

# Domestic freshwater usage under the final user perception. Evaluation of the metropolitan zone of Guadalajara

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## Abstract

Water management in urban agglomerations is a task normally handled by either public or private water supply companies, with civil society participation being almost forgotten during the decision-making process. In big cities such a Guadalajara in Mexico around 70% of the total freshwater delivered are consumed by households. From this, 7% are offered by private providers and 93% by public suppliers. However, the opinion of final consumers about the quality of water provision services is not considered. This paper presents the results of a field research carried out in the metropolitan zone of Guadalajara (MZG), which focused on analyzing the characteristics of domestic water consumption and final user's opinions about water supply services. A survey of 300 randomly selected houses was performed in MZG. Selected significant findings to be discussed include water consumption per capita distribution and the perception about water related problems.

## Keywords

Management; Sustainable development; Social conflicts.

## INTRODUCTION

Even though the majority of the surface of our planet is covered by water, only 0,26% of the total water available can be used for human consumption. In relation with the use of freshwater, the agriculture sector used 70% of the available water worldwide, while industry used 20%, and only 10% was used by households (Connors, Faures, Kuylenstierna, Margan, Steduto, Valle and van der Hoek, 2009). The urban water consumption shows a different picture, while in the national water consumption the agricultural usage represents the majority. In big urban agglomerations the households consume a bigger percentage of the water distributed. In big cities such as Berlin (73%) (Heizmann, 2000), Melbourne (60%) (Melbourne Water, 2009), Barcelona (65%) (Barcelona City Council, 2000) and Mexico City (67%) (Soto, 2007), more than half of the distributed water is used for domestic consumption purposes.

In 2004 it was laid down in the national water law that at least 50% of the council participants should be users' representatives. However this citizen representation is fragile due to different factors; several parties with different interests are represented, and sometimes these interests are different (like agricultural and domestic needs); also some of the users' representatives are weakly selected because the civic groups are not strong or well consolidated. This fragility impacts in the knowledge of the decisions taken. There are not efficient mechanisms to inform the represented about the decisions made in the council (Torregona, 2004).

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The major aim of this study is to analyze the householder's perspective about domestic water supply issues in the metropolitan zone of Guadalajara (MZG). The study focuses on some characteristics of users' water consumption; the users' will about water saving; the water supply perception by the final user; and the conflicts related with the water supply and sewage systems; Water consumption per capita is an important variable which is used to determine water consumption demand and allows performing forecasts. However, most of the time, the mean or average value of water consumption per capita is used without looking how water consumption is distributed. If a distribution is positive skewed, that means more percentage of the users consume less water per capita than the mean; on the other hand, if the distribution is negative skewed, more users consume more water per capita than the mean. One of the goals of this study is to find the characteristics of the probability distribution of water consumption per capita. On industrialized countries, such as EU countries, United States or Australia, consuming drinking water directly from the tap is an usual activity. The lack of adequate safe drinking water supplies that still face the less developed countries (ASCE, 1998) pushes towards to a major bottled water consumption. As is stated by several environmental organizations, Mexico is the second biggest consumer of bottled water in the world just surpassed by the United States of America.

The quality of the water supply service must be viewed from different points of view. Therefore it is important to know how the final users perceive the water supply service and the water related problems in order to know their concerns and the directions that public policies should take. Some of the most important factors related with a proper water supply service are water quality, continuity of the service, customer service (attention to complaints), speed and efficiency in the repairs, among others (Contreras, 2006).

