

From Fear of Cholera to Full Wastewater Treatment in Two Decades in Santiago, Chile



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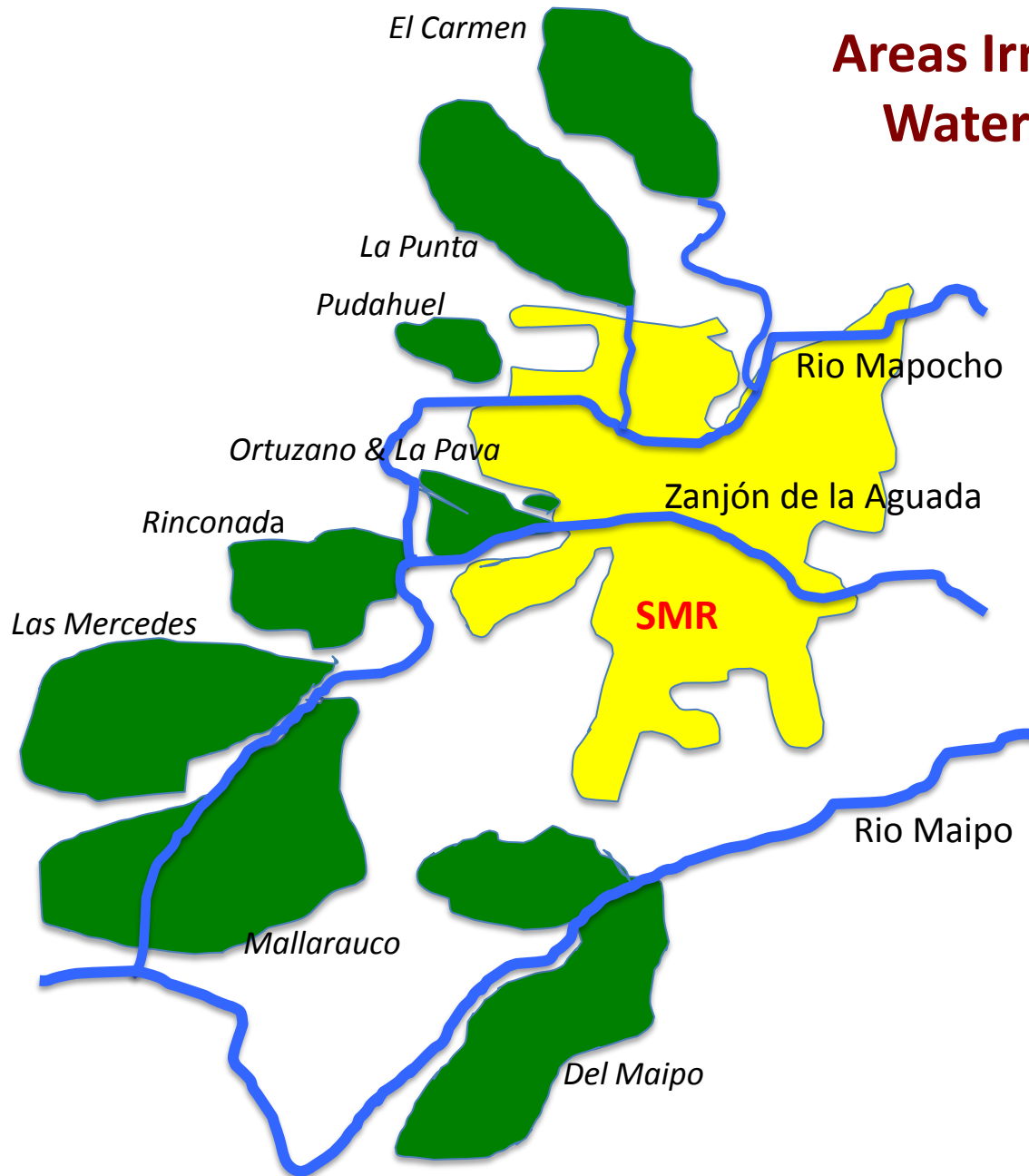
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1818 Society BBL, 8 November 2011

