

Under the High Patronage of His Majesty King Mohammed VI



XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco | 1-5 December 2025

Kingdom of Morocco



Ministry of
Equipment and Water

Sevilla public supply adaptation to water scarcity and droughts

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November 2025

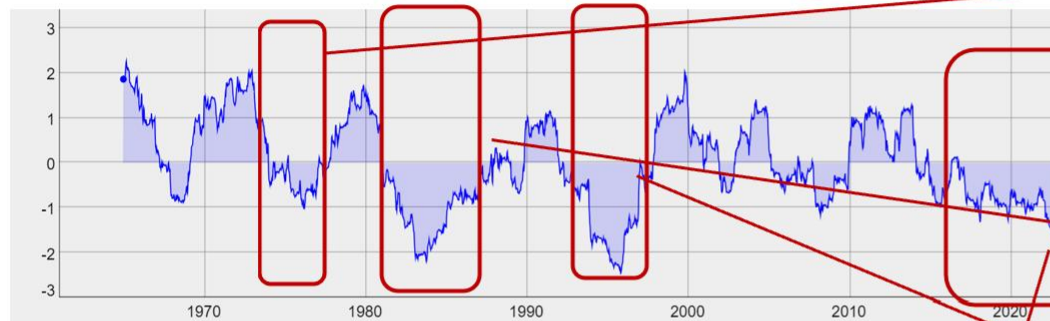
Define resiliency

Urban water resiliency is a city's ability to keep water services reliable in adverse conditions.





Sevilla Historical droughts



Sevilla: SPEI (24 months cumulated)
Source CSIC

1972-1976



1980-1983



1991-1995



2018-2024...

BANDO DE ALERTA POR SEQUIA

Sevilla y su área metropolitana han entrado en alerta por sequía

El agua potable sólo podrá usarse para fines esenciales



City response to droughts



| | | |
|---|-----------------------------|--|
| 1 | Increase water storage | Capacity increased from 456hm ³ to 641hm ³ (+40%) |
| 2 | Reduction final consumption | Final domestic consumption (at destination) 176 L/p·d to 106 L/p·d, (-34%) |
| 3 | Reducing water losses | Network system losses (leakage) reduced from 36% to 11% |
| 4 | Other measures | <ul style="list-style-type: none">• Drought Protocol• Artificial groundwater recharge and desalination• Farmers water right acquisition (1995, 2023) |



City response to droughts



Supply

1

Increase water storage

Capacity increased from 456hm³ to 641hm³ (+40%)

Demand

2

Reduction final consumption

Final domestic consumption (at destination) 176 L/p·d to 106 L/p·d, (-34%)

Demand

3

Reducing water losses

Network system losses (leakage) reduced from 36% to 11%

Supply

4

Other measures

- Drought Protocol
- Artificial groundwater recharge and desalination
- Farmers water right acquisition (1995, 2023)



[1]



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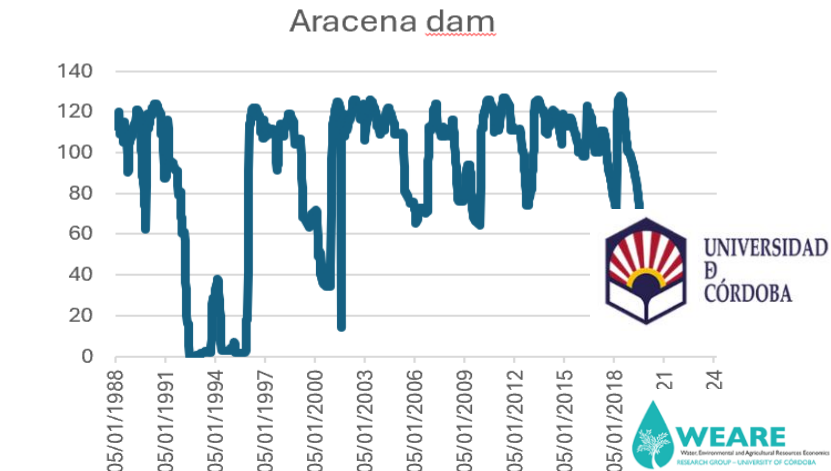
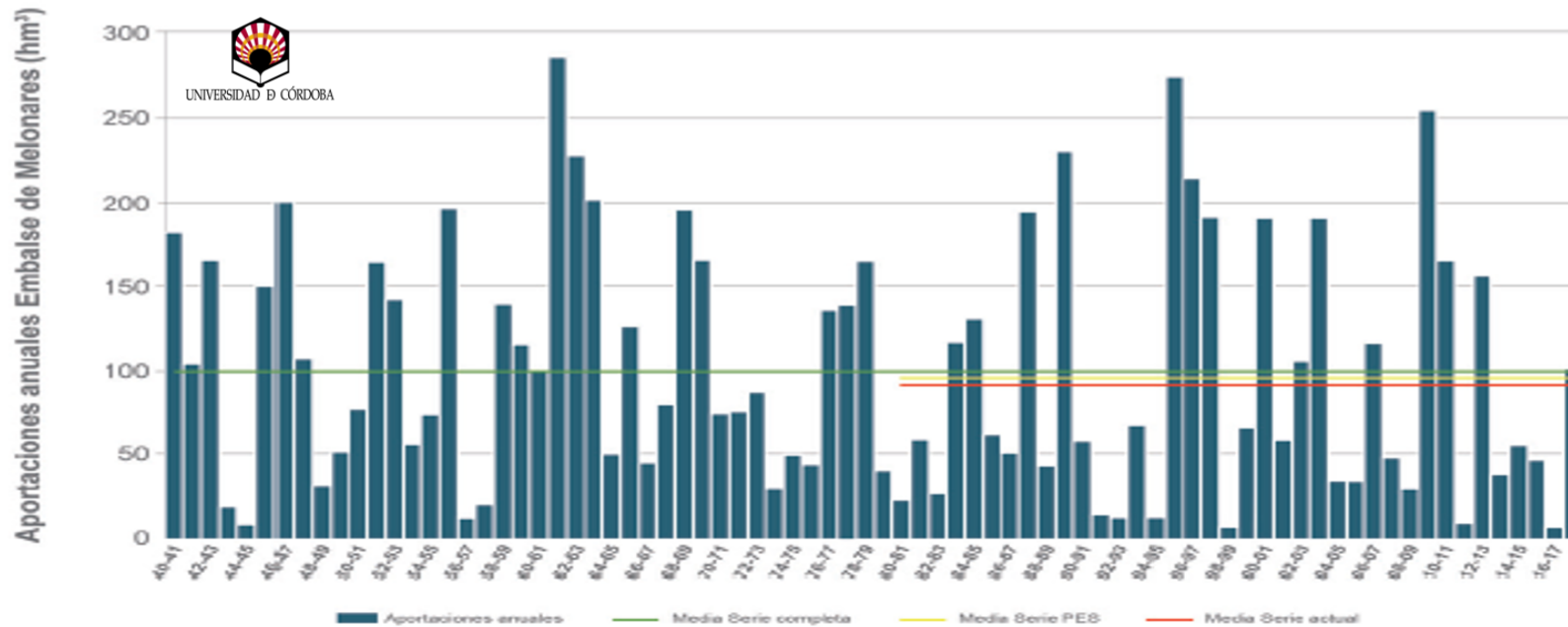
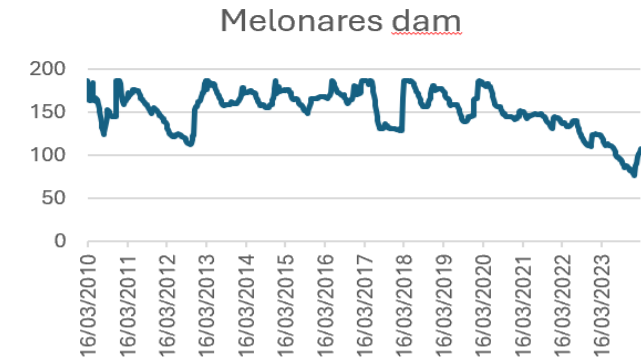
Enhanced supply measures

