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Assessing the economic leakage level in water distribution systems

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Introduction

- The Spanish great paradox: Water is scarce, but there is not any consumption control, neither any water price policy.
- A very severe drought 91-95has not been enough to change the water culture, while a very short drought in the UK (95), had the convenient answer.
- Although the European Framework Directive (2.000) claims for the full cost recovery principle, the Spanish Hydrologic Plan (2001) does not take into account any price policy.
- Great controversy around the Spanish PHN:
  - Some relevant data: an intertie of 1050 Hm3, 750 km long with a cost of around 600 million of euros. Aragon, the region where the intertie should be born, is strongly against the PHN.

Introduction

IT IS RIDICULOUS TO SPEAK ABOUT WATER CONSERVATION WITHOUT A CONVENIENT WATER POLICY. FOR THAT REASON I FULL AGREE WITH THE:

European Water Framework Directive (December 2000)

Article 9 : Basic economic principles

- Full cost recovery
- The poluter pays

Countries of the South of Europe (Great irrigation tradition, - agriculture represents 80% of the total water demand -, deep water culture) are far to apply these basic principles. SPAIN is a clear example.

Introduction

There is a close correspondence between the price of the water and the level of leakage of a water distribution network

- **Top: Germany, Switzerland, The Netherlands, Japan, Singapore.**
- **High: France, United Kingdom, United States.**
- **Medium: Italy, Spain, Greece.**
- **Low: Colombia, Venezuela, Mexico.**
- **Ununderstandable: Cuba**

Introduction

- **Managing the system, in the meddium – long terme-, a water utility never should lose money.**
- **There is an economic leakage level for each water price.**
- **I summarise a method, with an example, to calculate it.**

BASIC CORRESPONDENCES

- **Repairing and Maintenance Costs Curve versus water leakage: RMCC(x)**
- **Leakage Water Costs Curve versus water leakage: LWCC(x)**
- **Total Costs Curve TCC(x) = RMCC(x) + LWCC(x)**

Basic water figures of Valencia Network

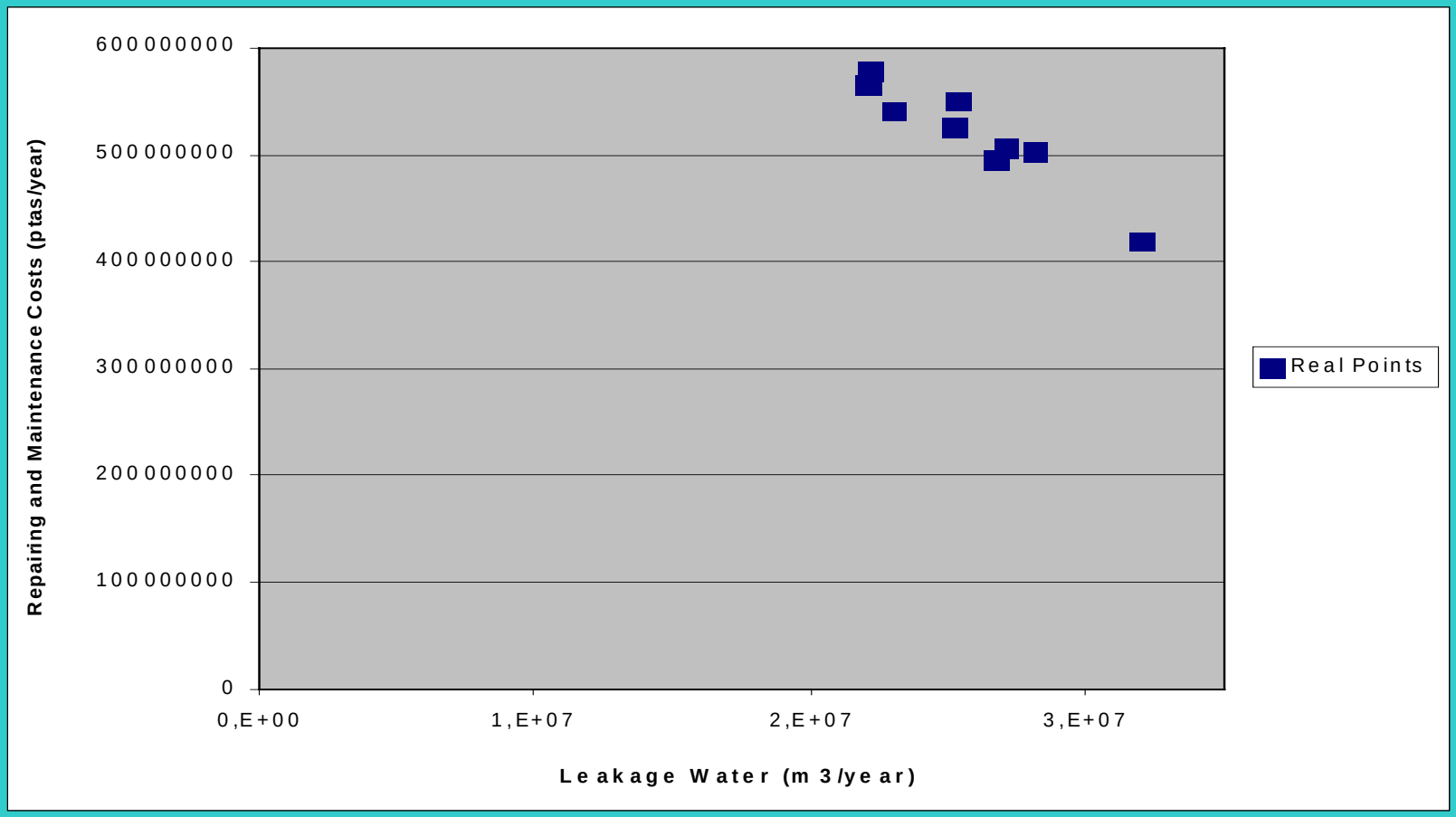
Year	*Input Water (10^3 m^3)*	*Metered Water (10^3 m^3)*	*Leakage Water (10^3 m^3)*	*Supplied Volume (10^3 m^3)*	*Network Efficiency (%)*	*Management Efficiency (%)*	*System/Global Efficiency (%)*
1992	99.702,0	64.161,8	31.986,2	67.715,8	67,9	94,8	64,4
1993	92.301,0	62.295,7	27.004,8	65.296,2	70,7	95,4	67,5
1994	88.580,0	57.363,6	28.094,8	60.485,2	68,3	94,8	64,8
1995	80.568,2	56.057,7	22.059,5	58.508,8	72,6	95,8	69,6
1996	79.492,0	55.068,2	21.981,4	57.510,6	72,3	95,8	69,3
1997	81.939,8	54.061,4	25.090,6	56.849,2	69,4	95,1	66,0