Indirect wastewater irrigation in the Santiago Metropolitan Region (SMR): Situation in 1991

- ❑ Population of SMR 4.7 million
- ❑ GNP per capita \$1,930
- ❑ Water and sewerage coverage:
 - Water supply 95%
 - Sewerage 87%
 - Treatment < 1%
 - 13.3 m³/s of raw sewage discharged into the Mapocho River, the Maipo River, and the *Zanjón de la Aguada* drainage canal (virtually an open sewer)
- ❑ 130,000 ha of high-producing agricultural land in SMR irrigated with highly polluted water
 - Including 7,000 ha of vegetable crops for raw consumption in the Santiago market
 - Also producing 40% of Chile's fruit exports
- ❑ Agricultural exports valued at \$1.1 billion annually
 - growing at 10% annually

Areas Irrigated with Polluted Water in the SMR (1991)



Agricultural Zone	Area (ha)
<i>El Carmen</i>	10,000
<i>La Punta</i>	6,000
<i>Pudahuel</i>	300
<i>La Pava</i>	200
<i>Ortuzano</i>	2,500
<i>Rinconada</i>	1,500
<i>Las Mercedes</i>	12,000
<i>Mallarauco</i>	28,000
<i>Del Maipo</i>	70,000
Total	130,500

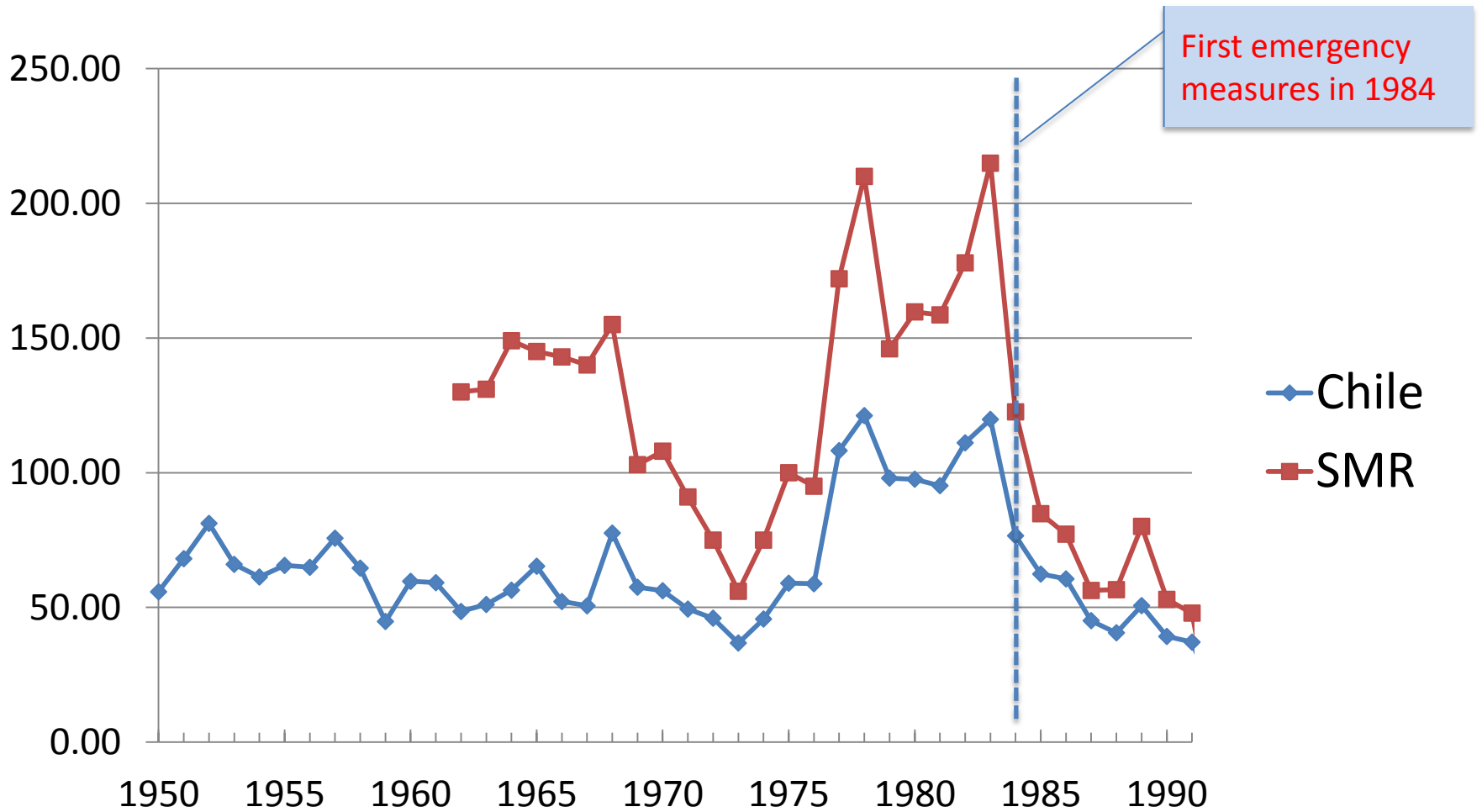
Source: Bartone, 1994

Health Dilemma in SMR

❑ Persistent endemic typhoid fever in SMR

- Unexpected in a country like Chile with moderate income and high levels of education, nutrition and health care
- Much higher rate of typhoid in SMR than in rest of Chile
- Linked to extensive indirect wastewater irrigation in the SMR
 - “Long-cycle” of transmission – the SMR loop:
Infected person → sewage → water pollution → raw vegetables → people
- Hyper-endemic typhoid rates between 1976 and 1983
 - up to 215 cases per 100,000 population
- First major intervention by Ministry of Health in 1984:
 - Prohibited cultivation of vegetable crops consumed raw:
 - Initiated public education campaign on risks of sewage irrigation
 - Resulted in 59% drop in typhoid by 1986, to average levels of endemicity

Typhoid Morbidity Rate in Chile, 1950-1991 (cases/100,000 population)



Source: Chile Ministry of Health, 2010

1991 Cholera Outbreak

- ❑ A major cholera outbreak started in January 1991 in Peru and quickly spread to other parts of Latin America