Water inflow and level of reservoir

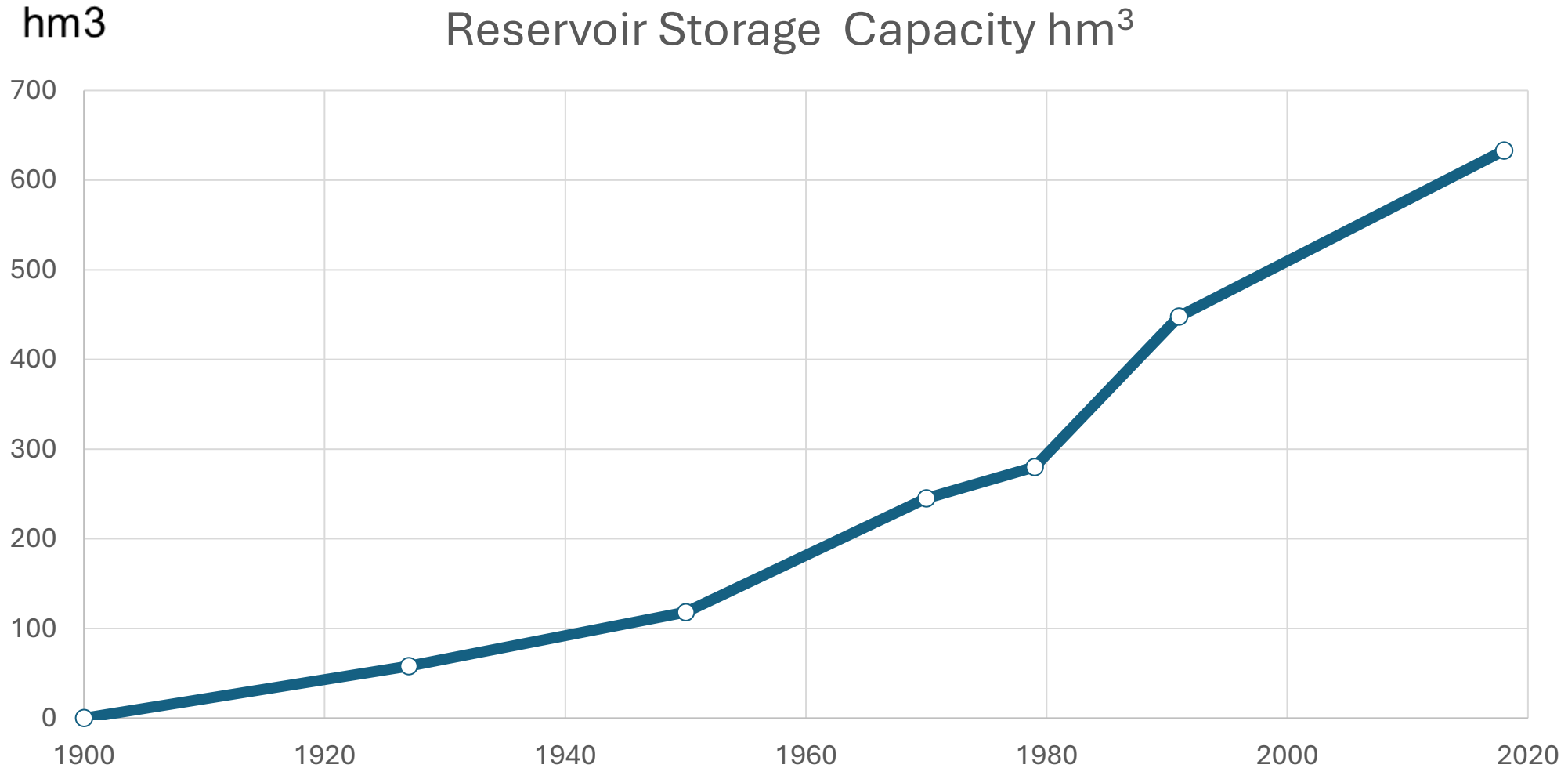


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| AÑO HIDROLÓGICO | OCT | NOV | DIC | ENE | FEB | MAR | ABR | MAY | JUN | JUL | AGO | SET | TOTAL |
|----------------------|-------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|-------|---------|
| Media Serie completa | 7,673 | 13,318 | 25,843 | 23,324 | 20,808 | 19,300 | 12,001 | 5,748 | 1,821 | 0,890 | 0,616 | 1,065 | 132,407 |
| Media Serie PES | 9,068 | 15,443 | 35,784 | 25,451 | 15,353 | 10,417 | 8,320 | 4,019 | 1,473 | 0,710 | 0,481 | 0,834 | 127,373 |
| Media Serie actual | 8,106 | 15,206 | 31,185 | 22,234 | 14,280 | 13,716 | 8,385 | 4,461 | 1,250 | 0,820 | 0,643 | 0,977 | 121,262 |

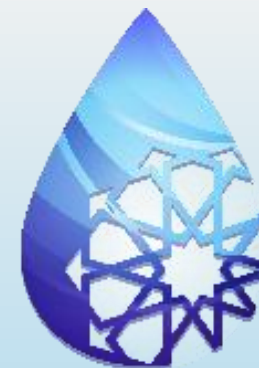


[1] Increasing reservoir capacity





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[2 and 3] **The model**

Managing wáter demand





The objective is...



