JÚCAR RIVER BASIN DISTRICT WATER ACCOUNTS (SEEA-WATER UN).

ANNEX 2

Methodology and Results for obtaining water accounts under the SEEA-W system for the Júcar River Basin District.

INTRODUCTION

This document presents a thorough description of the different steps taken in the development of water accounts. This description addresses the general methodology, the different parameters used, the gathered data, the identified gaps in the data and the applied solutions, the use of the PATRICAL model for those variables not directly measured, and the building of the tables per se, including the development of a specific data base.

In addition to providing detailed information on how the works were developed by EVREN, the aim of this document is to offer the possibility to other interested entities in following similar steps when developing water accounts (or balances) with the SEEA-Water system within the UN framework [1].

This annex is divided into a methodology section -in which we explain the procedure of data collection and nonexistent data estimation-, a section with key results, and brief a section of the main concluding difficulties encountered and suggestions for future similar works.

This document includes only those outstanding graphics to explain a particular aspect. However, all produced graphs are in the folder of the CD corresponding to this annex, in various graphic formats.

The database is also found in the aforementioned folder. It consists of a main table in flat format, where each record corresponds to a volume element (reservoirs, lakes, rivers, groundwater and soil), a particular territory -in this study, this corresponds to the nine water management systems (WMS) of the Júcar River Basin District-, one year and one month. For each record, there are columns with all the variables involved in the calculation of the balance. The field names are descriptive enough, so there is no need for additional documentation explaining them, except for the United Nations own manual. The same results are also stored in a developed format with the same four key fields above them, plus a fifth one that corresponds to the value of the variable stored in the last field, called “Value” (transforming to negative those variables corresponding to outflows). This last format is more convenient to create pivot tables, while the first one is for the adjustment processes.

It should be noted that the results of this project should be taken as a pilot exercise. The obtained results, either final or partial, should be taken as estimations of those values. The main achievement of this study is to show the possibility of developing water balances with a series of more or less complete data at the sub-basin level.

All maps and charts have been elaborated by EVREN, unless otherwise expressed.
METHODOLOGY

In this section, we discuss the process for data collection, estimation of missing data, consolidation in a database, especially for those data relating to water abstractions to the economy.

The whole mathematical framework is based on the following basic formula for the storage state, where subscript \( i \) and \( j \) indicate elements susceptible to store water (reservoirs, lakes, rivers, groundwater and soil –snow is not considered in these basins-) having its own equation, and \( t \) indicates a discrete moment in time:

\[
\text{State}_i(t + \Delta t) = \text{State}_i(t) + \text{Balance}_i(t)
\]

\[
\text{Balance}_i(t) = \sum \text{Inflows}_i(t) - \sum \text{Outflows}_i(t)
\]

\[
\sum \text{Inflows}_i(t) = \sum \text{Returns}_i(t) + \text{Precipitation}_i(t) + \sum \text{From}_i(t)
\]

\[
\sum \text{Outflows}_i(t) = \sum \text{Abstractions}_i(t) + \text{Evapotranspiration}_i(t) + \sum \text{To}_i(t) + \sum \text{ToSea}_i(t)
\]

Returns and abstraction to the economy considered over elements of type rivers are: hydropower, refrigeration, urban supply and irrigation. For groundwater elements are: urban supply and irrigation. And for soil the only abstraction taken is evapotranspiration due to crops (rainfed agriculture). Reservoirs have neither returns nor abstractions, as explained below, and lakes are insignificant in the basins of this study.

The terms From and To indicate flows between distinct elements in the period of time \( \Delta t \). As for example runoff:

\[
\text{From}_\text{soil},(\text{to})_\text{river} = \text{Runoff}
\]

from the point of view of the river, and

\[
\text{To}_\text{river},(\text{from})_\text{soil} = \text{Runoff}
\]

from the point of view of the soil.

The flow matrix considered is:

<table>
<thead>
<tr>
<th>To</th>
<th>1311 Artificial reservoirs</th>
<th>1312 Lakes</th>
<th>1313 Rivers</th>
<th>132 Groundwater</th>
<th>133 Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>1311 Artificial reservoirs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1312 Lakes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1313 Rivers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>132 Groundwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>133 Soil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The unit of measure for the volume elements used is \( \text{hm}^3 \) (\( 10^6 \text{m}^3 \)). The unit measure mm is used for volumes per unit area.