 - Peru experienced 322,562 cases and 2,909 deaths in 1991
 - Wastewater irrigation of crops a major factor is rapid spread of cholera
- ❑ In Chile, 41 cases and 2 deaths occurred in April-May 1991
 - 70% of cases attributed to consumption of Santiago vegetables
 - Fear of major outbreak since:
 - Cholera like typhoid is spread by “long-cycle”
 - Peru had similar rates of typhoid as observed in SMR
 - Fear of potential health, social and economic impacts
 - 1970 Jerusalem cholera outbreak nearly destroyed Israel’s agricultural exports to Europe (including flowers)
 - Estimated losses to Peru of \$177 million in direct and indirect health costs plus export and tourism losses in 1991
 - In 1989, Chile experienced a US embargo on all its fruit exports due to 2 grapes found with traces of cyanide – so GoC politically sensitized to the risk

Emergency Response to Cholera Hazard

- GoC took decisive action in 1991 aimed at eliminating the hazard of irrigation with untreated wastewater
 - Created National Commission to Avoid Cholera
 - Including Ministries of Agriculture, Health and Public Affairs
 - Put in place Emergency Control Program of public health interventions and sanitary education including:
 - Measures to improve irrigation water quality (construction of interceptors, chlorination of irrigation water, loans to farmers to drill wells)
 - Measures to change farmers' irrigation practices (banned sale of wastewater-irrigated produce, removed this produce from markets, banned transport of this produce outside SMR – accompanied by intensive sanitary inspections and destruction of any banned crops found growing)
 - Lettuce, chicory, coriander, parsley, radishes, carrots, celery, cauliflower, beets, spinach, watercress, and strawberries
 - Measures to change consumer behavior (intensive education campaigns on risks of eating raw vegetables; press coverage on cholera and typhoid; banned sale of raw vegetables in restaurants)
 - Emergency Control measures continued for several years
 - Typhoid rates dropped to 12 cases/100,000 population in 1993
 - A major cholera outbreak was successfully avoided