### **Overview of the area of study**

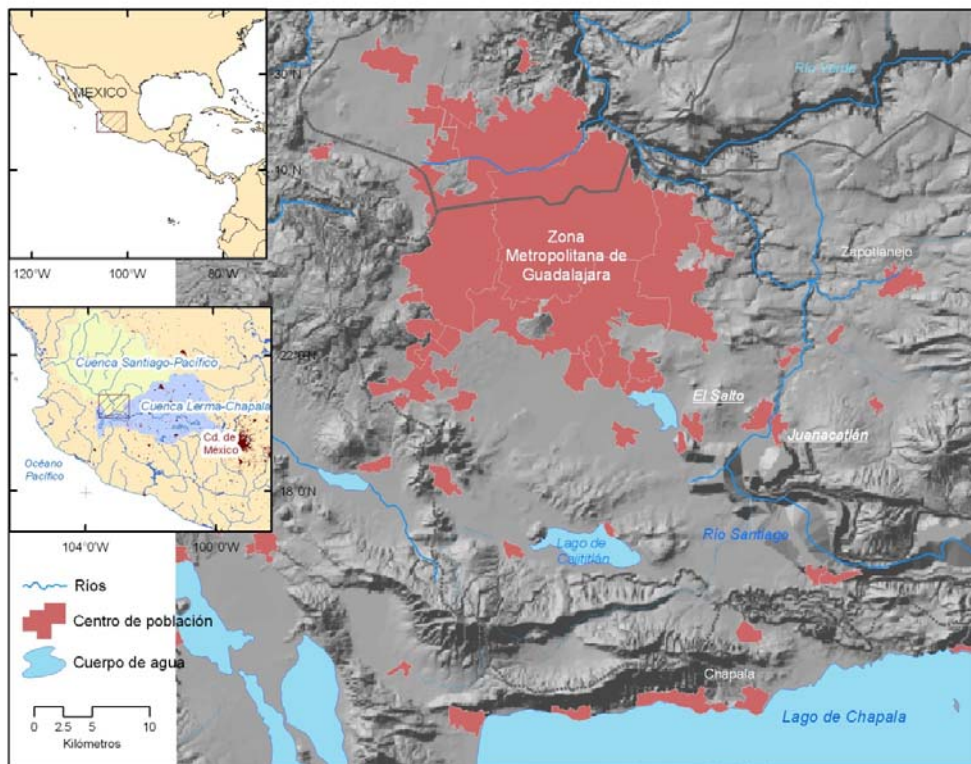
The city of Guadalajara is the second biggest city in Mexico and is the third industrialized city in the country. Guadalajara is the capital city of the state of Jalisco, localized in the western part of Mexico, and situated in an altitude of 1567 m over sea level. The MZG is composed of four districts: Zapopan, Tonalá, Tlaquepaque and Guadalajara. However, the currently growing urbanization is occupying an important sector of the district of Tlajomulco de Zúñiga and el Salto (figure 1); having a total population of 4,060,531 habitants, a surface of 544,7 square kilometres<sup>1</sup> and with an average annual population growth rate<sup>2</sup> of 1,8%.

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<sup>1</sup> Source: Aguilar A. (2004). Procesos metropolitanos y grandes ciudades. Camara de diputados, UNAM, CONACYT and Porrua.

<sup>2</sup> Elaborated by the Interagency Panel on the basis of the General Census of Population and Housing of 2000, and counts of Population and Housing of 2005; National Population Council (CONAPO).

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**Figure 1: The Metropolitan zone of Guadalajara (ITESO, 2009).**

Mexico City, Guadalajara, Monterrey and Ciudad Juarez produce more than 50 percent of total Gross Domestic Product (GDP) of Mexico (University of Monterrey, 2009). In 2000, the GDP of Guadalajara was 8,824 USD per capita (Municipality of Guadalajara, 2001). However, there is great social inequality within the city where most wealth is concentrated in a small sector of the population. Only 8% of the families in Guadalajara earn more than 6500 USD per month, while 57,3% of families must live on less than USD 890 per month (Mexican Associations of Marketing Research and Public Opinion Agencies (AMAI), 2005).

The main sources of freshwater supply in the urban zone of Guadalajara are the Chapala lagoon with 5,1 m<sup>3</sup>/sec, subterranean wells with 2,4 m<sup>3</sup>/sec, the Elias Gonzalez Chavez dam with 1,1 m<sup>3</sup>/sec and springs with 0,2 m<sup>3</sup>/sec; having a total supply of 8,8 m<sup>3</sup>/sec (SIAPA, August 2008). Of these, the lagoon of Chapala is the most important water supplier for the MZG.