DATA COLLECTION

During the early stages of the project, the team collected data from various public sources, which were indicated in earlier reports.
Later on, the Júcar River Basin Authority (JRBA) provided more reliable data, which are the ones usually employed by this entity. We compared these data with those obtained from public sources, contrasting that were similar. However, much of the JRBA information was more detailed and included in some cases longer time periods and other, better reflected the data distribution over the territory.

In particular, the JRBA provided the results from the hydrological model PATRICAL [2], which is explained later, and that has been used as an information source in each of the water management systems.

Among the sources of information used, the ECRINS database stands out for which we made several revisions. After these reviews, we concluded that the value of precipitation reflected by the data was close to 20% lower than the one obtained by employing more detailed hydrological models of the river basin (see report “14_HJD_Precipitation&ScaleReport v3” in the folder annex 3 of the final CD).

When a value is specified as a volume at a given point in time (for a given month and year), it is considered to correspond to the end of the period, except where indicated otherwise or whether it is in a field indicating the opening volume period.

**MONITORING DATA**

The team has used data from the gauging control network [3]to obtain inputs and outputs of the reservoirs, and to compare the volume obtained in the balances with the one considered in the gauging network and to take the initial storage value. The flow data of the network have not been considered directly. In the case of surface abstractions, flow values were taken directly from the ones provided by the JRBA. To estimate discharges into the sea, gauging stations are insufficient in the basin, so the PATRICAL simulation results in natural regime have been taken subtracting consumption (abstractions-returns).

We have completed the gauging control network data with those from the CEDEX web server [4] for the last three-month period, since at the time of data collection, the MAGRAMA server did not provide this information yet.

**HYDROLOGICAL MODEL**

The Patrical is a conceptual and distributed hydrological simulation and water quality model for medium and large catchments. It was developed by M. A. Pérez-Martín [2] based on the SIMPA model [5]. It is integrated into a geographic information system (GIS), with a small number of parameters (grouped in those related to the surface phase of the hydrological cycle and to the aquifer behavior), and it works by developing continuous simulation of long periods with monthly time steps. It is broadly used in Spain by water authorities (i.e. River Basin Authorities), responsible of the planning and management of both surface water resources and groundwater. The uses of this model are broad and include: assessment of resources, their spatial and temporal distribution, estimations of nitrate concentrations, or identification of environmental objectives according to the Water Framework Directive among other.

As for the hydrological module, the model discretizes basis in small cells (e.g. 1x1 km), and water surplus in each cell is estimated applying Témez model (1977) equations. The parameters used in those equations depend on the physiographic characteristics of the basin on each cell. Furthermore, within the model the river basin is divided into two vertical layers: an upper zone (unsaturated zone of the soil where vegetation can extract water) and a lower zone (groundwater storage in the basin). The model parameters include: the maximum storage capacity of soil moisture in each cell of the basin, the maximum monthly infiltration in each cell, the vegetative stress, the losses capacity in rivers, the discharge coefficient, the water storage coefficient, elevation of aquifer bottom, elevation of river-aquifer connection and matrix transmissivity between aquifers in the basin. Thus, the model has a conceptual formulation, operates on a monthly time scale, and obtains the water flows and storages (groundwater levels) in
the cells in which the basin is discretized, while preserving the principle of continuity and conservation mass. The initial data needed to operate the model are the monthly data coming from meteorological stations (e.g. rainfall and temperature).

The Patrical model has been developed in FORTRAN language, in UNIX shell scripting and in the programming language of GIS GRASS (1999) (Geographic Resources Analysis Support System), where the model is integrated.

The team has taken the values of the following variables directly from the results of the PATRICAL model, with the exceptions indicated in each of them:

- Precipitation, distributed in each type of reservoir element, lakes, rivers and soil.
- Real evapotranspiration, distributed over reservoirs, lakes, rivers and soil.
- Surface run-off.
- Infiltration.
- Surface and groundwater outputs to the sea.
- Interchange river-aquifer

The surface outputs to the sea are in natural regime, so the consumptions are subtracted from them in the process of calculating the balance sheets. In this report consumptions means the difference between abstractions and returns in the same volume element (rivers, groundwater, reservoirs, etc.).