RMCC(x)

- **Repairing and Maintenance Costs Curve versus water leakage: RMCC(x)**

Year	*Maintenance Costs (Mptas)*	*Maint. Costs (Mptas Yr 2000)*	*Metered Water (10^3 m^3)*	*Uncontrol. Water (10^3 m^3)*	*Used but not metered Water (10^3 m^3)*	*Leakage Water (10^3 m^3)*
1992	284,6	420,5	64.161,8	35.540,2	3.554,0	31.986,2
1993	360,8	507,7	62.295,7	30.005,3	3.000,5	27.004,8
1994	375,2	502,8	57.363,6	31.216,4	3.121,6	28.094,8
1995	453,1	578,3	56.057,7	24.510,5	2.451,1	22.059,5
1996	465,3	565,6	55.068,2	24.423,8	2.442,4	21.981,4
1997	454,7	526,4	54.061,4	27.878,4	2.787,8	25.090,6
1998	449,5	495,6	55.376,3	29.653,0	2.965,3	26.687,7
1999	524,5	550,7	56.193,7	28.165,1	2.816,5	25.348,6
2000	541,7	541,7	57.793,8	25.503,1	2.550,3	22.952,8

RMCC(x)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Repairing and Maintenance Costs (ptas/year)
Leakage Water (m 3/year)
Real Points