In the MZG around 70% of the water supplied is consumed by the domestic sector<sup>3</sup>. The main water supplier in the city is the Intermunicipal System of Potable Water and Sewage (SIAPA), which supplies 93% of the total water distributed to the MZG, the rest of the water is supplied by each municipality or is water licensed by the National Water Commission (CNA). The water consumption per capita in Guadalajara is around 214 litres per day (lpd), correlates with a production of residual water of 7,89 m<sup>3</sup>/sec (SIAPA, 2008). Almost 94% of the houses have access to tap water and 98,2% have drainage connection (National Institute of Statistics and Geography INEGI, 2005).

<sup>3</sup> In 1999 68,84% of the total water supplied to the MZG was consumed by the domestic sector, this calculation included the water supplied by SIAPA and also the water licensed by the CNA. (Boehm, Duran, Sanchez and Torres, 2002).

## **MATERIAL & METHODS**

The empirical method used in this study was a face to face interview. The primary unit of observation was the house in which mainly the head of the household was interviewed (the mean age of the respondents was 42 years old). A total of 300 houses from a universes of 914,024 houses (INEGI,2005) were surveyed in the MZG. The survey instrument contained both open and closed questions. The questions were designed to obtain information about water use characteristics, the user's will of saving water, the kind of water saving methods used by the final user, and the final user's opinion about the water supply service and his view of water supply related problems, and to define the socio-economical class to which the user belongs. No timing related questions, such as the time the final user spends in water usage activities, were made due to the uncertainty it brings in the analysis of the different timing perception among the users.

The sampling method used for the study was a simple random sampling of clusters. Originally the proponent decided to implement a stratified sampling using four different socio-economic classes in each stratum, using as a base the results from the national population and housing counting from the INEGI; however the variables used by INEGI does not allow differentiation of the middle and the upper socio-economic classes. Each cluster was defined as an area of 0.346 Km<sup>2</sup> from the MZG. Inside each cluster five houses were selected by systematic sampling following three main conditions: The starting point of the sampling route was selected randomly; every 13th house was surveyed; and the houses surveyed should correspond with the general socio-economic characteristics observed in the sub-area. The survey was conducted from May 2008 to June 2008 with the help of 12 interviewers.

## **RESULTS AND DISCUSSION**

The validity of the sample size was verified by comparing five variables between the information from the 2005 population and housing counting of INEGI and the survey's results; and comparing the socio-economic distribution obtained by AMAI with the distribution obtained from the survey's results. The variables comparison is shown in the Table 1. The variables inhabitants per house and rooms per inhabitant presented a confidence interval of 97,5% and 90% respectively, and the socio-economical distribution from the survey showed it belonged to the AMAI's socio-economic distribution with a significance level of 5% ( $\alpha=0,05$ ) and degree of freedom of 3<sup>4</sup>.

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<sup>4</sup> A Chi-square test was used to test the socio-economical distribution of our survey fits the socio-economical distribution of our universe of study.

TABLE 1: Survey's validation results<sup>5</sup>.

<i>Variable</i>	<i>Survey data</i>	<i>INEGI 2005 pop counting data</i>
Inhabitants P/House average	4,28	4,48
Rooms P/Inhabitant average	1,06	1
% of houses with wash machine	89%	84%
% of houses with WC	100%	98%
% of houses with water connexion	95%	94%
<i>Variable</i>	<i>Survey data</i>	<i>AMAI 2005 Data</i>
%Class A/B	7%	8%
%Class C	37%	34,70%
%Class D	52,7%	50,60%
%Class E	3,30%	6,70%

Water consumption per capita.

The domestic water consumption per capita in the MZG is positively skewed distributed (skewness of 2,04) with an average daily water consumption per capita of 169.23 litres, as shown in Figure 2. According to SIAPA, the governmental body responsible for the water supply of the MZG, the daily water consumption per capita in the MZG are 214 litres, including the 20.34% lost in the distributions, networks, and in the houses water intake. If we remove the amount of water lost in the system from the total reported by SIAPA, the net daily water consumption per capita is 170.47 litres, which is almost the same amount reported by our results. However, 170 litres lpd are still over the 130-140 litres suggested as the amount of water every person should have access to as part of human and civil rights (Arrojo, 2008) and it is also high compared to some other cities considered sustainable such as Barcelona with 116 lpd (Aigües de Barcelona, 2006), Berlin with 115 lpd (Berliner Wasserbetrieb, 2009) or Singapore with 158 lpd (MEWR Singapore, 2009). Our positive skewed distribution reflects that a bigger percentage of the population (around 68%) consumes less than 170 lpd; however, no relation between the amount of water consumption per capita and socio-economical status could be confirmed.