This consumption may be negative for an element and a particular time. For example, in urban areas where abstractions are preferably from groundwater, the consumption seen from the viewpoint of river element can be negative if surface water extractions are smaller than returns from groundwater.

**ABSTRACTION AND RETURN DATA**

Supply data (system abstractions) have been provided by the Júcar River Basin JRBA. Approximately, 78% of supplies taken from surface water is known by direct measurement at gauging stations. In the case of groundwater, 38% is controlled, by water meters virtually all supplies of the operating system Vinalopó-Alacantí (which represents 8% of the total); and through remote sensing abstractions in the Mancha Oriental aquifer (30% of the total). Permits and surveillance control the rest.
From the supply data provided, we extrapolated the consumption data for the whole river basin. In addition, in the case of groundwater supply of the Vinalopó-Alicante system, we extrapolated the data of the beginning of the study period taking the supply average trend, modulating the monthly supply from the averages obtained for each month (see Figure 2).

For the extrapolation of the supplies for the entire JRBD, we have taken into account the annual gross demand of each agricultural and urban demand unit. In the case of the agricultural demand, these data are known for the years 2005 and 2009, and for the urban demand for each year from the population census data. These data are those that have been used for the production of different documents of the draft River Basin Management Plan (RBMP).

In addition, we had to complete the urban demand data for 2010, simply by repeating those for the year 2009 in the original table. With subsequent modulation of uses, going from annually to monthly scales, and by applying the observed trend for the entire period, the results for these years are displayed somewhat differently in terms of abstractions.

Figure 3 shows the evolution of groundwater withdrawals for irrigation on the Mancha Oriental aquifer, from which the behavior of abstractions in the rest of the territories was extrapolated. The extrapolation was made taking into account the estimated abstraction values for the year 2005, for urban as well as irrigation. Then, it was checked against 2009 data. These values were provided by documents of draft RBMP.

The reservoirs are taken as regulatory elements in which abstractions are not produced. Abstractions are considered to occur in river elements immediately downstream from reservoirs. This is done in this way given the measurement system of the gauging stations and the reservoir level. Furthermore, it is considered that there are no direct returns to the reservoirs (there is a small urban spill near one of the dams but its volume is negligible).

The abstractions for agriculture—both rainfed and irrigated—directly from the soil element are estimated from real evapotranspiration considering agricultural censuses of 1999 and 2009 [6],[7], interpolating values for the intermediate years taking into account the evolution of survey data on crop areas and yields (ESYRCE) [8]. In the months of November, December, January and February we have considered that there is no water use for crops. This approach may still be valid even if the production period is extend to these months, since the evapotranspiration in these months is considerably lower than the rest year. From ESYRCE data, it can be observed a decrease of agricultural surface in the Valencian Region estimated at 12 800 ha/yr (11 400 ha/yr in rainfed land and 1 400 ha/yr in irrigated land) (See Figure 4).

There has been a monthly modulation based on urban surface supplies registered in gauging stations. For each year, we have taken the average proportion of each month for the total supplies in the JRBD, obtaining a temporal modulation coefficient. Then, the annual gross historical endowment (2001-2010) has been multiplied in each municipality by the modulation coefficient, and finally grouped into each WMS. Actually measured surface supplies have not been incorporated into the database, so they would not produce duplications.
In the case of urban water supplies originating in groundwater, we have considered the evolution registered in the Vinalopó WMS (see Figure 2), taking as reference of consumptions in each municipality, those gathered in the documents of the RBMP corresponding to the year 2005, matching with the middle of the study period.