Sanitation Plan for SMR

- Beyond the Emergency Control Program, the GoC also focused on longer-term structural measures to control pollution from urban wastewater and guarantee the sustainability of health, social and economic benefits
 - EMOS, with World Bank support, prepared a long-term Sanitation Plan for wastewater interception and treatment in the SMR
 - World Bank ESW on economic impacts of environmental issues in Chile included a policy cost-benefit analysis of wastewater treatment:
 - Concluded that annual health and agricultural benefits would significantly offset the annual cost of treatment
 - Policy-makers came to view wastewater treatment as a necessary and viable environmental infrastructure investment
 - EMOS' original target was to reach 100% wastewater treatment by 2024
 - Policy reforms of the water sector, initiated in 1989, were designed to prepare the way for eventual privatization
 - A first step transformed EMOS into a state-owned stock corporation under private commercial law
 - Subject to a regulatory framework that mimicked the design of a concession with a private utility

World Bank Support for the *Empresa Metropolitana de Obras Sanitarias (EMOS)*

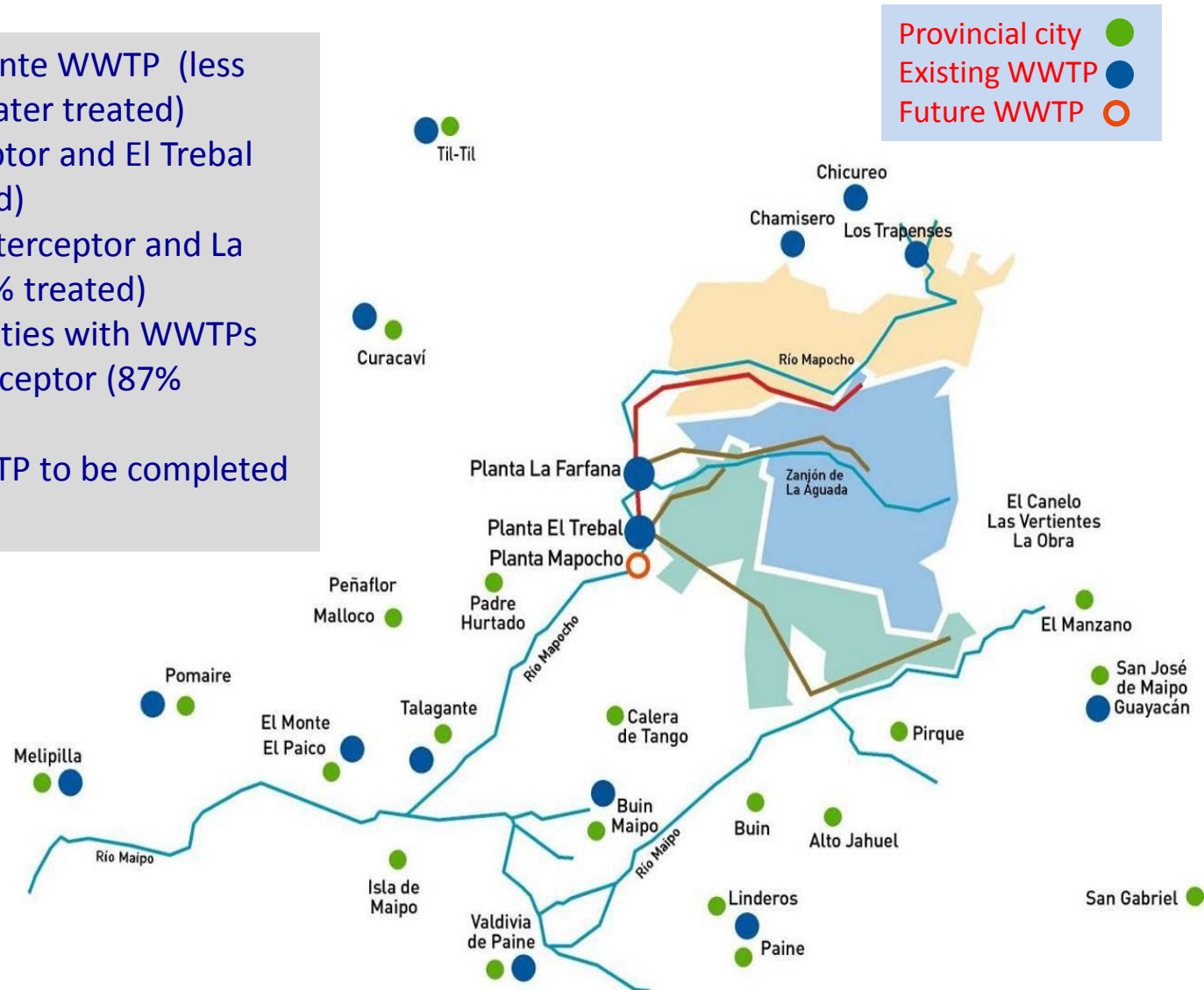
- Second Santiago Water and Sewerage Project approved in 1986
 - First of 3 objectives:
 - “To support the first phase of a plan to alleviate sewage disposal and reuse problems with a view to reducing incidence of typhoid fever and other enteric diseases.”
 - Sewerage component (\$44.6 million)
 - 70 km of trunk mains and 200 km of secondary sewers
 - Pilot WWTP Santiago Poniente
 - WWTPs for provincial cities in SMR
 - Technical assistance to help finalize wastewater treatment master plan
 - Results in 1995:
 - Sewerage coverage increased from 87% to 96%
 - Construction of first major interceptor of the Zanjón de la Aguada protecting 2,700 ha of irrigated land (Ortuzano and La Pava irrigation zones)
 - Relocated major sewage discharge to Canal El Carmen eliminating primary pollution of 10,000 ha of irrigated land
 - Santiago Poniente Pilot WWTP operational, plus one provincial city WWTP
 - In 1995, EMOS approves “*Sanitation Plan for Greater Santiago, 1995-2024*” calling for progressive sanitation of agricultural zones through wastewater interception and treatment