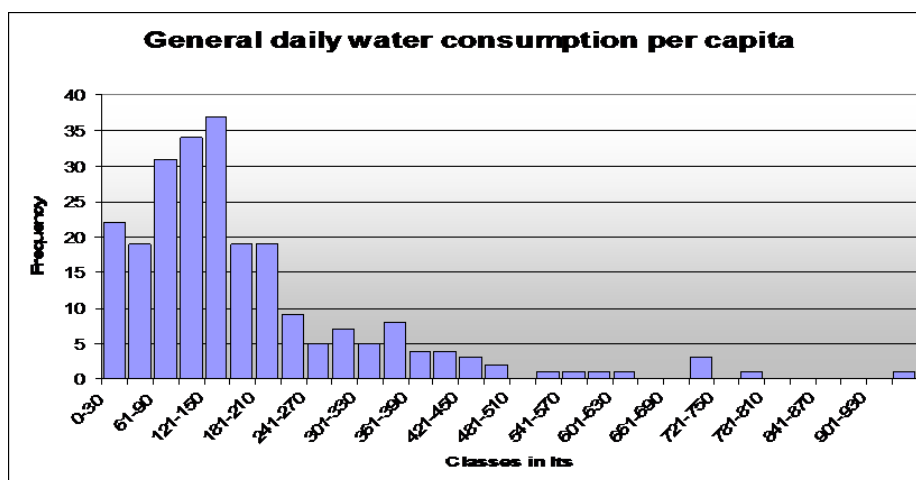


Figure 2: Daily per capita water consumption distribution.

<sup>5</sup> The socio-economical classes presented correspond to the following: Class A/B = Upper class, class C = Middle class, class D = Lower class and class E = Economical class (class in extreme poverty).

### Bottled water consumption.

In contradistinction to European behaviour, the Mexican citizens prefer drinking bottled water to drinking directly from the tap. 99% of the households surveyed consume bottled water for drinking purposes; consuming an average of 2.23 litres per capita per day<sup>6</sup> but with monthly expenses of 59.3 pesos (4.56 USD<sup>7</sup>) per person. However, every person pays an average of 26,11 pesos (2 USD) per month for the water supply service, which means more than 200% more is paid for bottled water as for whole water supply service it self. However if the difference between the bottled water and the water service expenses is expressed in cost per litre, then it represents a very big difference: 1 litre of bottled water in 20 litre container costs in average 89 cents out of a peso (6,8 US pennies), and 1 litre supplied by SIAPA costs 0,47 cents out of a peso (0,036 US pennies). The reason why the householders prefer consuming bottled water for drinking purposes is the lack of confidence in the water quality of the water supply service.

### Physical characteristics of the houses regarding water consumption.

In this section some of the most important physical characteristics on water consumption found in the houses are presented.

In Mexico, it is common for the governments to implement occasional cuttings in the water service to save water during shortage seasons. However, this kind of measure does not work properly because the majority of the houses have a cistern or water tanks. According to the survey's results, 50,33% of the houses have cistern and water tank; 32,67% only a cistern; 8,67% only a water tank; and only 8,33% neither.

### Water saving devices and methods.

In spite on the fact that SIAPA promotes water saving methods and the use of water saving devices, only 53% of the surveyed householders mentioned they use at least one water saving method; the saving methods most frequently mentioned were reusing the water from the washing machine, reusing the mopping water, and reusing water in general. Only 18% of the respondents have at least one water saving device. The main reasons they do not have any device were lack of awareness of such device, lack of money, and lack of interest. The information obtained from the survey reflects the low impact of the campaigns designed by the decision makers. It also shows that is important that the final user be deeply involved in water savings strategies formulated by the decision makers. Perhaps for that reason, the government of the state of Jalisco together with CNA foster communication and education programs to promote the culture of water as one of the strategies of the Hydrological Program of the State of Jalisco 2010-2030.

### Householders' perception about the water supply service, water problematic in the MZG, and citizen organization knowledge.

