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26th ERC & 66th IEC

REDUCING THE ENERGY DEMAND IN IRRIGATION WATER SUPPLY SYSTEMS. EXPERIENCES FROM SOUTHERN EUROPE

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Presentation outlines

1. Introduction
2. Water and energy use in Andalusian irrigation districts
3. Potential energy saving measures
4. Conclusions

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1. Introduction

Main Challenges → Improvement of agricultural water management

2002

National Irrigation Plan and an Emergency Plan for Modernization of Irrigation

Aim: saving 3000 Mm^3
Investment: 7400 M€
Affected area: 2 Mha

New pressurized networks have replaced some of the obsolete open-channel hydraulic infrastructures

- Farmers got a much greater degree of flexibility.
- Irrigation efficiency was increased.

- Water use has been reduced by 21% from 1950 to 2007
- Energy demand was subsequently increased by 657%.
- Amortization costs of the infrastructure and installation of irrigation systems and the operating costs.

Current situation of the irrigation energy demand supported by real data from irrigation districts and shows different alternatives for reducing the energy dependence

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2. Water and energy use in Andalusian irrigation districts. Upscaling the energy problem in pressurized systems

Irrigation district	Irrigated area (ha)	Energy consumption per unit of irrigation water supplied (kWh/m^3)	Energy to total water costs ratio (%)
F. Palmera	5611	0.73	27.05
Las Coronas	450	0.34	65.27
El Villar	2726	0.89	48.67
Genil-Cabra	16100	0.33	29.50
M. D Bembezar	11262	0.15	18.55
P. Guadiana	4520	0.33	32.40
P. Bancos	1336	0.53	49.89
Los Dolores	4500	0.39	40.17
C. Noroeste	8383	0.17	16.05

↳ Energy is now becoming a major factor even more important than the water availability in some regions.

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3. Potential energy saving measures

Research lines on energy efficiency of the Area of Irrigation and Hydraulic Engineering of Córdoba University are based on the following strategies:

1. Irrigation network sectoring.
2. Critical points detection.
3. Improving the energy efficiency of the pumping system.
4. Irrigation systems at farm level.
5. Water supply using solar energy.

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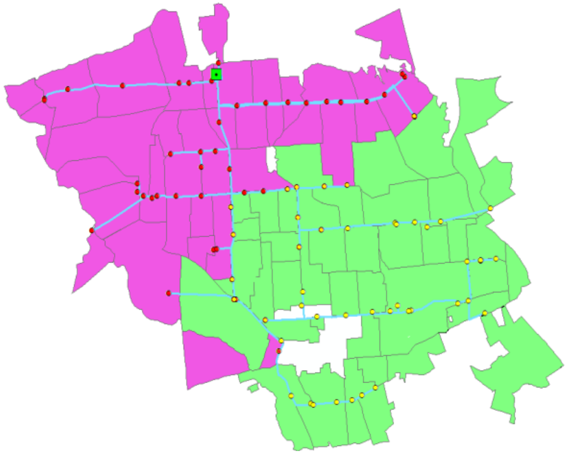
3. Potential energy saving measures. Irrigation network sectoring



- Development of models for optimum network sectoring according to homogeneous energy demand sectors and organize farmers in irrigation turns.
- Optimization models for branched and looped networks with one or several water supply points.
- Potential energy savings around 20-30%.

