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Article Title: A Novel Integrated Decision Support Tool for Sustainable Water Resources Management in Singapore: Synergies between System Dynamics and Analytic Hierarchy Process

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Supplementary Materials

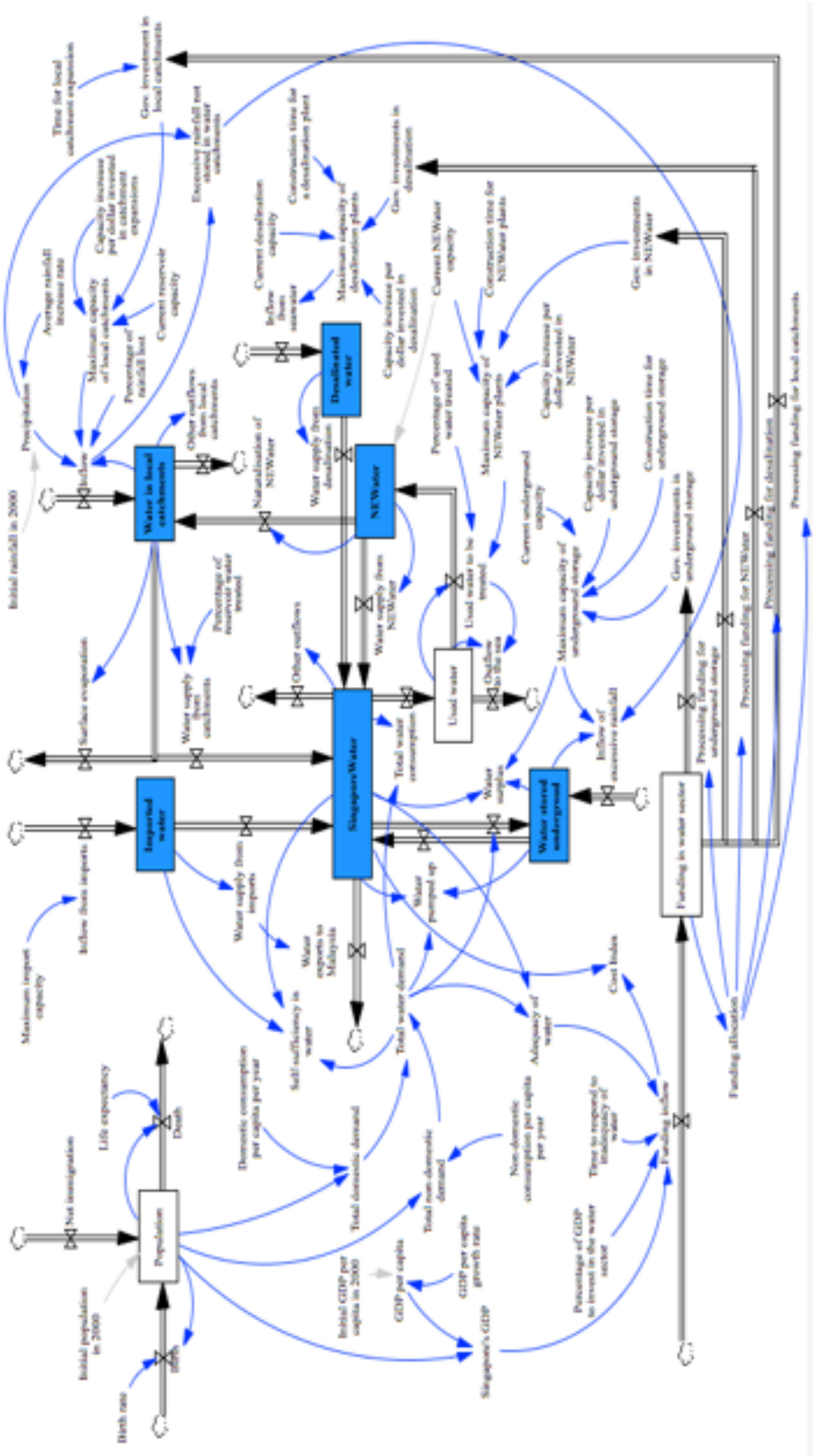

Fig. S1 Full stock and flow diagram in *SingaporeWater* system dynamics model

Table S1 Key input data based on related projects in Singapore

	Projects	Construction time / Concession period	Construction cost *(S$)*	Capacity *(m^3 /year)*	Capacity increase per dollar invested
Sea desalination	SingSpring Desalination Plant at Tuas (Hyflux 2002)	1.75 years (2004 to 2005) / 20 years (2005 to 2025)	250 million	49.8 million	0.20
	Tuaspring Desalination Plant at Tuas (Peng 2012)	2~3 years (2011-2013) / 25 years (2013 to 2038)	1.05 billion	116.25 million	0.11
NEWater	Bedok NEWater Plant (Hyflux 2001)	1~2 years (2001 to 2002) / N.A.	16.1 million	14.6 million	0.91
	Kranji NEWater Plant Phase 1 (PUB 2005)	1~2 years (2001 to 2002) / N.A.	N.A.	12.4 million	N.A.
	Kranji NEWater Plant Phase 2 (PUB 2005)	0.5 years (2005 to 2006) / N.A.	7.4 million	4.15 million	0.56
	Seletar NEWater Plant (Hyflux 2003)	0.5~1 years (2003 to 2004) / Decommissioned in May 2009	27.8 million	14.6 million	0.53
	Ulu Pandan NEWater Plant (Keppel 2010)	2 years (2005 to 2006) / 20 years (2007 to 2027)	90~100 million	54 million	0.54~0.6
	Changi NEWater Plant (Channel NewsAsia 2008)	2 years (2008 to 2010) / 25 years (2010 to 2035)	N.A.	83.2 million	N.A.
Local water catchments	Marina Reservoir (PUB 2011c)	2 years (2009 to 2011) / N.A.	226 million	60 million	0.265
	Punggol- Serangoon Reservoir (AsiaOne 2011b)	5 years (2006 to 2011) / N.A.	300 million	30 million	0.10
Underground rock caverns	Jurong Rock Caverns Phase 1 (Teo 2011)	5~6 years (2007 to 2013) / N.A.	890 million	1.47 million	0.00165