In the return of urban use, the team has considered that the main towns of the district are coastal and return water to the sea, outside the system. Therefore, an overall return of 75% has been considered initially. Due to the increasing use of wastewater reuse, in the future, it should be considered that much of the returns of coastal populations will occur on the soil element (instead of to the elements River) and through infiltration to groundwater the surplus from irrigation. In inland populations also wastewater reuse increases, but this will not affect the overall balance of the management system, since outputs to the sea will not decrease. However, this will affect the balance of the different elements within the system -returns to groundwater will rise while returns to rivers will fall.
In the case of surface and underground returns coming from irrigation, we used Júcar RBA values estimated in 2005 modulated in the same way that abstractions for irrigation.

The returns are not considered to soil element, since it is assumed that water is still in the economy element (already computing as abstraction), taking into account only that water that is not fully taken, infiltrating to the aquifer.

Although the cases of approximating the global behavior of the entire district by actual measurements in specific areas maybe a little reckless, overall, this represents a better performance of uses, especially in the evolution over time (urban consumption decreases around 4% per year, or it is replaced by external resources as desalinated seawater). In the case of surface uses, the process is even more reliable, given that virtually all uses are controlled. In the case of groundwater, although the main uses are controlled within the District, it would be desirable to study the goodness of the approximation made, taking as reference other studies that have already been performed or through zonal balances in which to contrast with the evolution of piezometer measurements. Later on, this report shows an example of the evolution of a piezometer representative for the Vinalopó WMS case together with the evolution of stored water obtained from the balance sheets (see Figure 7).

The only transfer between water management systems that is operative during the period of study is the channel Júcar-Turia. It has not been taken as an output from the territory corresponding to the Júcar system, but it has been accounted for as an abstraction to the economy. In addition, potential returns on the target territory are minimal, since they mainly end up in the sea or end up in the management system of origin itself through regenerated discharges from the city of Valencia (in Turia WMS) to provide resources to the Albufera lake (in the Júcar WMS).

The abstractions for electricity generation have been considered with a return of 100%, always following the same criterion mentioned for which abstractions occur in rivers and not in reservoirs, even though they occur immediately after leaving the reservoirs.
The only considered abstractions for cooling purposes are the ones for the Cofrentes Nuclear Power Plant (drawdowns represent approximately 29 hm$^3$/yr on average in the period, with an average consumption of 17.4 hm$^3$/yr, representing an average return of 40%).

**WATER ACCOUNTS DATABASE AND PROCEDURE**

To store data, a database has been created which incorporates the information received from the JRBA, along with information gathered from public sources. In this same database, tables were generated presenting in rows records corresponding for each item type (rivers, lakes, artificial reservoirs, soil water and groundwater), each region, each year and month, having in cells values of each of the variables considered for the preparation of the balances and the status of each item. With the table constructed in this way, all the operations are carried out on rows, except for the update of the initial status from the value of the final status and the initial status prior to the opening of the study period.

The names of the fields that are composed of multiple words are initial uppercase for readability. The first word indicates a group of variables, so that alphabetically sorting of all similar variables appear consecutively listed.

The value of the initial status of each element, except for reservoirs, in the opening period (January 2001) has been taken so that the minimum storage value of each element is positive (which in any case would not present a problem, if they were considered relative at the beginning of the period). In the case of reservoirs, the initial state value to be known is set to the end of December 2000.

After a first run of the balances, we observed solid results for all items except for the items river in all water management systems. The latter could be caused by various reasons: the rate of return used was perhaps not correct, abstractions were not well estimated, or some of the variables of the hydrological model were not well calibrated. The first two problems have no solution with the existing data because each modification in the Gains term also is done over the Losses. These is due because the variable ToSea is in terms of natural regime. Should be the third problem, it would be outside the scope of this study. The solution adopted has been to estimate a
constant coefficient for each WMS introducing a mismatch term proportional to the total outputs of element river for each month, and making the trend of storage on rivers plain over the whole period.

The term of mismatch introduced as loss can be negative, indicating that the inputs to the system are undersized or losses are oversized. This term encompasses various sources of error as the non-correct recording of extractions or returns (net consumption by the economy) or of variables from the hydrological model or flows between the various elements.

The absolute value of the mismatch term is on the order of magnitude of 10% over the outflow to the sea, except for Júcar and Vinalopó WMS for which the ratio is about 40%.