One of the main goals of the survey was to ascertain how users perceive the freshwater supply service and how much they know about water problems in the MZG. The respondents were asked to rank the water supply service from very good to very bad; as shown in the Figure 3, 82% of the respondents ranked the water supply service between good and very good. Because

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<sup>6</sup>This includes just included the bottled water consumed inside the houses, the bottled water bought out side in smaller presentations was not included in this study.

<sup>7</sup> Taking the exchange rate in 13 pesos per dollar.

ranking is dependent on subjectivity and personal view, an open question was made to determine the reason of the given ranking. The householders who ranked the water supply service “good” and “very good” gave as a main reason of their ranking the availability of water; as opposed to those who ranked the water supply service between regular and very bad, who gave as a main reason water scarcity. It is clear that the cultural perception about a good or bad water supply service depends only in the presence or absence of water leaving important aspects such as water quality<sup>8</sup>, wastewater treatment (just 2,7% of the wastewater is treated) or pricing meaningless even though their lack of confidence in the water quality pushes them to buy bottled water (Aguirre and Moran, 2006).

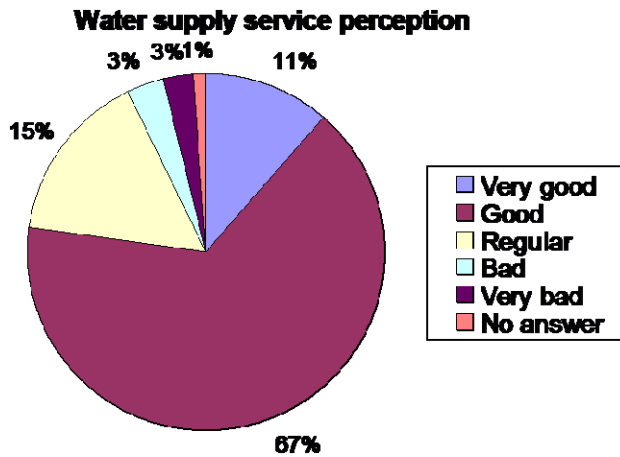


Figure 3: Ranking of the water supply service.

The respondents were asked if they believe there exists an overall water problem in the city of Guadalajara; 74,33% answered that they indeed believe that there is a water problem, 22% believed that there is no problem and 3,67% did not know (the results do not show any tendency related to the socio-economic class to which each household belongs). About what kind of water problems Guadalajara might have, the respondents' answers are shown the Figure 4. Once again, the respondents related the water problems mainly to the absence of water, although lack of water saving conscience was strongly mentioned. Nevertheless, just 9% of the respondents mentioned water quality as a problem in the MZG, even though the Santiago River (the river which borders the MZG in the east and northeast) is one of the most polluted rivers in Mexico and the water quality in the lagoon of Chapala is poor (Duran and Torres, 2006; Navarro, Lopez and Caire, 2004).

<sup>8</sup> The Lerma-Chapala basin is highly deteriorated due to its poor water quality. Also the deterioration in the water quality of Santiago river is due to the use of the river as a drainage system by the industrial settlements located in industrial corridor from Ocotlan to the MZG and the sewage discharges of the MZG, with almost no treatment (Vargas, Scherman, Contreras, Gallardo and Rios, 2006; Duran and Torres, 2006).