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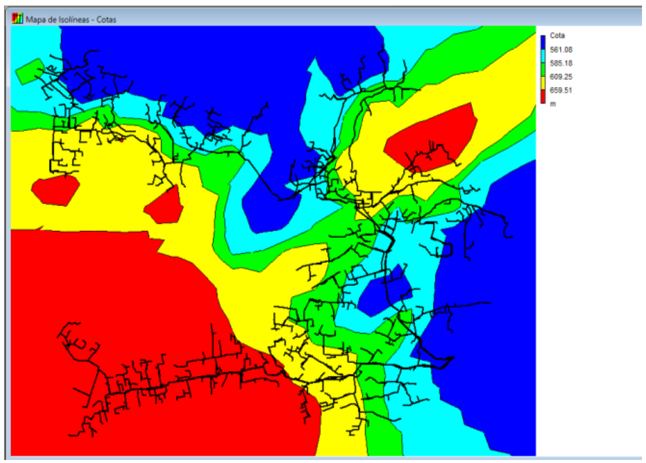
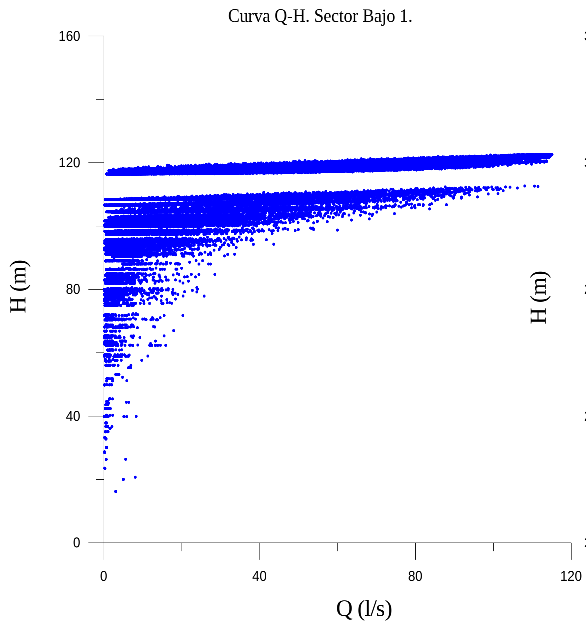
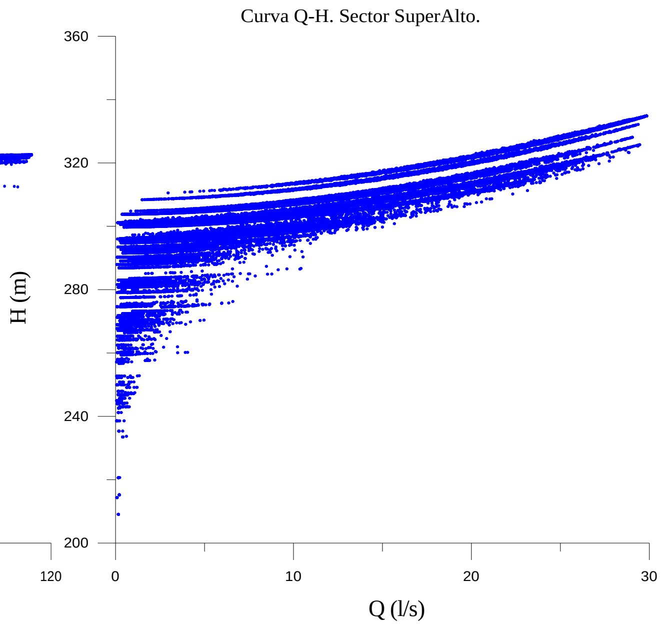
3. Potential energy saving measures. Irrigation network sectoring



Dehesa Portillo Albardinales I.D.





Navarro Navajas, J. M., Montesinos, P., Poyato, E. C., & Rodríguez Díaz, J. a. (2012). Impacts of irrigation network sectoring as an energy saving measure on olive grove production. Journal of Environmental Management, 111, 1–9

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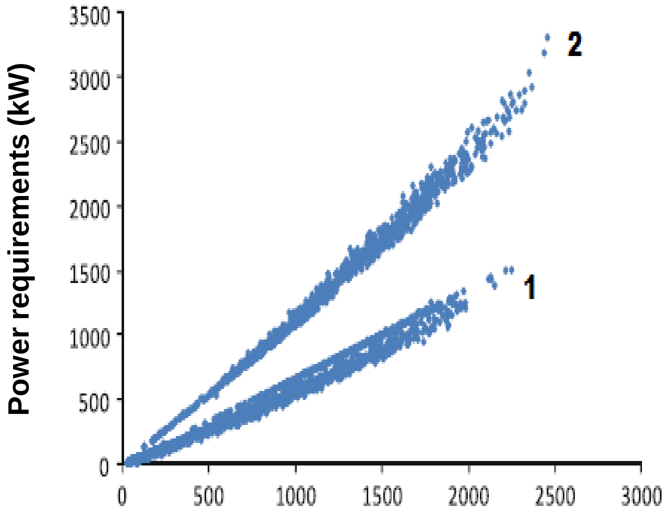
3. Potential energy saving measures. <u>Critical points detection</u>



Power demand when critical hydrants are disabled (1) and enabled (2).