***SingaporeWater* model input data, formulae, and data sources**

(01) Adequacy of water=SingaporeWater/Total water demand
Units: Dmnl [0,10] (Dmnl stands for dimensionless)
The goal is to have sufficient water supply to meet the water demand in any particular year. This means that supply/demand should be larger or equal to 1.

(02) Average rainfall increase rate=RANDOM UNIFORM(-0.01, 0.025, 10)
Units: Dmnl
The annual rainfall data is obtained from Singapore government (http://data.gov.sg/).

(03) Birth=Population/100*Birth rate
Units: persons per year

(04) Birth rate=RANDOM UNIFORM(0.0085, 0.0128, 8)
Units: Dmnl
This estimate is obtained from Singapore Department of Statistics (http://www.singstat.gov.sg/stats/keyind.html).

(05) Capacity increase per dollar invested in catchment expansions=
RANDOM UNIFORM(0.1, 0.3, 6)
Units: cubic meters per dollar [0,?]
Based on Marina Reservoir and Punggol-Serangoon Reservoir.

(06) Capacity increase per dollar invested in desalination=
RANDOM UNIFORM(0.1,0.2,5)
Units: cubic meters per dollar [0,?]
This is derived from Hyflux's 200-million-dollar project to build a desalination plant which could provide 5.11×10^7 cubic meters of water (http://www.pub.gov.sg/mpublications/Pages/PressReleases.aspx?Ite).

(07) Capacity increase per dollar invested in NEWater=
RANDOM UNIFORM(0.5, 0.6,3)
Units: cubic meters per dollar [0,5]
This is based on the costs of the existing five NEWater plants in Singapore.

(08) Capacity increase per dollar invested in underground storage=0.00165
Units: cubic meters per dollar [0,?]
This estimate is based on the Jurong Underground Rock Caverns Project.

(09) Construction time for a desalination plant=
RANDOM UNIFORM(1.5, 2.5, 1)
Units: years [0,10]
The two existing desalination plants in Singapore took about 1.5 to 2.5

years to complete construction.

(10) Construction time for NEWater plants=RANDOM UNIFORM(1,2,3)
Units: years [0,10]
Based on existing five NEWater plants in Singapore.