![Figure 5: Other losses computed to make constant the trend of stored volume in rivers. Comparison between distinct WMS.](image)

We thus proceeded to determine these general return coefficients for each water management system by minimizing the absolute value of the stored volume trend in river elements, since this type of element must have an average trend close to zero. With these new coefficients obtained, we processed the final balances.

This mismatch value somehow expresses the uncertainty of the results. While it would have been preferable to obtain this value by other methods, this has not been performed due to non-subdivision of the basin and because there were no intermediate calibration points.

A better procedure would be to incorporate all the elements and variables necessary for the exercise of balances within the calibration of hydrological models, or within management models. Probably a mixed intermediate solution would be an optimal one.

A view of the results in volume per unit area (mm) has been created in order to compare water management systems (since they have different areas) and to pool results to obtain the balance for the district as a whole.

**RESULTS**

This section includes the results obtained from the developed analysis, including evolution of the aridity index, and the comparison of storage volume of each element between WMS.
From the SIMPA model [9] data, publicly available, we generated yearly maps with the aridity index [10] from 2001 to 2010 (see Figure 6). We observe for instance that for 2005, which was a very dry year, aridity was present in almost the whole district. In contrast, the map for 2008 clearly shows a “wet” year. The observed difference between them is very marked, showing how both the Vinalopó and Júcar WMS, in a “wet” year, have a huge surface area with low values of the index.

Figure 6. Aridity Index (UNEP) for period 2001-2010 comparison in the Júcar River Basin District.

COMPARISON BETWEEN WMS FOR EACH CLASS OF ELEMENT

Figure 8 shows the evolution of the storage status of each type of element comparing all water management systems in the same graph. The left column shows absolute terms (larger basins typically have higher values), and the right column shows terms related to the area of each WMS.

Except for element 1311 Artificial reservoirs, the initial values are taken so the series do not contain negative values. Therefore, for example for soil or groundwater, it should not be assumed that the entire WMS surface has
dried out, or that the groundwater has been emptied even if in the graph it appears touching the abscissa axis. These are simply relative units comparing volumes with the initial situation.

For the 1311 element *Artificial reservoirs* it can be noted the big difference in the Júcar system storage respect to others. By comparison we see a similar trend in all the systems.

As for the lakes, while we have still not taken into account other inputs and outputs to them besides precipitation and evapotranspiration, the evolution relatively increases. Although, as discussed previously, the order of magnitude of this element with respect to others is negligible (for example, with respect to reservoirs it is about 1%).

The river elements are the most difficult to interpret as volume storage items. In view of the results obtained after adjusting the slope of the storage state as discussed in the methodology, there is a very distinct behavior for the Júcar, Turia and Vinalopó WMS compared to the rest. Comparing the evolution of groundwater both Turia and Júcar show an inverted behavior respect to the river, while the case of the Vinalopó completely decreases and does not recuperate normal values after the 2005 drought episode.

As for the the soil element, it is only noteworthy the continued decline in the Turia WMS.

![Figure 7: Comparison between piezometer levels and stored volume in Vinalopó-Alacanti WMS. Value of piezometers relatives respect to the initial value of the period.](image-url)
Comparison of volume in elements

Figure 8: Volume state evolution per class of element. Comparison in absolute value and in terms relative to WMS area.

Average flow among the various elements is shown in Table 1. This table shows how elements soil and lakes do not receive any inputs from other elements in the system.
<table>
<thead>
<tr>
<th>From</th>
<th>1311 Artificial reservoirs</th>
<th>1312 Lakes</th>
<th>1313 Rivers</th>
<th>132 Groundwater</th>
<th>133 Soil</th>
<th>Total general</th>
</tr>
</thead>
<tbody>
<tr>
<td>1311 Artificial reservoirs</td>
<td>---</td>
<td>4 097</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>4 097</td>
</tr>
<tr>
<td>1312 Lakes</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>406</td>
<td>---</td>
<td>4 676</td>
</tr>
<tr>
<td>1313 Rivers</td>
<td>4 270</td>
<td>---</td>
<td>1 934</td>
<td>2 784</td>
<td>---</td>
<td>4 223</td>
</tr>
<tr>
<td>132 Groundwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 934</td>
<td>1 934</td>
</tr>
<tr>
<td>133 Soil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 439</td>
<td>2 784</td>
</tr>
<tr>
<td>Total general</td>
<td>4 270</td>
<td>7 470</td>
<td>3 190</td>
<td></td>
<td></td>
<td>14 930</td>
</tr>
</tbody>
</table>

The graphs corresponding to evolution per type of abstraction are included in the folder of Annex 2 on the final CD.