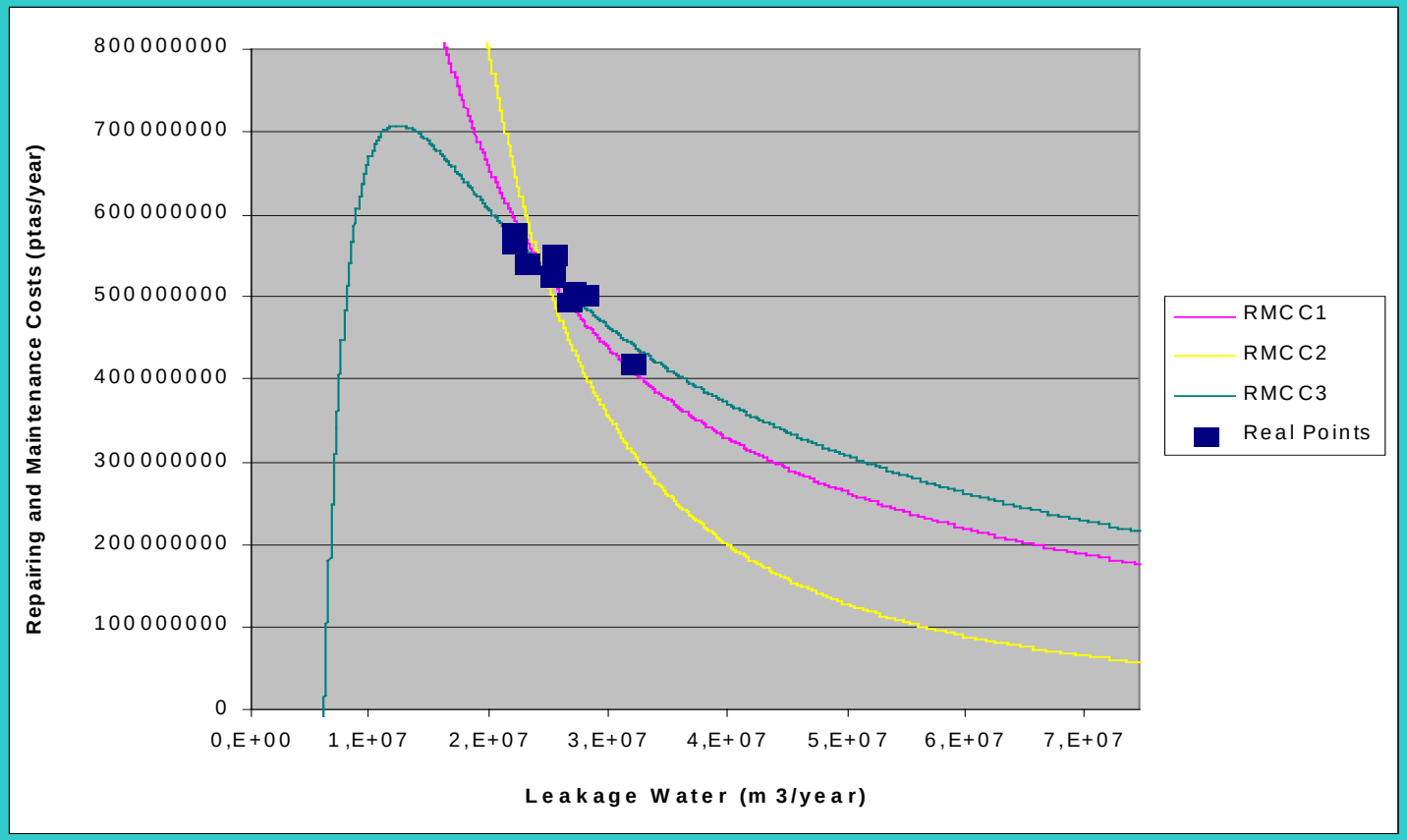
RMCC(x) – proposed adjustments

$$E1: \quad RMCC_1(x) = \frac{1,3157 \cdot 10^{16}}{x}$$

$$E2: \quad RMCC_2(x) = \frac{3,20471 \cdot 10^{23}}{x^2}$$

$$E3: \quad RMCC_3(x) = \frac{-1,08847 \cdot 10^{23} + 1,75591 \cdot 10^{16} \cdot x}{x^2}$$

RMCC(x) – adjustment curves



Leakage Water Costs (1992 – 2000)

Chemicals (Mptas)	*Electricity (Mptas)*	Plant Maintenance (Mptas)	*Plant Personnel (Mptas)*	*Produced Water (Mm^3)*	*Internal Unit Cost ($ptas/m^3$)*	*Internal Unit Cost (ptas Yr 2000 / m3)*
56,2	285,2	56,8	170,268	113,434	5,0	7,4
57,6	283,1	64,4	183,036	108,235	5,4	7,6
64,2	290,1	67	193,104	107,193	5,7	7,6
43,2	291	79,2	214,836	98,6297	6,4	8,2
51,2	282	68,5	213,576	101,315	6,1	7,4
48,3	295,8	91,1	221,484	108,181	6,1	7,1
45,3	302,5	77,3	225,192	112,247	5,8	6,4
49,9	270,2	94	231,492	111,920	5,8	6,1
53,4	294,9	94,8	238,596	112,122	6,1	6,1