(11) Construction time for underground storage=RANDOM UNIFORM(4,6,1)
Units: years [0,10]
Based on Jurong Underground Rock Caverns Project in Singapore.

(12) Cost Index=Funding inflow/SingaporeWater
Units: dollars per year/cubic meters per year [0,?]
This indicator measures how much funding has been invested in order to generate one cubic meter of water in Singapore.

(13) Current desalination capacity= STEP(4.98e+07,2006)+STEP(-4.98e+07,2026)+STEP(1.1625e+08,2013)+STEP(-1.1625e+08,2038)
Units: cubic meters per year [0,?]
Data is obtained from PUB website (http://www.pub.gov.sg/water/Pages/DesalinatedWater.aspx). The second desalination plant will operate from 2013 to 2038.

(14) Current NEWater capacity=STEP(1.46e+07,2002)+STEP(-1.46e+07,2022)+STEP(1.655e+07,2006)+STEP(-1.655e+07,2026)+STEP(1.46+07,2005)+STEP(-1.46e+07,2009)+STEP(5.4e+07,2007)+STEP(-5.4e+07,2027)+STEP(8.32e+07,2010)+STEP(-8.32e+07,2035)
Units: cubic meters per year [0,?]
Data is obtained from PUB website (http://www.pub.gov.sg/water/newater/Pages/default.aspx).
Assume that each plant has a life span of 20 years, if the commission period of the project is not available.

(15) Current reservoir capacity=1.5e+08
Units: cubic meters [1e+08,5e+08]
This is cited from P. O. Lee, "The Four Taps: Water Self-sufficiency in Singapore," in *Management of Success: Singapore Revisited*, T. Chong, Ed., ed Singapore: ISEAS Publishing, 2010, pp. 417-442.

(16) Current underground capacity=STEP(1e+07*5*0,2020)
Units: cubic meters [0,1e+08]
Up to now, Singapore does not have underground rock caverns to store water.

(17) Death=Population/Life expectancy
Units: persons per year

(18) Desalinated water= INTEG (Inflow from seawater-Water supply from desalination, 0)
Units: cubic meters [0,?]

(19) Domestic consumption per capita per year=RANDOM UNIFORM(140, 170,1)*0.001*365
Units: cubic meters per person per year
Estimated based on data from K. C. Goh, "Water Supply in Singapore," Greener Management International, 2003.

(20) Excessive rainfall not stored in water catchments=IF THEN ELSE(Precipitation>Inflow, Precipitation-Inflow, 0)
Units: cubic meters per year [0,?]
This assumes that all the extra rainfall not captured in the local water catchments will go to the underground rock caverns, if they are built in Singapore. And if the rock caverns are full, no extra rainfall could be collected.

(21) FINAL TIME = 2100
Units: Year
The final time for the simulation.

(22) Funding allocation=Future funding in water sector
Units: dollars per year

(23) Funding inflow=IF THEN ELSE(Adequacy of water>=1,0, DELAY3(Singapore's GDP*Percentage of GDP to invest in the water sector,Time to respond to inadequacy of water))
Units: dollars per year [0,?]
Assume that both the public and private sectors, such as PUB and private water companies, will only start to fund projects in the water sector when there is inadequacy of water in Singapore.

(24) Future funding in water sector= INTEG (STEP(Funding inflow-Processing funding for desalination-Processing funding for NEWater-Processing funding for local catchments-Processing funding for underground storage,2013),0)
Units: dollars [0,?]

(25) GDP per capita = INTEG (GDP per capita growth rate*GDP per capita, Initial GDP per capita in 2000)
Units: dollars per year per person [0,?]
This value is estimated based on the year-by-year growth rate in the past one decade. GDP per capita is at current price.

(26) GDP per capita growth rate=RANDOM UNIFORM(-0.04, 0.05,6)
Units: Dmnl

Based on data from Singapore Department of Statistics (http://www.singstat.gov.sg/stats/themes/economy/hist/gdp.html).

This is the real growth rate, taking into account the impacts of inflations on purchasing power.