The **OBJECTIVE** is to reduce percapita gross abstraction (*water withdrawn from a source*)

$$Q_a = \alpha Q_h$$

Abstracted volumen

Losses

Final consumption

e.g., Sevilla 1992:

$$211 \frac{L}{pcpd} = \left(\frac{1}{(1 - 0,33)} \right) \cdot 142 \frac{L}{pcpd}$$



Measure 1: Reducing losses

Efficiency improvements

Capital investment + Operational expenses

Cost increase

Measure 2

Cost recovery

€

Δ Water price => Reduced demand

Passing costs to users

Intensify

Measure 3

Behavioural Interventions



Behavioural Change

Result A:
Loss reduction

+

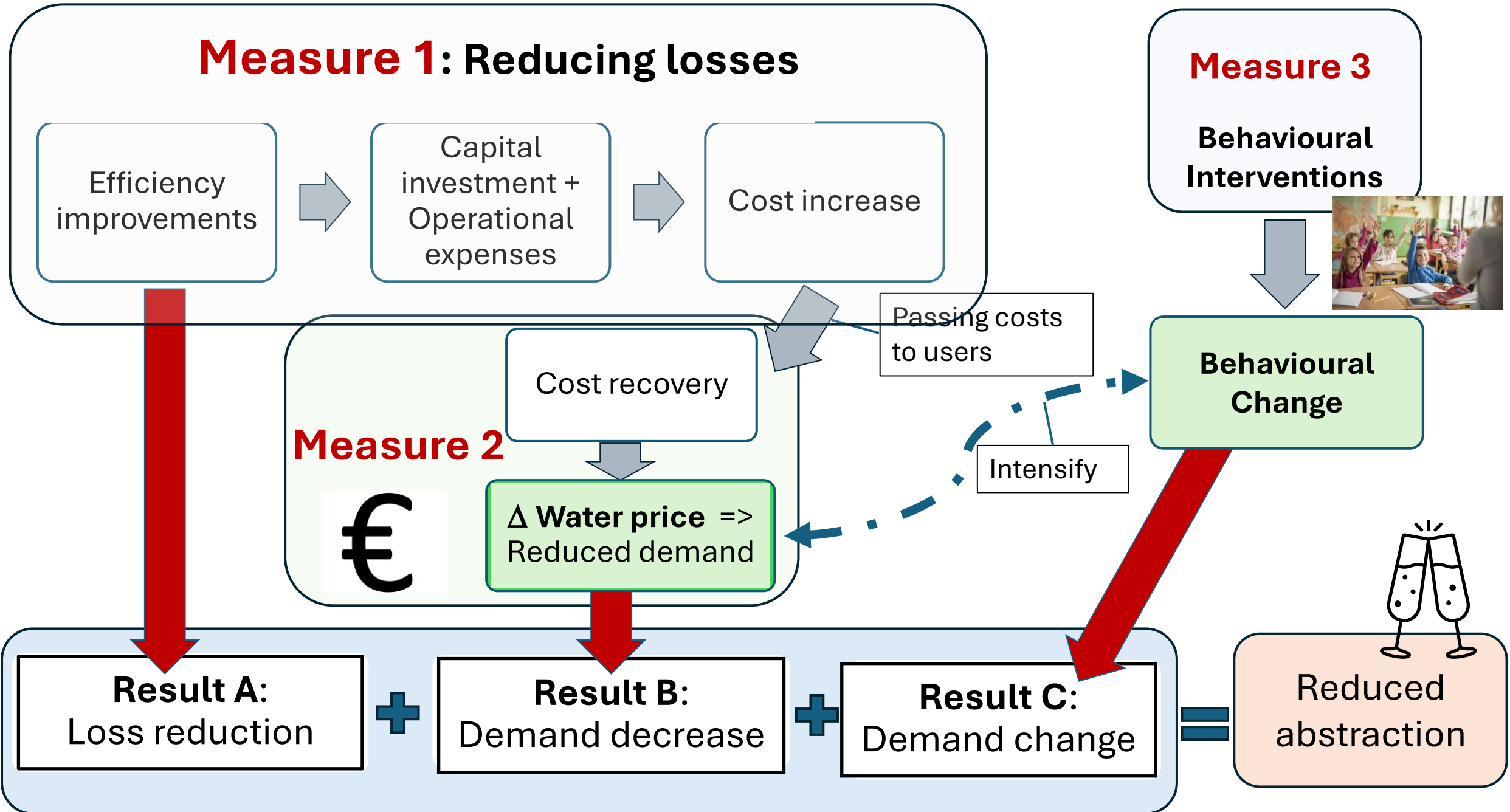
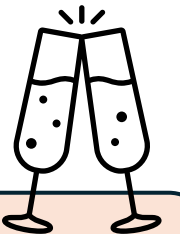
Result B:
Demand decrease