Impact of Privatization of EMOS

- The final major reform of the water sector aimed at attracting private sector investments to achieve universal water and sewerage services, including sewage treatment
 - In 1999, water and sewerage services in the SMR were fully privatized through the sale of 50.1% of EMOS' shares to the private consortium AguasAndinas
 - Other investors include the Chilean State Development Corporation(CORFO) 35%; pension funds 10.1%; workers 2.8%; and small investors 2%
 - Under the terms of the privatization, AguasAndinas agreed to fully finance and implement the Sanitation Plan
 - The target date for reaching full wastewater treatment was cut in half
 - In under two years the first major WWTP, El Trebal, was built and operating, and the second, La Farfana, became operational in 2003
 - In provincial cities 9 WWTPs have been built and 13 operating in total
 - By the first quarter of 2012 the final major WWTP, Mapocho, will enter in operation and 100% of wastewater in SMR will be treated

Progressive Accomplishments to Date of Sanitation Plan for SMR

- 1995 – Santiago Poniente WWTP (less than 3% of wastewater treated)
- 2001 – Maipo interceptor and El Trebal WWTP (23% treated)
- 2003 – Final Zanjón interceptor and La Farfana WWTP (74% treated)
- 2008 – 13 provincial cities with WWTPs
- 2010 – Mapocho interceptor (87% treated)
- 2012 – Mapocho WWTP to be completed (100% treated)