**CONCLUSIONS**

For the development of water accounts, data uncertainty should be considered and even calculated for practical reasons. When data is not systematically measured (lack of instruments or economic resources), hydrological models and estimations are necessary (e.g. in the Júcar Basin for urban abstractions indirect estimations are made based on population and well measured consumption volumes). In addition, the danger of accumulating errors if these are present in different variables should be closely monitored.

When producing balances, the sum of surface and groundwater allocation and supplies percentages greatly vary. These errors are often linked to variables that cannot be measured directly (e.g. evapotranspiration) and due to bad calibration of models, or lack of data. The margin of errors might be too high to contribute to clarifying and controlling water assets and flows in a river basin, and might even generate greater confusion for the public (see other similar studies [11]). Thus, information should be presented to the public with either very clear explanations, or by providing estimates in the errors and produced uncertainty. Perhaps the best method is to indicate the numbers as ranges between the most probable values, for example instead of 20 hm$^3$, if the uncertainty in the value is 5 hm$^3$, it should be indicated in tables “15 hm$^3$ to 25 hm$^3$”. Texts of scientific, academic or regulation nature, should always use standard established expression of uncertainty from the GUM guide (*Guide to the expression of uncertainty in measurement* [12]).

An additional problem with the water account methodology is that while a highly controlled and confined system might be very well measured in terms of storages, and flows between infrastructures, if the reporting is extended to a large extent (neighboring territories, the whole hydrological cycle), the information will be less reliable as inaccuracy increases when inserting items requiring indirect measurements (P, infiltration, ET...). Thus, the resulting balances could provide a distorted image (poorly controlled system), far from reality. This should also be explained or demonstrated to the audiences receiving the corresponding information.

As a specific observation in the Júcar RBD, although there is a continuing decline in resource use in the District, it is not expected that the trend will be maintained long-hold –there are fewer and fewer supplies that can be optimized and on the other hand, the basin may be reaching a minimum of productive agricultural fabric.

In future projects or SEEA-W exercises, it would be appropriate to subdivide water management systems, making balances over the territory upstream of gauging stations. This would allow calibrating surface outputs of the system, and thus, better approximate the unknown variables of each subsystem. By subdividing the territory, the balances could be expressed at the water body scale (surface or groundwater) which could be of high interest for the future development of WFD related works.
We understand that the best option is to integrate the exercise of balances within hydrological or resource management models themselves. Hydrological models, to determine the altered regime, have all the elements necessary to obtain well-calibrated balances, maybe we should just incorporate the distinctions between classes of extraction. Moreover, in the management models calibration of the inputs and outputs of the system should be done, together with the well-known values of extractions and returns in certain moments of time with other hydrological values coming from other models. Alternatively, a mixed solution could be applied, capable of integrating both types of models in a joint one, on which the measured known values are calibrated or estimated by other means.

In the future, the measurement and control measures may increase according to cheaper technologies needed for their automatization, which would allow a better understanding of the functioning of watersheds and the use of resources, and therefore, make more accurate and detailed balances.

In terms of opportunities to combat desertification, in view of the results, it is observed that at the basin scale the consumptions for the economy (abs-ret) due to human action are relatively small compared to natural phenomena. In any case, the availability of water in the soil will depend on the level of water stored underground and its ability to return to the surface in places at a higher levels. The use of groundwater by the economy should perhaps be taken as a loan that is made to society, but that should be given back. This is due because an inadequate level of groundwater will cause lack of water outlets to the surface and therefore, increase the risk of desertification and damages to the environment, including to other economic areas of the society. Moreover, a greater proportion of cultivated or forested land will result in less availability of water resources to the economy, making the efficiency measures the optimal ones to adopt, especially those who still have wider scope as wastewater reuse in coastal areas.

REFERENCES