+

Result C:
Demand change

=

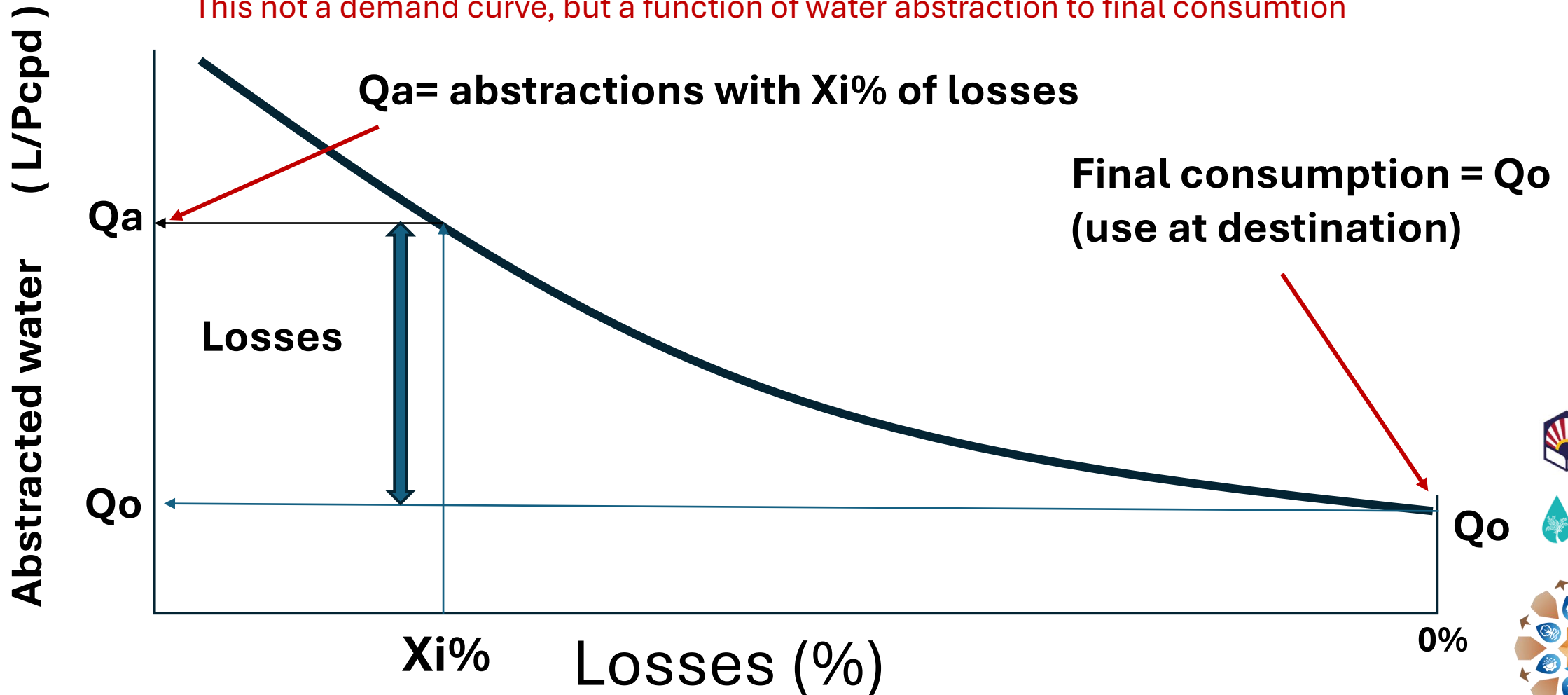
Reduced abstraction





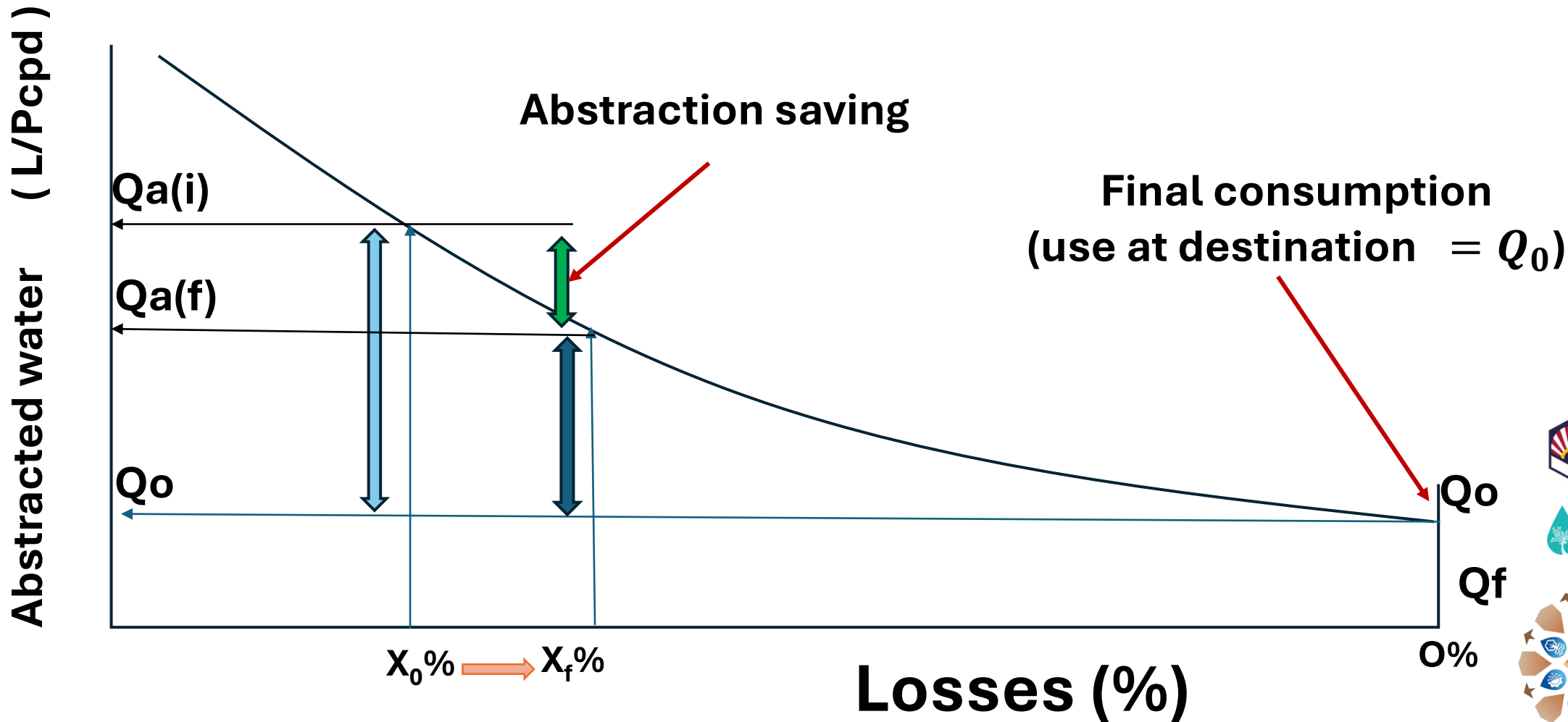
The model (general)

This not a demand curve, but a function of water abstraction to final consumption