- Hydrants with high energy requirements due to their elevation, distance to the pumping station or network's topology.
- Models for Critical points control based on the installation of booster pumps and the replacement of undersized pipes.

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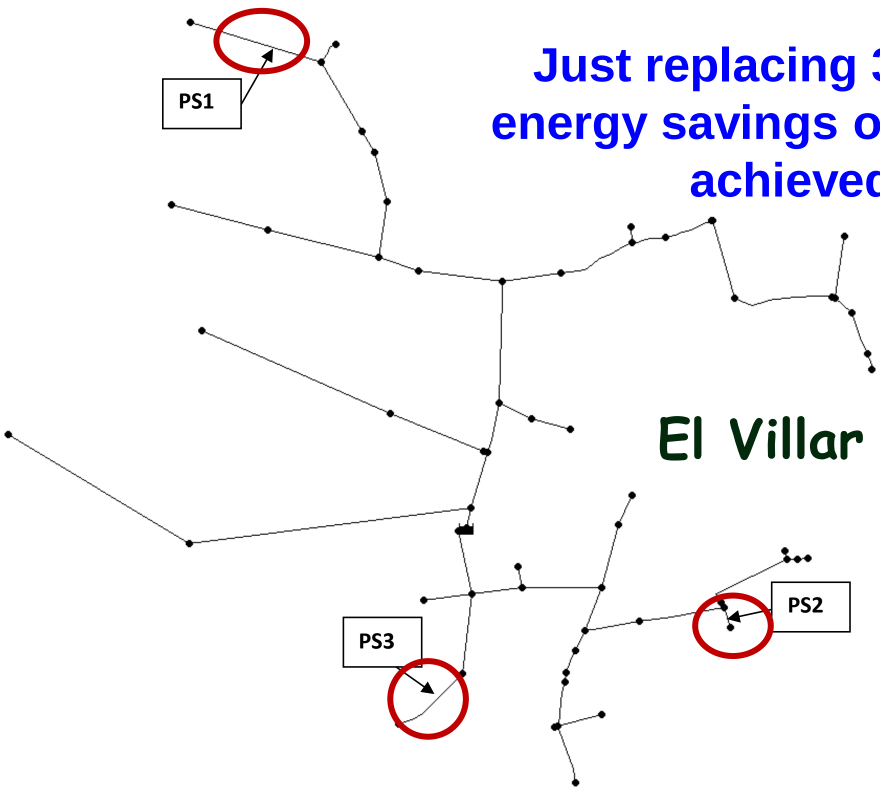
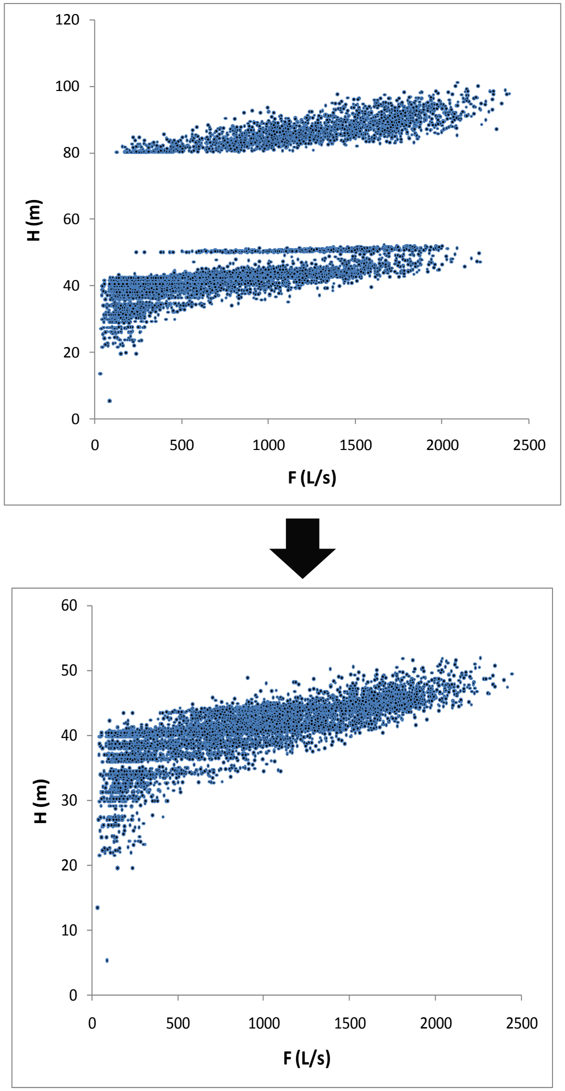
3. Potential energy saving measures. Critical points detection



