo Basin that enable the transfer of water from the Tajo headwaters to the Segura basin. While "transfer," in the strict sense, is defined as the Tajo-Segura Aqueduct (from Bolarque in the Tajo Basin to the

Talave in the Segura Basin). And Postrasvase (post-transfer) is the set of channels, aqueducts, siphons and reservoirs, water flow stations, etc., for distributing the water transferred once it reaches the Segura Basin (Figures 2 and 3).

The waters transferred by the Tajo-Segura Aqueduct (ATS) are distributed in the Postrasvase (post-transfer) area to meet irrigation and supply needs, and benefit the provinces of Murcia, Alicante and Almeria. Most are used for irrigation (up to 400 $hm^3$/year), but the supply to the population has priority (up to 110 $hm^3$/year), and is managed by the Commonwealth of Canales del Taibilla (MCT).

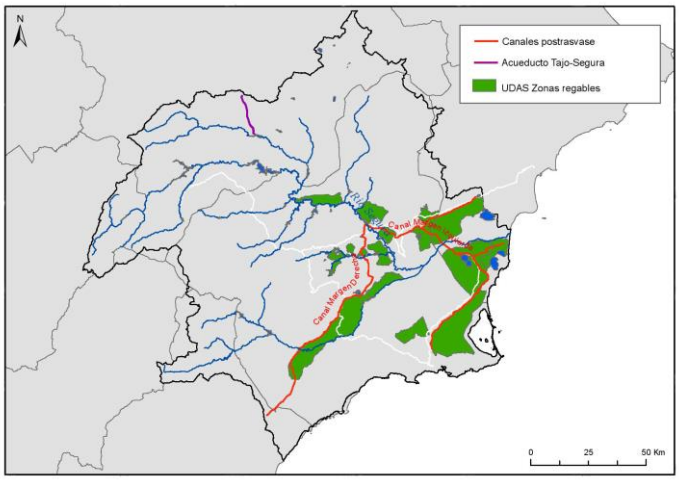


**Figure 3**. Irrigation areas in the Tajo-Segura Postrasvase (post-transfer). Right and left margin channels.

In recent years, a decrease in rainfall in the headwaters of the Segura and Tajo has required the MCT to increasingly turn to desalination flows (Bernabé & Gómez, 2015:286). During this period (1979-2017), the operation of the Tajo-Segura Transfer has been irregular, which in a way jeopardizes its future. An average of 324 $hm^3$/year has been transferred through a channel built to transport 1 000 $hm^3$/year. During hydrological years such as 1998/99 to 2002/03, more than 500 $hm^3$/year were transferred, while other years less than 300 $hm^3$/year were transferred. The official explanation for this variability in transfers is that the resources at the headwaters, whose historical average is 1 311 $hm^3$/year (1940/41-2010/11), have decreased to 776 $hm^3$/year during the period 1980/81-2010/11 (22% less). In the basin as a whole, the average for the period 1980/81-2010/11 shows a decrease in contributions of 16%, compared to the historical series (1940/41-2010/11). This difference in reductions in the headwaters, and in the basin as a whole, suggests that parameters other than rainfall are significantly affecting the resources of Entrepeñas-Buendía. We would highlight: a

poor policy for dams and water releases, excessive and illegal exploitation of aquifers in the Tajo headwaters and those close to the aqueduct path (such as no. 23, de La Mancha aquifer), and the non-completion of some of the works planned in the 1967 Draft, such as the West solution for the supply of Madrid. To this we must add that there are more and more needs to be met by the Tajo-Segura Transfer, charged to the resources of the Tagus capital. Thus, the ecological flow (Qe) in Aranjuez increased from 5 to 6 $m^3$/sec but much more has been left, which has meant more than 50% of the contributions of the headwaters of the Tajo (AP), as observed in the data in Table 1. Also to meet the environmental needs of spaces such as Tablas de Daimiel (up to 30 hm3/year) and to supply populations in municipalities in the La Mancha plains (Guadiana and Guadalquivir basins), up to 50 hm3/year (Gómez *et al*., 2011:70).