Source: Larrain, 2009

El Trebal Sewage Treatment Plant

- Operational October 2001
- Capacity 4.4 m³/s
- Cost US\$150 million



La Farfana Sewage Treatment Plant

- Operational 2003
- Capacity 8.8 m³/s
- Cost \$315 million



Mapocho Interceptor and WWTP



Mapocho Interceptor

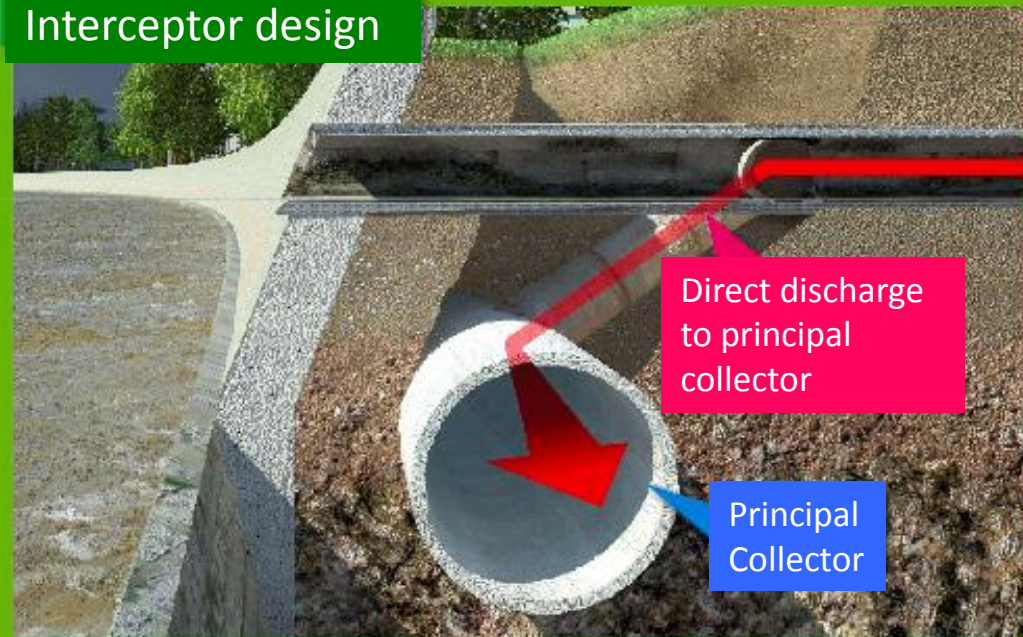
- Completed 2010
- 28.5 km collector intercepting 21 major discharges
- Cost US\$113 million
- Using existing spare capacity at El Trebal and La Farfana to treat intercepted flows