Just replacing 3 pipes, energy savings of 30% are achieved

El Villar I.D.



Díaz, J. a R., Montesinos, P., & Poyato, E. C. (2012). Detecting Critical Points in On-Demand Irrigation Pressurized Networks - A New Methodology. Water Resources Management, 26(6), 1693–1713

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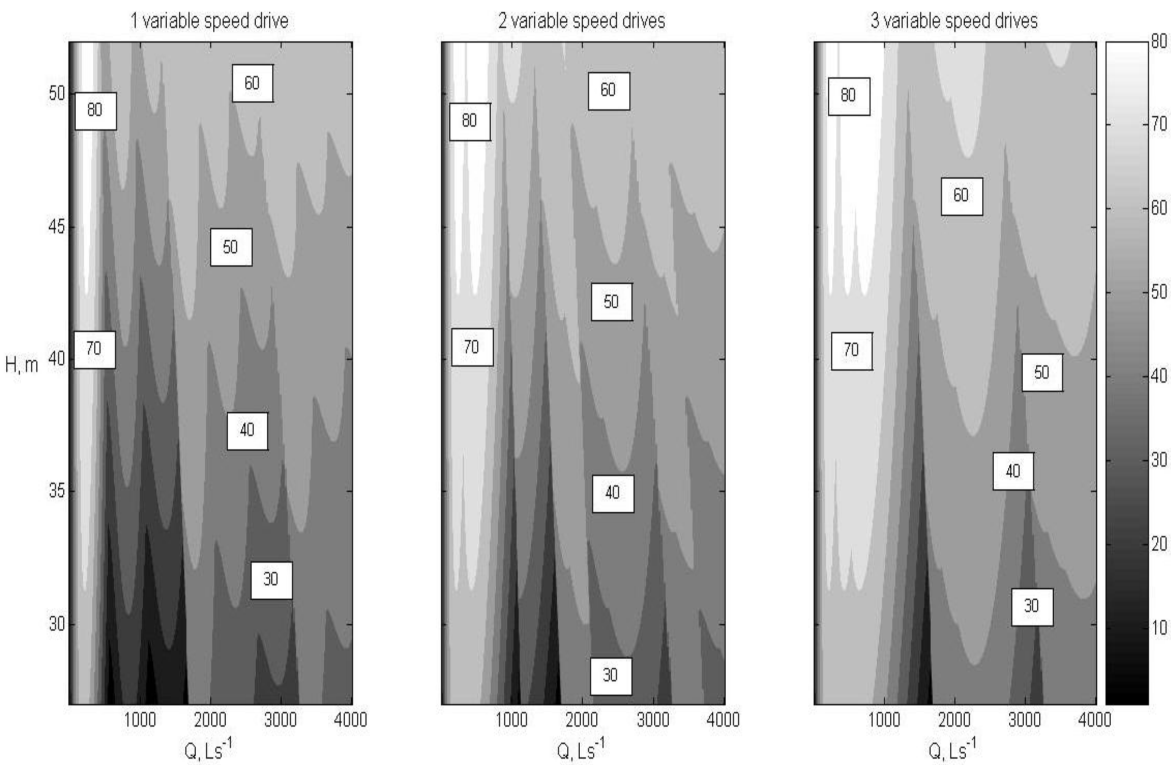
3. Potential energy saving measures. **Improving the energy efficiency of the pumping system**



Modelling the pumping efficiency for 1, 2 and 3 variable speed drives in Bembézar MI

