WARP – Water main Renewal Planner

WARP is a computer software that analyzes historical breakage rates of water mains, projects future breakage rates, computes life-cycle costs and generates planning scenario. Time dependent effects such as climate and cathodic protection are explicitly considered.

Background

Identifying water main breakage patterns over time is an effective and inexpensive alternative to measure the structural deterioration of a water distribution system. Breakage rates of water mains are affected by many factors, pipe-intrinsic, environmental and operational. An effective water main renewal plan must consider their future breakage rates, and to forecast breakage rates one must (a) identify the "true" background deterioration rates of the water mains, and (b) quantify the impact of various environmental factors as well as operational strategies on future breakage rates.

Description

WARP uses a multi-covariate exponential model to discern breakage patterns while considering time-dependent factors such as temperature (in the form of freezing index), soil moisture (in the form of rainfall deficit) and cathodic protection (CP) strategies, including hotspot CP as well as systematic retrofit CP. Non-time-dependent (or static) factors such as pipe characteristics or soil type are considered through water main grouping.

The background ageing rates of the water mains enable to project their future breakage rates. In addition, the impact of operational strategies such as various schedules of cathodic protection (both hotspot and retrofit) and pipe replacement can be tested. Subsequently, the life cycle costs of various scenarios operational strategies can be evaluated and fine-tuned to achieve maximum efficiency in resource allocation.

Traditional approaches to analyzing water main breakage patterns consider only static factors influencing these breakage patterns. WARP is the first and so far the only approach that enables the consideration of dynamic factors such as climate and cathodic protection. WARP is also the only approach that allows the consideration of cathodic protection strategies in forecasting the life cycle costs of water mains.

Users and beneficiaries

WARP is an invaluable decision support tool for the effective planning of water main renewal. Users include municipalities, water utilities and consulting engineers.

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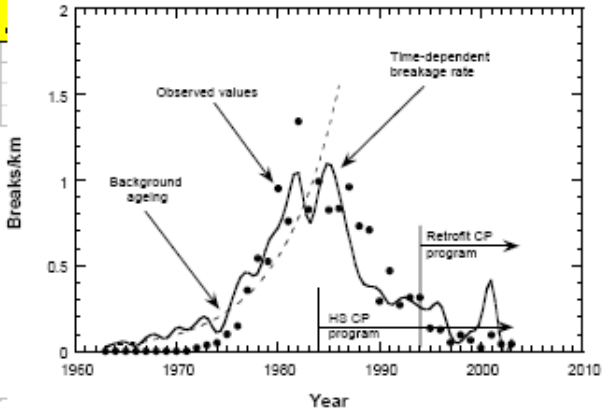
WARP - WAter main Renewal Planner