**Table 1**. Exploitation data for the Tajo headwaters.

| Hydrological year | AP Contribution | Bolarque Release | Qe Aranjuez | Head consumption | Shipments ATS $hm^3$/year | Qe/AP |
|---|---|---|---|---|---|---|
| | $hm^3$/año | | | | | % |
| 1977-78 | 1573 | | 1428 | | | 91 |
| 1978-79 | 1848 | 1525 | 1582 | -57 | 63 | 86 |
| 1979-80 | 992 | 1212 | 1116 | 96 | 36 | 112 |
| 1980-81 | 503 | 729 | 659 | 70 | 253 | 131 |
| 1981-82 | 637 | 592 | 577 | 15 | 345 | 91 |
| 1982-83 | 494 | 511 | 573 | -63 | 94 | 116 |
| 1983-84 | 987 | 460 | 472 | -13 | 141 | 48 |
| 1984-85 | 1121 | 459 | 470 | -11 | 350 | 42 |
| 1985-86 | 869 | 440 | 360 | 80 | 353 | 41 |
| 1986-87 | 719 | 440 | 318 | 122 | 377 | 44 |
| 1987-88 | 1250 | 476 | 328 | 148 | 275 | 26 |
| 1988-89 | 762 | 545 | 417 | 128 | 348 | 55 |
| 1989-90 | 611 | 470 | 315 | 155 | 250 | 52 |
| 1990-91 | 826 | 438 | 333 | 105 | 309 | 40 |
| 1991-92 | 513 | 392 | 366 | 26 | 238 | 71 |
| 1992-93 | 464 | 334 | 299 | 35 | 185 | 64 |
| 1993-94 | 602 | 331 | 255 | 76 | 250 | 42 |
| 1994-95 | 405 | 315 | 225 | 90 | 196 | 56 |
| 1995-96 | 1039 | 295 | 198 | 97 | 343 | 19 |
| 1996-97 | 1378 | 295 | 250 | 45 | 465 | 18 |
| 1997-98 | 1229 | 313 | 294 | 19 | 447 | 24 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1998-99 | 404 | 291 | 279 | 12 | 561 | 69 |
| 1999-00 | 683 | 303 | 293 | 10 | 589 | 43 |
| 2000-01 | 1367 | 355 | 345 | 10 | 567 | 25 |
| 2001-02 | 471 | 333 | 372 | -39 | 516 | 79 |
| 2002-03 | 1091 | 325 | 394 | -69 | 518 | 36 |
| 2003-04 | 973 | 335 | 240 | 95 | 498 | 25 |
| 2004-05 | 364 | 368 | 220 | 148 | 412 | 61 |
| 2005-06 | 398 | 251 | 220 | 31 | 218 | 55 |
| 2006-07 | 615 | 239 | 225 | 14 | 217 | 37 |
| 2007-08 | 497 | 249 | 237 | 12 | 237 | 48 |
| 2008-09 | 681 | 284 | 244 | 40 | 276 | 36 |
| 2009-10 | 1340 | 265 | 258 | 7 | 292 | 19 |
| 2010-11 | 748 | 332 | 277 | 55 | 378 | 37 |
| 2011-12 | 364 | 401 | 281 | 120 | 386 | 77 |
| 2012-13 | 916 | 355 | 257 | 98 | 372 | 28 |
| 2013-14 | 733 | 376 | 273 | 103 | 487 | 37 |
| 2014-15 | 491 | 363 | 295 | 68 | 292 | 60 |
| 2015-2016 | 681 | 300 | 289 | 11 | 192 | 42 |
| TOTALES | 31639 | 15994 | 15833 | | 12326 | |
| Medias período | 811 | 432 | 406 | 47 | 324 | 53% |
| Average volume transferred in the period | | | | | | 324 |
| Excess of ecological flow in Aranjuez | | | | | | 219 |
| Transferable volume in the period | | | | | | 530 |

Source: Own preparation with CHT data. (Gómez, 2017:58).

The Tajo-Segura Aqueduct was established as the set of *"works necessary to prevent the abandonment of southeast Spain,"* providing resources for supplies and irrigation, and for the economic development of the southeast. It is a public work that is being amortized by users through fees that were set by Law 52/1980, of October 16, regulating the economic regime of the exploitation of the Tajo-Segura Aqueduct. With news regarding the existing fee regime, such as cost recovery (twenty years before the Water Framework Directive institutionalized this for the countries of the European Union). As of January 1, 1986, the amounts obtained by the portion of the fee corresponding to the cost of the works, that is to say component "A" of the fees, were to be directed entirely to the communities of Castilla-La Mancha, Madrid and Extremadura, in the proportion of 4/9, 3/9 and 2/9, respectively, for the execution of

hydraulic works and sanitary engineering, such as those indicated in the Preliminary Draft of 1967, in these Autonomous Communities.

The Tajo-Segura Aqueduct infrastructure has become essential to water uses along its route, especially in situations of drought. Some works not only enable the distribution of transferred waters from the Tajo, Guadiana or Júcar, but also resources from the southeast. An agreement was reached for payment of a fee by the beneficiaries of the waters for the use of these hydraulic infrastructures. Along with its tracings, water treatment plants, irrigated spaces, and economic activity have been developed. The development in the southeast region has come about due to "waterways" such as the Postrasvase network, the Commonwealth of Canales del Taibilla, the Negratín-Almanzora Connection (C NA), the Rabassa-Fenollar-Amadoiro (in connection to the Júcar-Vinalopó water transfer), and water distribution networks for desalination as well as those for WWTP and STP after purification for reuse.

4.-Conclusions and proposals

The TTS infrastructures are public works with a clear policy of amortization and cost recovery. The users of the Tajo-Segura transfer have contributed through a fee per cubic meter transferred, to amortize the works and to cover fixed and variable operating expenses. Also, the current legislation grants users the right to use the Transfer and Post-transfer infrastructure forthe flows transferred to the Tablas de Daimiel, the supply of Alto Guadiana with transferred water, the southeast supplied with its own waters, irrigation uses in the southeast with its own waters, supply the Júcar for irrigation in the Llanos de Albacete, supply the Júcar to supply Albacete, supply the Júcar for the southeast, compensation for filtrations of the Talave Tunnel in the Llanos de Albacete, and compensation for filtrations of the Talave Tunnel in Hellín.