Fernández García, I., Moreno, M. A., & Rodríguez Díaz, J. A. (2014). Optimum pumping station management for irrigation networks sectoring: Case of Bembezar MI (Spain). Agricultural Water Management, 144, 150–158

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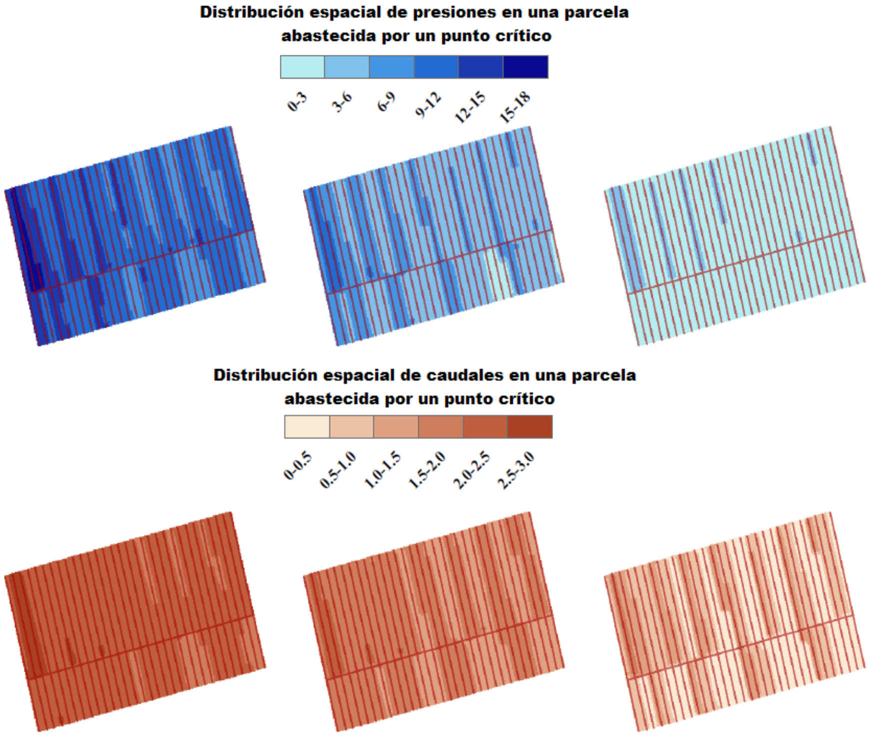
3. Potential energy saving measures. Irrigation systems at farm level



- Evaluation of impacts on yields of changes in pressure head at the pumping station and demand simultaneity.
- Appropriate selection of emitters that maximizes yields and minimizes the energy demand in critical fields (supplied by critical hydrants).
- Potential energy savings around 30% vs yield production losses 3.4%.

González Perea, R., Camacho Poyato, E., Montesinos, P., & Rodríguez Díaz, J. a. (2014). Critical points: interactions between on-farm irrigation systems and water distribution network. Irrigation Science, 32(4), 255–265

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3. Potential energy saving measures. Water supply using solar energy

iwes
Spin-off of the University of Córdoba
(www.iwes.es)

- Citrus field with drip irrigation.
- The installed power was 14.25 kW with an estimated annual energy production of 24225 kWh.
- After the first year of operation, the economic savings where 100% of the energy costs since solar panels produced all the energy requirements and no additional energy was purchased from the main grid.
- The environmental benefits were estimated in 1688 kg $CO2$ year^{-1} by avoiding the use of fossil fuels.
- Payback period around 3-6 years.

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4. Conclusions

- In Spain, open channel distribution networks have been replaced by on demand-pressurized networks to improve the efficiency of the water distribution systems.
- This effect has been evaluated in several Irrigation Districts. Although results show a reduction of approximately 40% of water use, the energy requirements have dramatically risen. Thus, the total costs have also dramatically increased after modernization, typically increasing fourfold.
- Energy represents an important percentage of the total water costs (around 40%), in agriculture, nowadays water use and energy efficiency cannot be considered independently.
- There are realistic alternatives to increase energy use efficiency for irrigation. Some these energy saving options are presented in this work.

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THANK YOU

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