Mapocho WWTP

- Completion 1st quarter 2012
- Capacity 2.2 m³/s
- Cost ~US\$140 million

Source: Fuentes, 2009

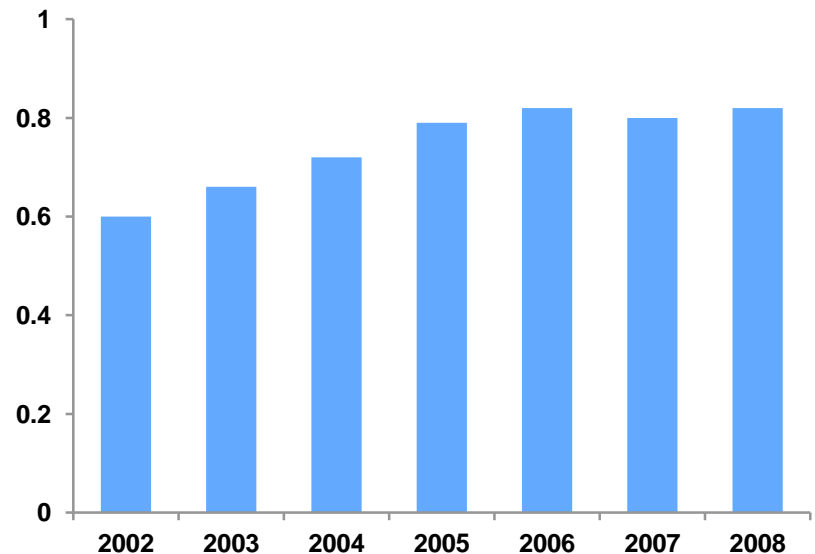
Interceptor design



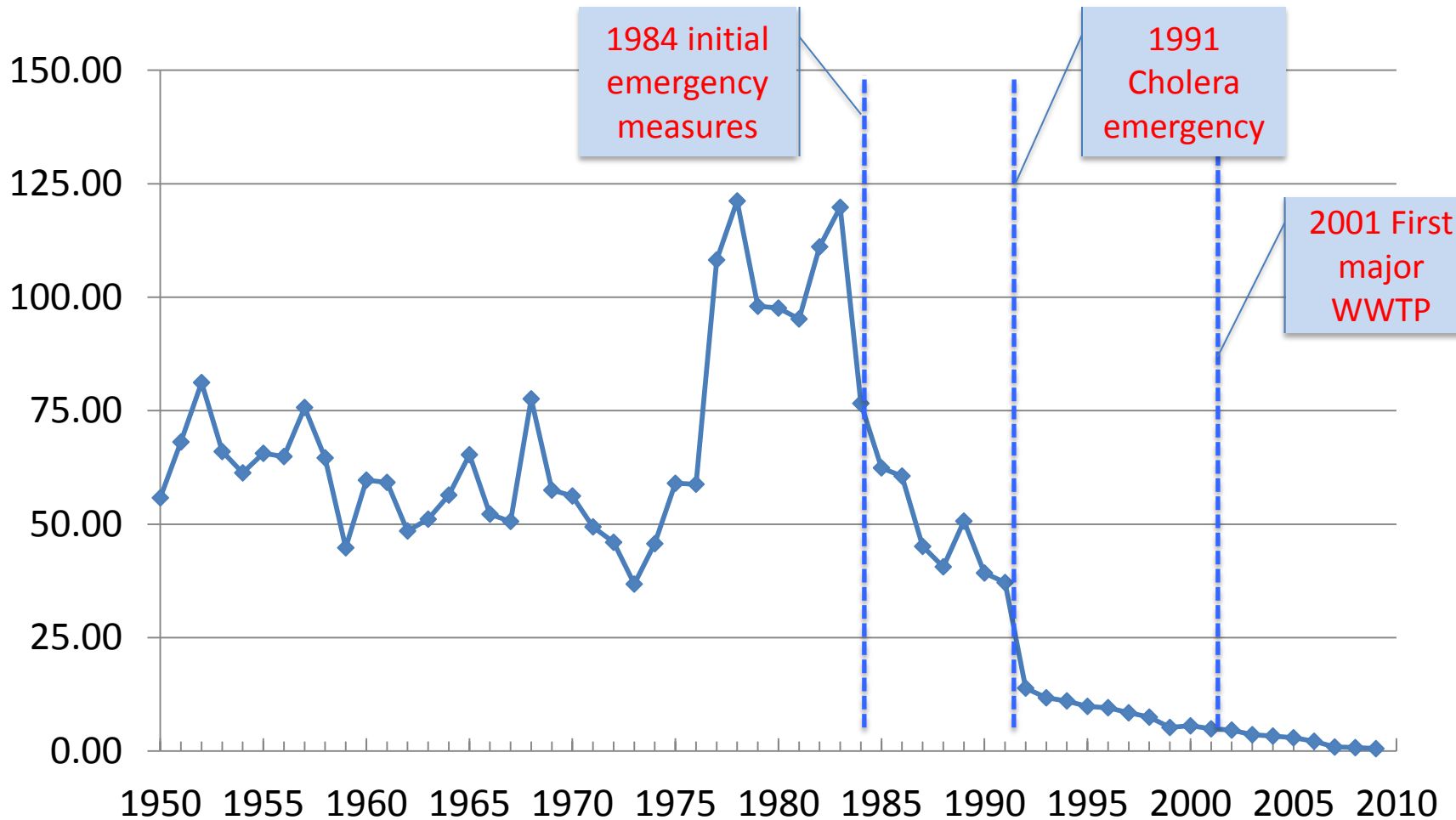
Impact of Sanitation Plan on Tariffs

- ❑ Average tariffs have increased due to the start-up of the new sewage treatment infrastructure
- ❑ In 2008, the tariff was divided 52% for water and 48% for sewerage services. The latter was only 36% in 2003.
- ❑ Tariffs are adjusted every 5 years according to a formula based on marginal costs
 - Chart shows tariffs in force since March 1, 2005
 - Automatic interim adjustments based on inflation