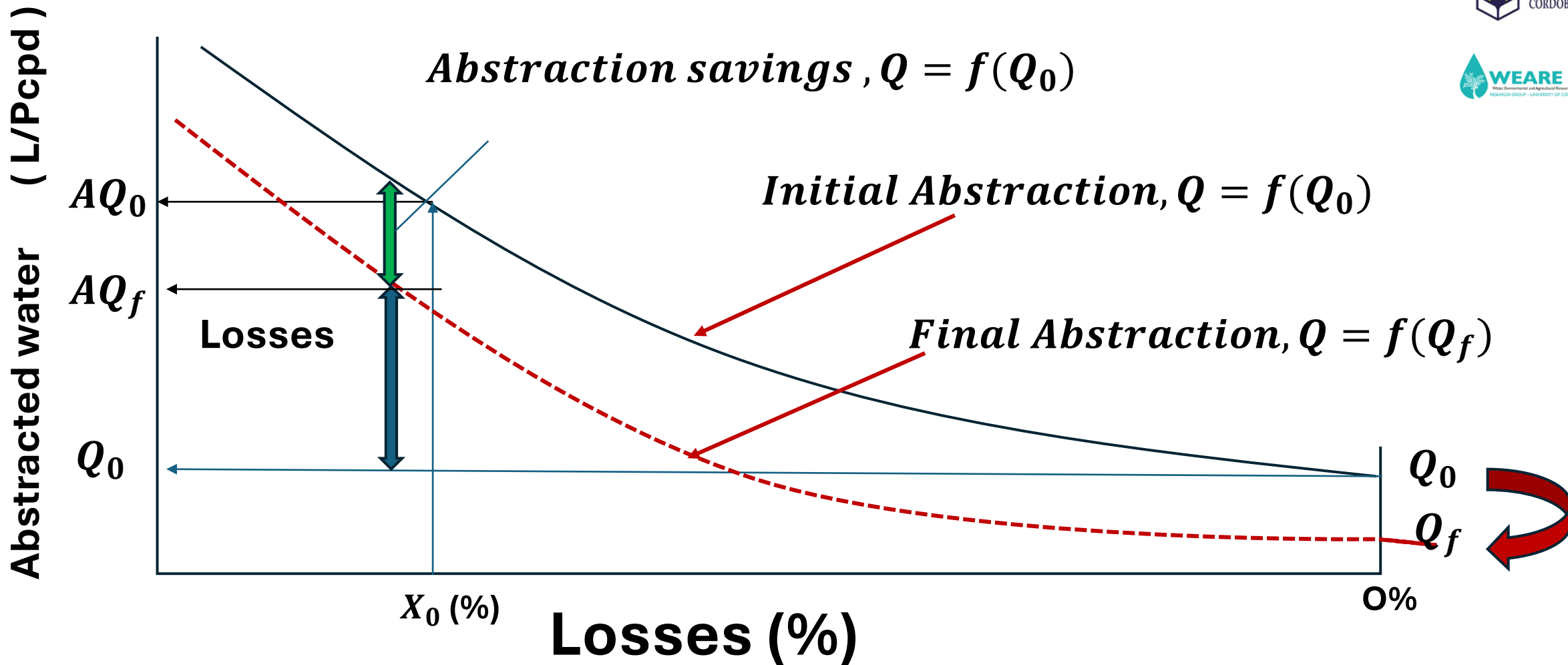




Impact of reducing network losses *from X_0 (%) to X_f (%)*



Impact of reducing final consumption [from Q_0 to Q_f]