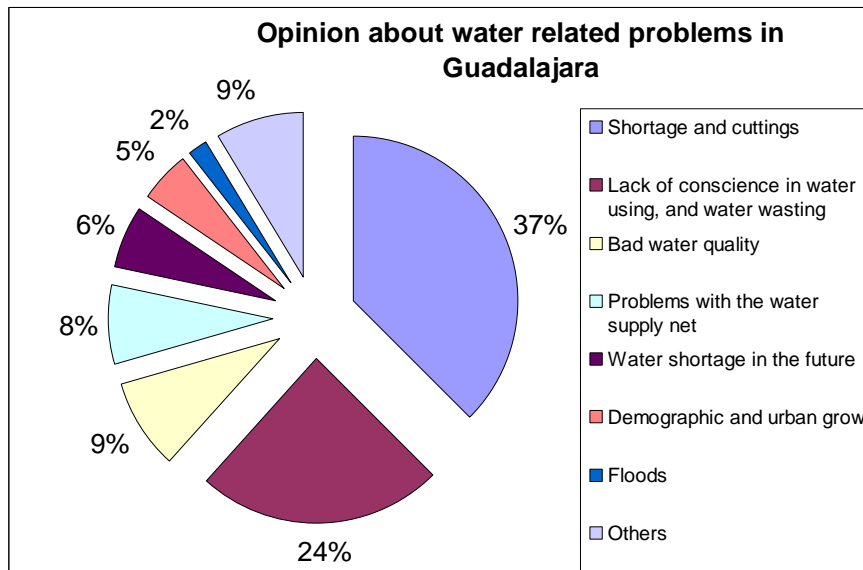


Figure 4: About which water related problematic exists in the city of Guadalajara

Finally, one question asked in the survey was focused on determining the householders' knowledge about civic groups working on water issues and only 6% of the respondents gave a positive answer.

## CONCLUSIONS

If Guadalajara wants to become a sustainable city in its water resource management the first step is to reduce the water consumption per capita. In order to accomplish this goal, good coordination between government and society should take place. It is unacceptable that only 50% of the population is concerned about saving water, and is actually implementing actions about it. However, these single actions, such as just reusing water, or placing a block in the WC container to reduce its capacity, are not enough to significantly reduce water consumption. A drastic modification in water use behaviour is necessary, more promoted water saving techniques and water saving devices as well as better public policies should be implemented to reach these goals.

After reaching an acceptable water consumption rate, the next step in the way of reaching sustainability, is to improve water quality, particularly if the water is used for drinking purposes. It is unacceptable, from a human rights point of view, people prefer to buy bottled water (which is much more expensive as the one supplied by SIAPA) because their lack of confidence on water quality supplied by the network. Almost all bottled water consumed in Guadalajara is produced in Guadalajara by transnational companies. Then it can be conclude there is enough clean water to supply the MZG in order to meet population's needs for drinking and cooking purposes of the population.

Civic participation and public opinions should be the foundation on which public policies are planned. Crucial decisions about water management, particularly involving fresh water supply, should not be taken without knowing the final users' opinions, in this case the householders. Nevertheless, it is crucial that the citizens are well informed about the factors and problems, pros and cons related to the governmental water supply system in order to express and enforce their opinions. If there is no pressure from the society to demand a good water supply service and is

only interested in the availability of water without considering the characteristics of a proper water supply service, the decision makers will focus on accomplishing just this demand. The Arcediano project is a clear example of this situation, where the government, concerned only with satisfying the actual water demand, shows a lack of interest in other important factors like river sanitation or sustainable water consumption<sup>9</sup>.

Education is the main tool to raise awareness of the citizens. Civic groups (Non Governmental Organizations (NGOs), religious groups and education centres) and governmental entities usually are responsible for supplying the proper information to increase awareness about water related problems and the actions and activities the householders can take to contribute to the solution of these problems. Nowadays there are civic organizations, NGOs and academic groups working in Guadalajara trying to solve the water problem in the city, but this is not a solitary work. This should have the support of the entire society. However, how is it possible for the society to support these groups if the people are not aware of them? Nor about the goals and actions implemented by each group? Therefore, it is necessary the mission and agenda of these organizations are promoted in a more efficient way. These organizations need to move the society towards sustainability, even more when the government has shown poor interest in doing it.

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<sup>9</sup> To improve the current condition of the basin Lerma-Chapala and the increase in the population of the MZG, the Water Commission of the state of Jalisco (CEA) is planning to develop a project to construct a dam (known as Arcediano project) in the north part of the MZG. This water reservoir will supply 280 lpd until 2030. This project is against of the sustainable development guidelines due to two main reasons (among others). The first one is determining the water consumption per capita to be 280 litres per day, which is something considered totally unsustainable, instead of planning better strategies for water consumption reduction, and the second one is supplying the Arcediano dam by Verde and Santiago rivers. The Santiago river receives industrial and domestic discharges without any treatment. The Arcediano project does not include sanitation of water from the Santiago river prior to it being used for domestic water supply purposes (CEA).

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