Average Tariff (US\$/m³)



Impact of control measures on Typhoid Rate (cases/100,000 population)



Source: Chile Ministry of Health, 2010

Benefits of the Sanitation Plan

- It guarantees that 130,000 ha of agricultural land is now irrigated with safe water, helping to provide for:
 - Removal of restrictions on growing vegetables
 - Public health protection maintaining low levels of typhoid fever, hepatitis and diarrheal diseases, and avoiding cholera problems
 - Access to existing and new markets, thanks to meeting international standards for agricultural exports
 - A clean, pollution-free environment for future generations

Lessons Learned

- Over three decades Santiago achieved control over hazards of indirect wastewater use for irrigation
 - Confronted with hyper-endemic typhoid, early rudimentary crop restriction and education measures (1983) helped to halve the health impacts
 - Faced with the real threat of a cholera outbreak – and potential loss of agricultural exports – political resolve led to the implementation of comprehensive emergency control measures (1991) that drastically reduced typhoid rates and avoided the establishment of cholera in the SMR
 - Commitment to long-term structural changes:
 - Development of the Sanitation Plan for the SMR required a full decade of concentrated effort (1986-1995)
 - Carried out major policy reforms transforming the water sector and leading to privatization of EMOS (1989-1999)
 - Starting with pilot operations, full wastewater interception and treatment will be achieved after two decades (1993-2012), drawing heavily on the investment capacity of the private sector
 - Including US\$610 million private investment in wastewater treatment plants

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Epilogue



World Bank's Track Record on Wastewater Irrigation

1. Active partner with WHO and UNDP from 1981 to 1994

- Supported research on wastewater treatment and safety of use for irrigation and aquaculture, issued seminal publications on epidemiology of reuse contributing to establishment of 1989 WHO Guidelines; published 1994 Planning Guide
- Co-developed DALY metric for 1993 WDR on Investing in Health – permitted eventual development of 2006 WHO Guidelines (QMRA)

2. Examples of lending operations:

- **Israel Sewerage Project** (1972, \$75M) a first for the Bank – financed sewage treatment and reuse facilities, supported development of Wastewater Treatment and Storage Reservoirs, instituted cost-sharing provisions and division of responsibilities between cities and farmers for wastewater irrigation
- **Santiago Water and Sewerage II Project** (1986, \$45M) financed major interceptors, design and construction of pilot treatment plant, and preparation of treatment master plan; plus ESW on economic impacts of wastewater irrigation
- **Tehran Sewerage Project** (2000, \$121M) financed 5.2 m³/s wastewater treatment plant and allowed additional 15,000 ha of irrigation in Varamin Plains Irrigation Scheme
- **Current Portfolio** includes 25 projects that address wastewater treatment and (possible) use in agriculture, but only 7 had major financial commitments (<0.5% of total sewerage and wastewater treatment portfolio)
 - Tunisia \$19 million; China \$10 million; Iran \$3 million

Emerging Priority for the Bank?

The report *“Sustaining Water for All in a Changing Climate”* (World Bank, 2010) recommends wastewater reuse as a strategic principle, but points out the need to develop core skills in this area to prepare and supervise projects or engage in high-level policy dialogue with client countries on this issue.

A Bank wastewater irrigation agenda should seek to:

- Support client efforts to develop wastewater use policies, investment plans and programs within a broader IWRM framework
- Enhance the quality of policy dialog with clients and of project preparation activities focused on application of the 2006 WHO Guidelines and phased introduction of appropriate treatment technologies
- Leverage private sector resources
- Build up the capacity of Bank staff across key sectors (water, urban, agriculture, health, environment, social) to better respond to client demands – the current ad-hoc structure is not adequate
- Work with and build support among key external partners – clients, donors, specialized institutions (especially WHO and FAO), and NGO/CBOs

Recent World Bank ESW

Scheierling, S.M., Bartone, C.R., Mara, D.D. & Drechsel, P. (2010).
Improving Wastewater Use in Agriculture: An Emerging Priority. Policy Research Working Paper No. 5412.
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