The case of Sevilla demand reduction

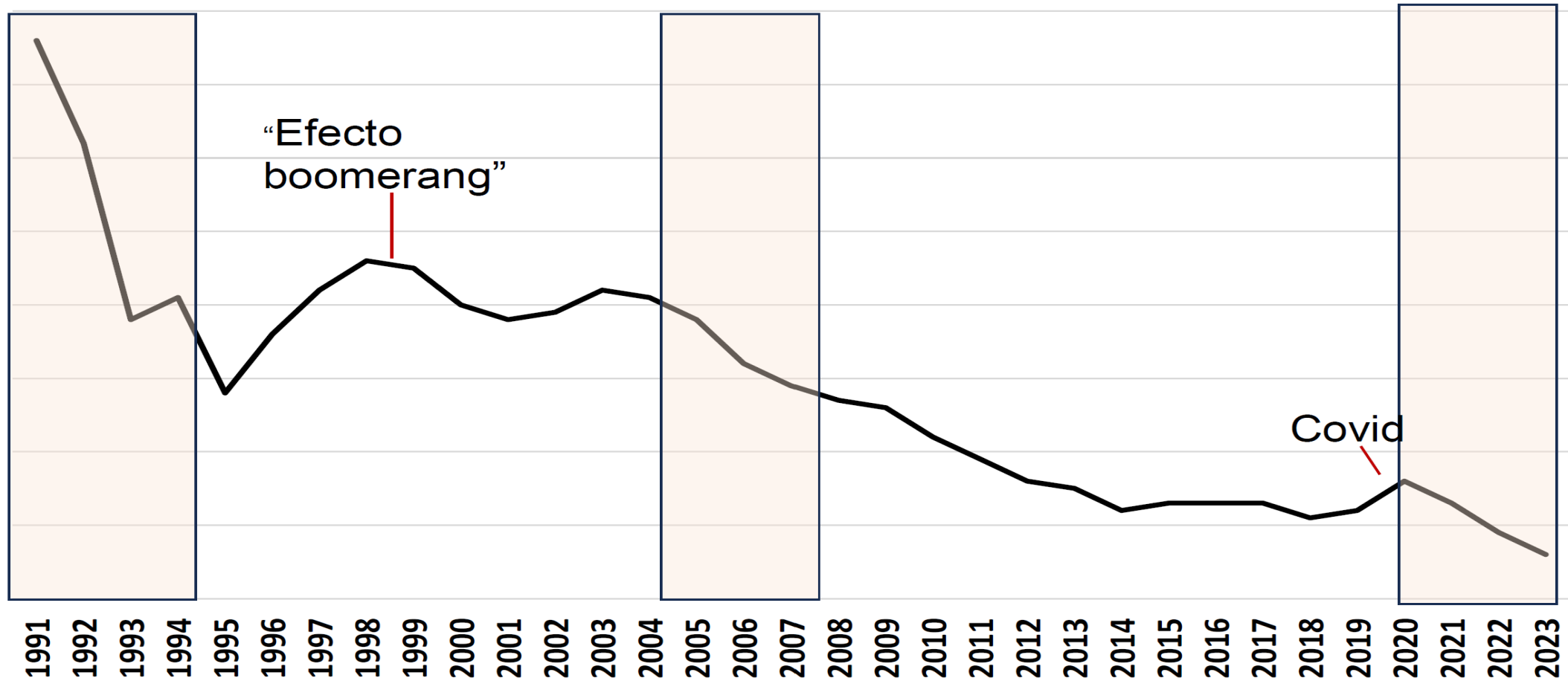


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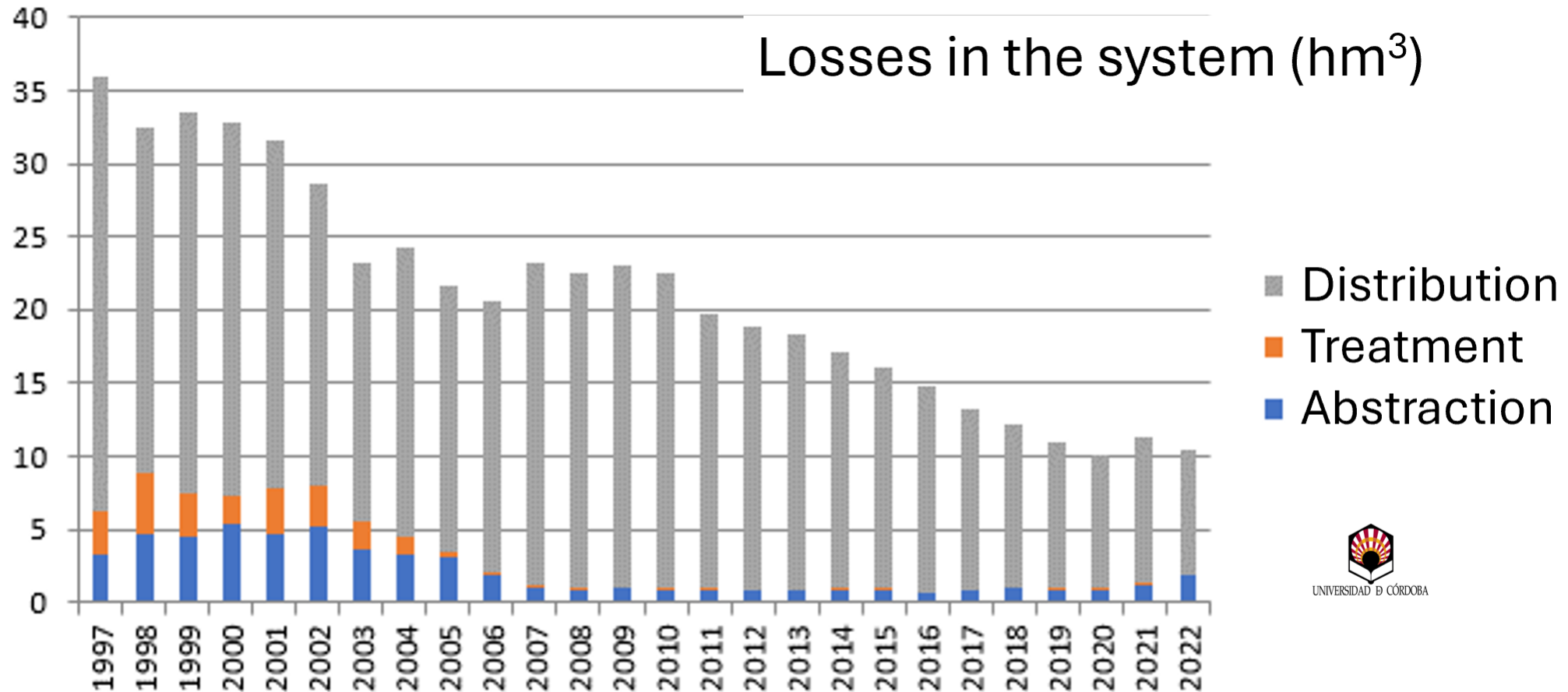


[2] Domestic final consumption reduction (L/p·d)

Sevilla final consumption (L/pcpd) 1991-2022



[3] Improving system efficiency



From 36% (1997) to 11% (2023)



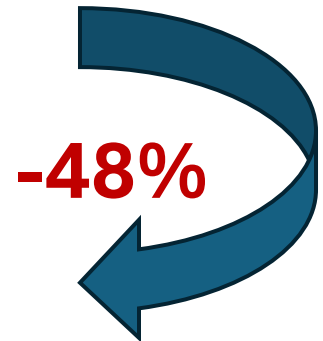
Result

Losses, consumption and abstraction



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| Year | Per capita consumption (L/pcpd) | Losses % | [2] Water abstracted (L/pcpd) |
|------|---------------------------------|----------|-------------------------------|
| 1999 | 142.0 | 33% | 211.9 |
| 2022 | 109.0 | 11% | 122.5 |



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Source: EMASESA, Authors' own

[1] Constant prices, 2022; [2] water abstracted for domestic use excluding administration and economic sectors



Decomposing effects



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Gross per-capita demand decreases by nearly half (-48%)