The Tajo-Segura Transfer is part of a policy to offer resources to the southeast, but in consumption it is necessary to apply a demand management policy. Worth mentioning among the measures to supply resources are: greater regulation with more reservoirs and better management of releases; more reuse and improvement of water quality; more desalination at affordable prices for irrigation, etc. And demand management measures, such as the reduction of losses in high and low distribution networks, the modernization of irrigation with savings and efficiency in the use of water, deficit irrigation application practices, changes in productive approaches to varieties of crops with lower water demand, etc.

To ensure the continuity and the future of the TTS, proposals are needed: the Alto Tajo Exploitation System (Head) must give priority to the demands of the system itself and the first phase of the TTS. The supply of Madrid and its surroundings must depend on the west

(Tiétar, Alberche, Guadarrama) and not to the east. The improvement of the purification of waters in Madrid and its surroundings will incorporate more than 600 $hm^3$/year of returns to increase the Tajo level in Talavera de la Reina. Control is needed in the exploitation of aquifers from the subterranean watershed between the headwaters of the Tajo and the neighboring basins of the Ebro and Júcar (water masses of Sigüenza-Maranchón, Molina de Aragón, Tajuña-Montes Universales and Entrepeñas in the sector of the Alto Tajo). Improve the discharge policy and control the volumes destined to ecological flow (6 $m^3$/s in Aranjuez mean to contribute 189.2 $hm^3$/year, that is, more than 23% of the headwaters, and there have been years with more than 50%). Once the Montoro and Fresneda reservoirs are built, it will not be necessary to take resources from the ATS for the regions of Puertollano and Valdepeñas, as it can already be assumed from the Guadiana. The regulation of the Tajo basin and the modernization of irrigation systems make it easier for some Irrigation Communities, when transfers of rights can be made for the use of water in situations of drought. The desalination in the southeast is not an alternative to the TTS, it is complementary to be increasingly used in times of droughts (a continuous supply and in combination with irrigation).

## References


*Dictamen de la Comisión de Estudios para el Aprovechamiento de los ríos Castril y Guardal*, Legajo 15334. Archivo de la Confederación Hidrográfica del Segura (ACHS) (1942).

Bautista, J., & Muñoz, J. (1986). *Las presas del Estrecho de Puentes*. Murcia, España: Conf. Hidrográfica del Segura.

Bernabé, M. B., & Gómez, J. Ma. (2015). El abastecimiento de agua a Cartagena. *Cuadernos Geográficos*, 54(2), 270-297.

Dirección General de Obras Hidráulicas, DGOH. (1967). *Anteproyecto General del Aprovechamiento conjunto de los Recursos Hidráulicos del Centro y Sureste de España. Complejo Tajo-Segura*. Madrid, España: Ministerio de Obras Públicas (MOP).

Fernández, E. (2006). *Agua y vida en Cuevas del Almanzora. Una historia de luchas y anhelos.* Cuevas del Almanzora, España: Arráez Editores.

Flores, F. J. (2004). La Confederación Hidrográfica del Tajo y el Trasvase Tajo-Segura. En: Autor (coord.). *50 años de la Confederación Hidrográfica del Tajo* (pp. 186-212). Madrid, España: Gramosa.

Gil, E. (2017). Antecedentes de trasvases de agua al sureste de España como la Conexión Negratín-Almanzora. *Cuadernos Geográficos*, 56(2), 48-71.

Gómez, J. Ma., López, J. A., & Montaner, M. E. (coords.) (2011). *Modernización de regadíos: sostenibilidad social y económica. La singularidad de los regadíos del Trasvase Tajo-Segura.* Murcia, España: Fundación Séneca, SCRATS, Editum.

Gómez, J. Ma. (2017). *El trasvase Tajo-Segura. Propuestas para su continuidad y futuro*. Saarbrücken, Alemania: Editorial Académica Española.

Lorenzo, M. (1933). *Plan Nacional de Obras Hidráulicas. Exposición General*. Madrid, España: Ministerio de Obras Públicas, Centro de Estudios Hidrográficos, Sucesores de Rivadeneyra, Artes Gráficas.

Mula, A., Hernández, J., & Gris, J. (1986). Las obras hidráulicas en el Reino de Murcia durante el reformismo borbónico. Los Reales Pantanos de Lorca. Murcia, España: Colegio de Ingenieros de Caminos, Canales y Puertos.

Sáenz, C. (1971). Evocación del Ingeniero de Caminos D. Manuel Lorenzo Pardo, fundador del Centro de Estudios Hidrográficos. *Revista de Obras Públicas*, abril (1971), 239-247.

Torres, M. (1961). *El regadío murciano problema nacional*. Murcia, España: Instituto de Orientación y Asistencia Técnica del Sureste.