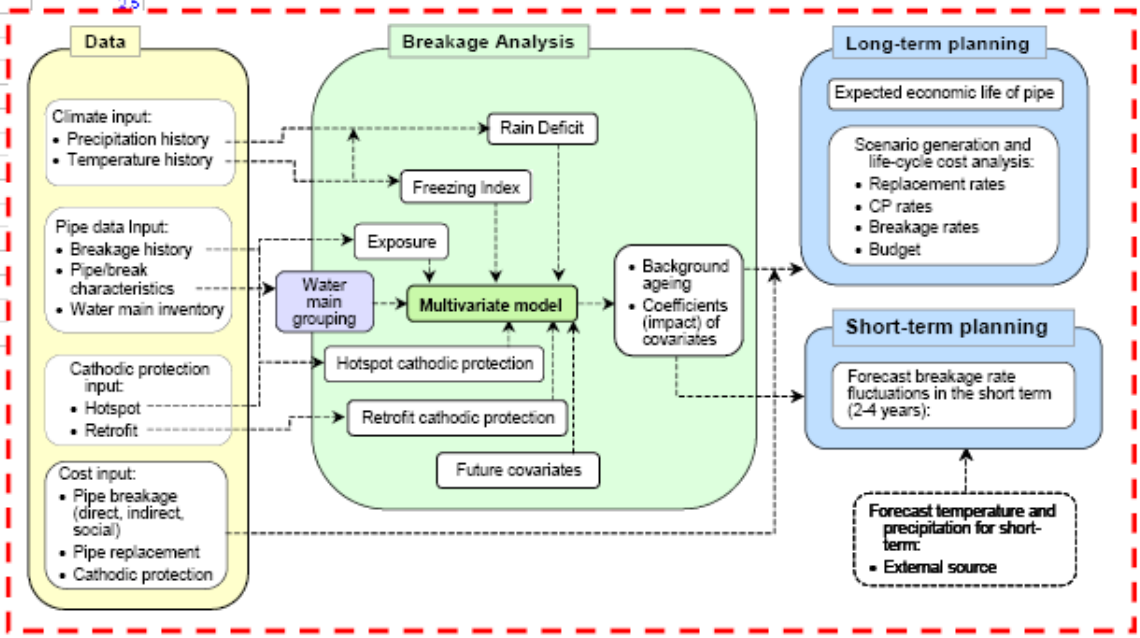
Break Year	Break Month	Pipe Material	Installation Year	DIAM	LENGTH	Soil	CP type	CP year	Break Type
2003	2	PVC	1996	150	20.83	Gravel			CIRC
1998	8	DI	1971	150	435.07	Gravel	retrofit	1998	BLOW
2000	7	DI	1981	300	357.32	Gravel	retrofit	2000	HOLE
2000	11	DI	1980	150	286.51	Gravel	retrofit	2000	HOLE
1995	4	DI	1983	300	207.5	Gravel	retrofit	2000	HO
1998	4	DI	1978	300	362.86	Gravel			HO
1995	7	DI	1978	300	362.86	Gravel			HO
2000				300	1972	retrofit	1991	Gravel	
2000				300	1978			Gravel	
2002				300	1978			Gravel	
2002				300	1972			Gravel	
1986				400	1972			Gravel	
1986									

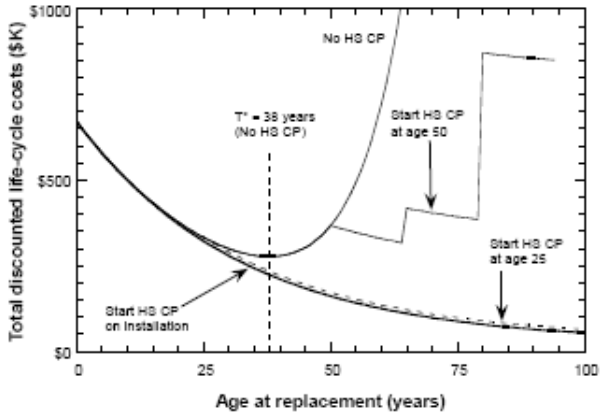
PipeID	LENGTH	Pipe Material	DIAM	Installation Year	CP type	CP year	Soil
BRY-L009	54.67	PVC	150	2000			Gravel
BRY-L008	34.24	CI	150	2000			Gravel
BRY-L026	20.83	PVC	150	1996			Gravel
BRY-L035	18.36	Other	400	1996			Gravel
BRY-L043	52.78	CI	150	1989			Gravel

Year	Month	Monthly average values Precipitation (mm)	Temperature (deg C)
1960	1	68.1	-8.3
1960	2	64.8	-7.9
1960	3	38.9	-10.6
1960	4	64.5	-2.5
1960	5	116.8	
1960	6	55.6	
1960	7	103.9	
1960	8	39.5	
1960	9	6.4	
1960	10	57.9	
1960	11	57.2	
1960	12	17.0	
1961	1	10.9	
1961	2	59.2	
1961	3	77.0	
1961	4	98.3	
1961	5	64.0	
1961	6	82.8	

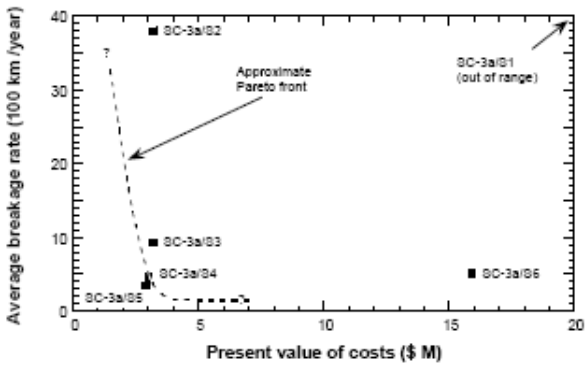


Breakage analysis





Life cycle cost analysis



Pareto graph for planning scenarios