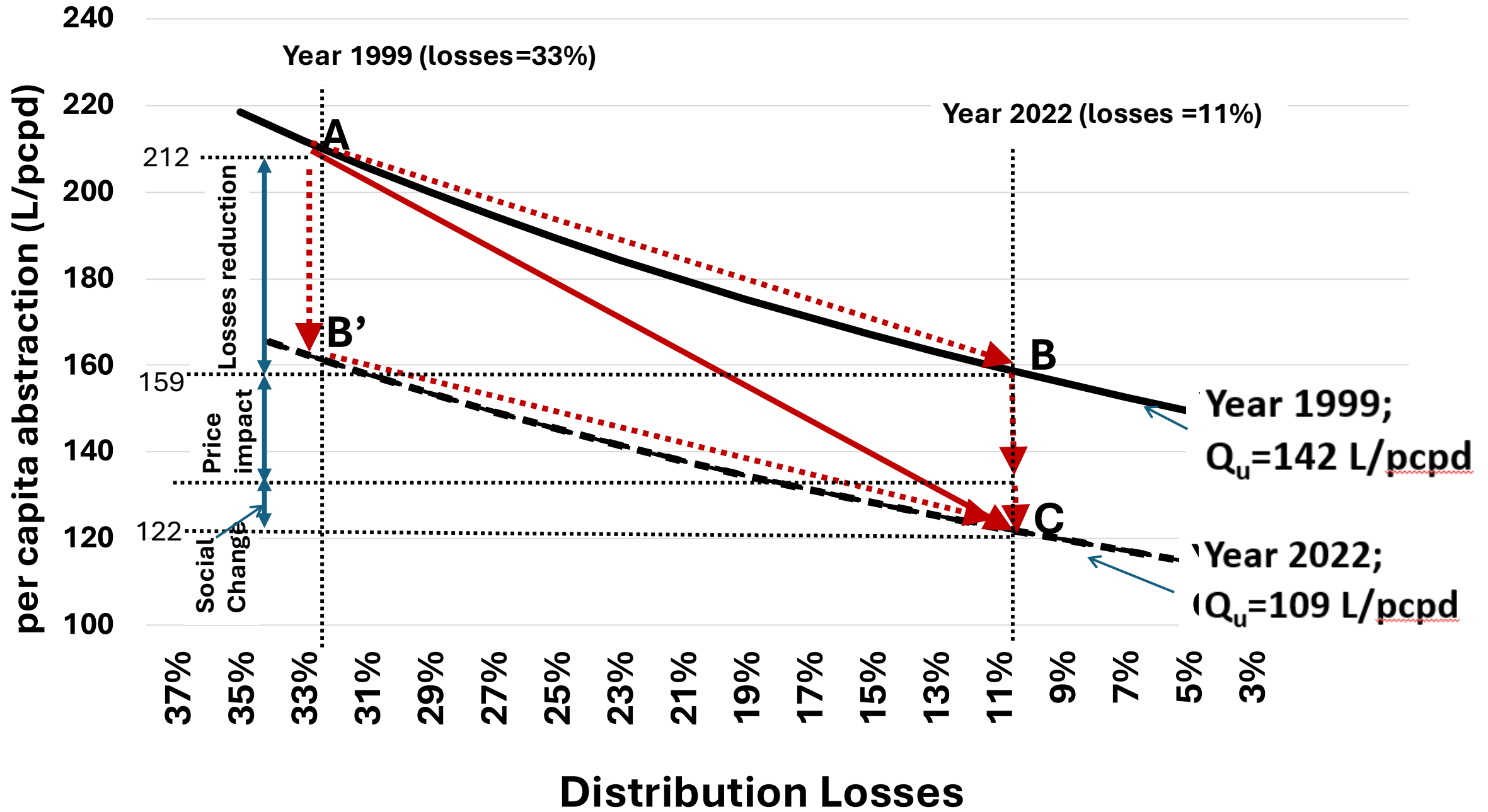
Question



What **contribution does each measure** make to achieving this reduction?"

- a) reducing network losses
- b) water pricing
- c) social awareness





Decomposing losses reduction vs demand management .l

| Policy strategy & transition (Figure 3) | Water-abstraction reduction (L/pcpd) | % of total | Description |
|---|--------------------------------------|------------|--|
| Policy strategy 'losses first' | | | |
| From A to B | 49.3 | 55% | Impact due to loss reduction from 33% to 11% |
| From B to C | 40.2 | 45% | Impact due to consumption reduction (from Q=142 to Q=109) |
| Total Saving | 89.5 | 100% | Total impact achieved without decomposing (from A to C) |

Decomposing Price and non Price measures





Decomposing “price effect” and “social awareness”

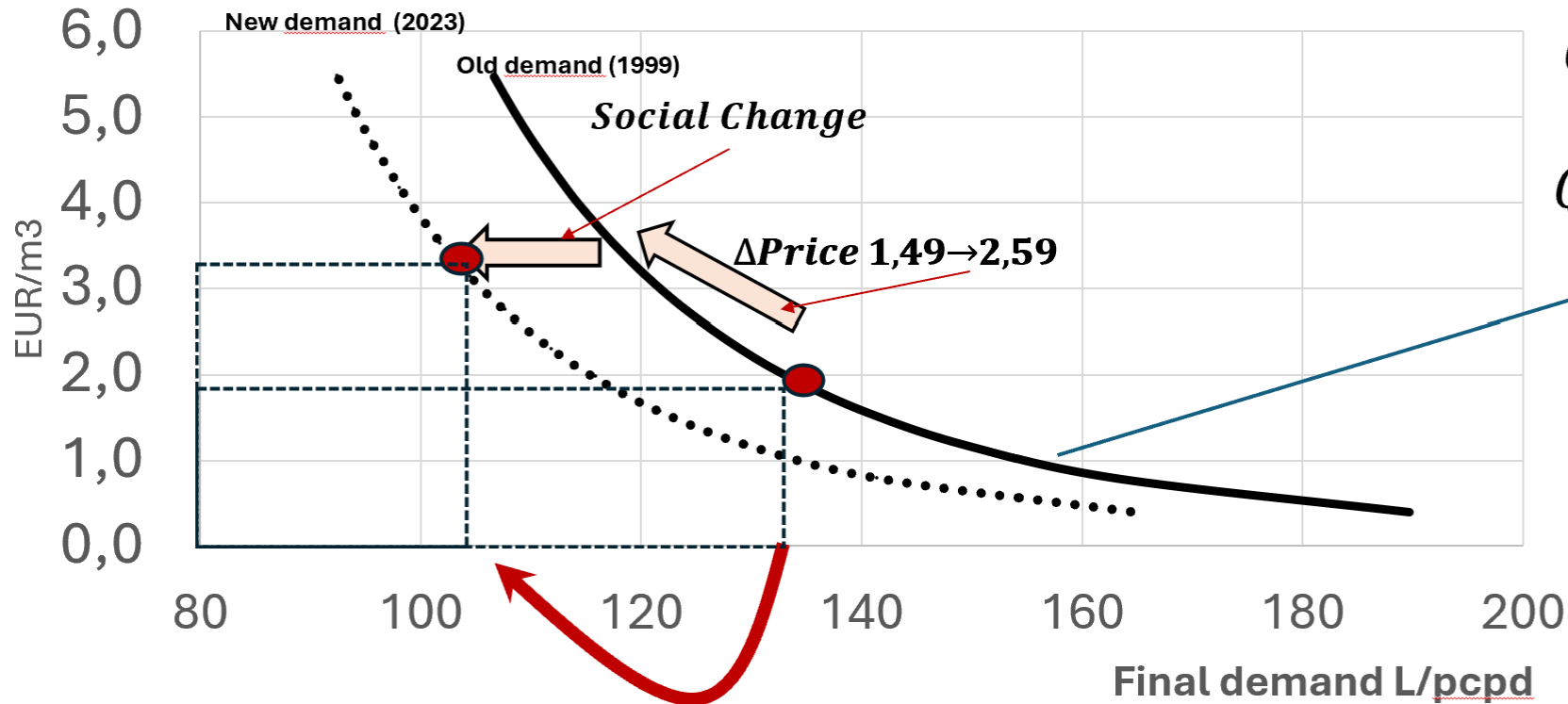
$$Q_{o,2022} = K \cdot P_w^e = 56.58 \cdot 2.59^{-0.22} = 45.27 \text{ m}^3/p \cdot y = 125.7 \text{ L/pcpd}$$