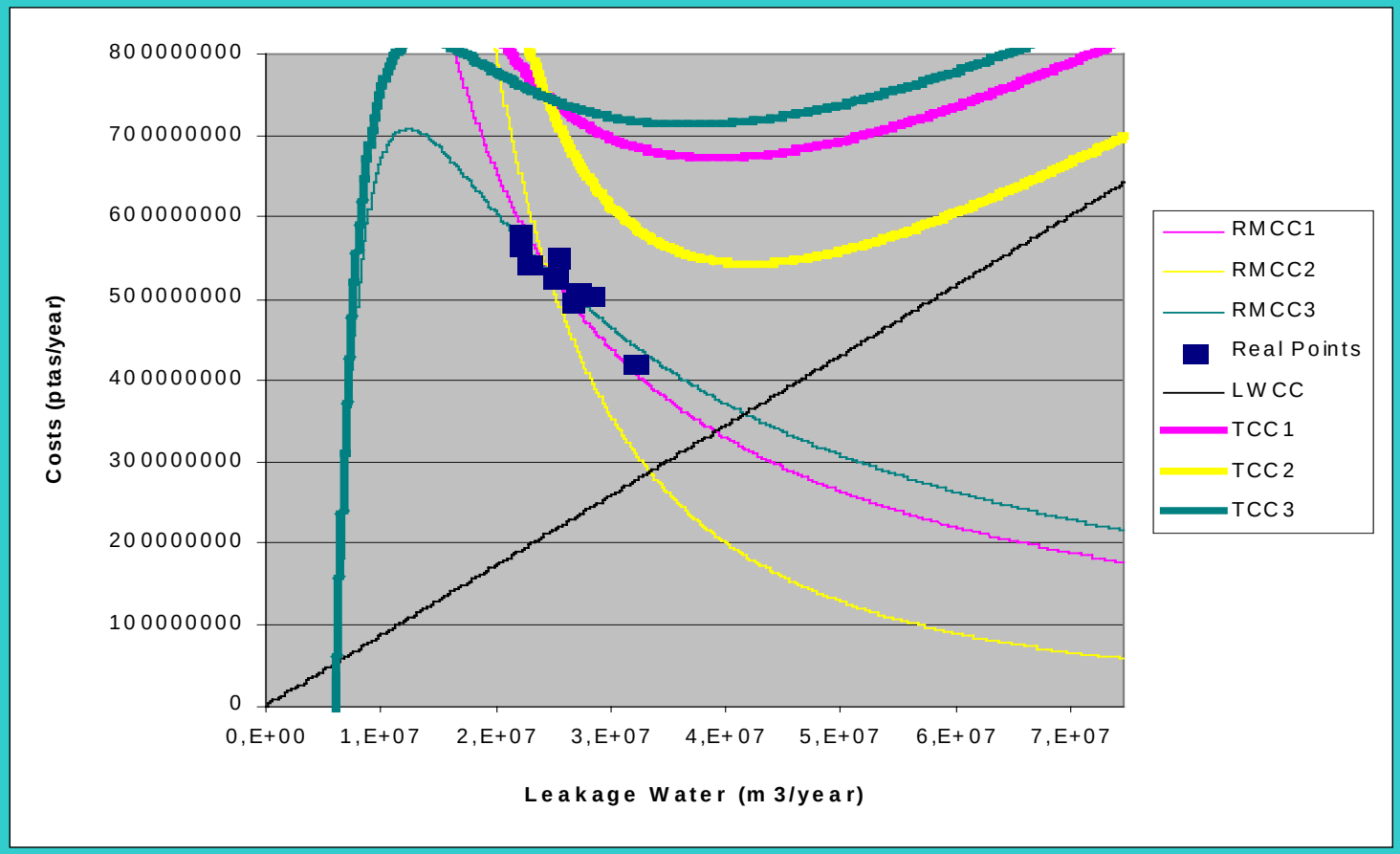
Economic leakage level

$$\frac{d\ TCC\quad(x)}{d\ x} = \frac{d\ RMCC\quad(x)}{d\ x} + \frac{d\ LWCC\quad(x)}{d\ x}$$

$$\frac{d\ TCC\quad(x)}{d\ x} = 0$$

RMCC 1: (x opt = 39,115,000 m3/year; y opt = 672,756,123 ptas/year)
RMCC 2: (x opt = 42,085,000 m3/year; y opt = 542,870,786 ptas/year)
RMCC 3: (x opt = 36,795,000 m3/year; y opt = 713,254,479 ptas/year)

Economic leakage level



CONCLUSIONS

It is impossible to claim for a rational use of water without a convenient economic policy.

IN SPAIN (Irrigation tradition), the European Framework Directive will have (as far as water prices concerns) strong resistance to be implemented.

It is most than necessary to change the water culture

We need to learn from other countries with less water stress, and with less water history(Tribunal de las Aguas, IX century) but with a more rational water policy.