| Policy measure | Initial consumption (L/pcpd) | Estimated consumption (L/pcpd) | Consumption reduction (L/pcpd) | % Reduction |
|------------------|------------------------------|--------------------------------|--------------------------------|-------------|
| Pricing impact | 142.0 | 125.7 | 16.3 | 49% |
| Awareness impact | 125.7 | 109.0 | 16.7 | 51% |
| Total impact | 142.0 | 109.0 | 33.0 | 100% |



Decomposing price and non-Price demand changes

Water demand Sevilla



$$Q_h = K P_w^{-\epsilon}$$

$$Q_h = 54,23 P_w^{-0,24}$$



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Results: Reduced abstractions

Abstracted: from 174hm³/y (1991) to 94 hm³/y (2022)



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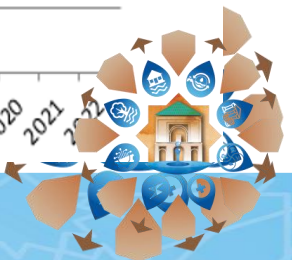
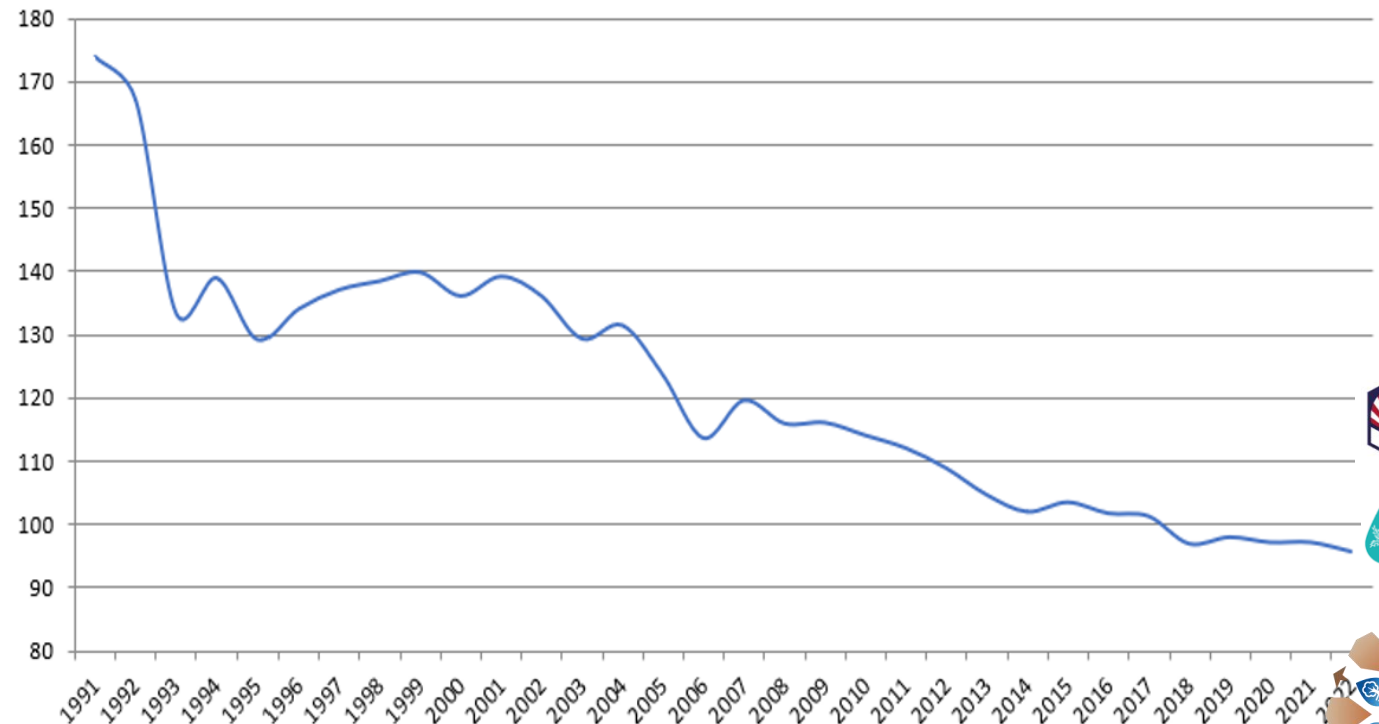
$$\text{Water Abstracted} = \frac{\text{Final consumption}}{(1 - \alpha)}$$

-43%

-23%

-22%

Water Abstracted (hm³)
Captado (hm³)





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Results



Storage vs abstraction ratio and beyond

| Year | Abstracted (hm ³ /y) | Capacity (hm ³) | Abstraction vs. Capacity (%) |
|-------------|---------------------------------|-----------------------------|------------------------------|
| 1991 | 174 | 448 | 39% |
| 2022 | 94 | 633 | 15% |



Although the system's capacity is 6.6 times the gross demand, it remains insufficient. In 2022, Seville initiated preliminary steps to acquire water rights from a nearby irrigation network, which operates independently from the urban supply system, as well as other measures



[4] Additional measures to enhance urban resiliency

Drought protocol

Digitalization

Water markets (adquisition of irrigation rights)

Aquifer recharge

Desalination (low salinity estuary)

Concluding remarks

Improved supply resilience
(1999-2023) achieved by

abstraction reduction **+43%**
increase storage capacity **-48%**

- **Technical investment**
 - network loss reduction
 - water storage increase
- **Economic instruments**
 - Water Price increase
 - Social awareness



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Thank you!

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