(27) "Gov. investment in local catchments"=DELAY3(Processing funding for local catchments, Time for local catchment expansion)

Units: dollars per year

(28) "Gov. investments in desalination"=Processing funding for desalination

Units: dollars per year

(29) "Gov. investments in NEWater"=Processing funding for NEWater

Units: dollars per year

(30) "Gov. investments in underground storage"=Processing funding for underground storage

Units: dollars per year

(31) Imported water= INTEG (Inflow from imports-Water supply from imports, 5.6575e+08)

Units: cubic meters per year [0,?]

(32) Inflow= INTEG (MIN((1-Percentage of rainfall lost)*Precipitation, Maximum capacity of local catchments-Water in local catchments), Maximum capacity of local catchments)

Units: cubic meters per year [0,?]

Rainfall could only be collected when there is spare capacity in the reservoirs.

(33) Inflow from imports=Maximum import capacity

Units: cubic meters per year [0,?]

Assume that Singapore is importing water from Johor at the maximum capacity, as stipulated by the water agreements between Singapore and Malaysia.

(34) Inflow from seawater=Maximum capacity of desalination plants

Units: cubic meters per year [0,?]

Assume all desalination plants are operating at full capacity during their lifespan.

(35) Inflow of excessive rainfall=IF THEN ELSE (Excessive rainfall not stored in water catchments>0, MIN(Excessive rainfall not stored in water catchments, (Maximum capacity of underground storage-Water stored underground)),0)

Units: cubic meters per year [0,?]

(36) Initial GDP per capita in 2000=40974

Units: dollars per year [0,?]

GDP per capita in year 2000, data is obtained from Singapore Department of Statistics (http://www.singstat.gov.sg/stats/themes/economy/hist/gdp.html).

(37) Initial population in 2000=4.0279e+06
Units: persons [0,?]
Population in year 2000. Data is obtained from Singapore Department of Statistics.

(38) Initial rainfall in 2000=1.7e+09
Units: cubic meters per year [1e+09,3e+09]
This is estimated based on the study of Seattle's annual rainfall volume (http://hypertextbook.com/facts/2006/GinaCastellano.shtml).
As Singapore is in the tropical region with an average rainfall of 2400 mm and it is about 3 times larger than Seattle, the rainfall volume in Singapore is estimated to be 1.7e+09.

(39) INITIAL TIME = 2000
Units: Year
The initial time for the simulation.

(40) Life expectancy=RANDOM UNIFORM(78,81,2)
Units: Dmnl [70,100]
From Singapore Department of Statistics (http://www.singstat.gov.sg/stats/keyind.html).

(41) Maximum capacity of desalination plants=
Current desalination capacity+DELAY3(Capacity increase per dollar invested in desalination*"Gov. investments in desalination", Construction time for a desalination plant)
Units: cubic meters per year [0,?]
Assume that the increase in desalination capacity is gradual, instead of increasing sharply after the opening of a new desalination plant.

(42) Maximum capacity of local catchments=
INTEG (MIN(Capacity increase per dollar invested in catchment expansions*"Gov. investment in local catchments", 1e+09-Maximum capacity of local catchments), Current reservoir capacity)
Units: cubic meters per year [0,5e+08]
There is a limit to reservoir expansions, due to the limited land space Singapore has. It is assumed to be 1 billion cubic meters in this study.

(43) Maximum capacity of NEWater plants=
Current NEWater capacity+DELAY3(Capacity increase per dollar invested in NEWater*"Gov. investments in NEWater",Construction time for NEWater plants)
Units: cubic meters per year [0,?]
Assume that the increase in NEWater capacity is gradual, instead

of increasing sharply after a opening of a new NEWater plant.

(44) Maximum capacity of underground storage=
INTEG(MIN(DELAY3("Gov. investments in underground storage"*Capacity increase per dollar invested in underground storage, Construction time for underground storage),1e+08-Current underground capacity), Current underground capacity)
Units: cubic meters per year [0,?]
There is a limit to how many underground rock caverns could Singapore possibly build. We assume 100 million m^3 in this study.

(45) Maximum import capacity=STEP(-1.15e+06*365, 2061)+ 1.15e +06*365+400000*365+STEP(-400000*365,2011)
Units: cubic meters per year [0,?]
Data from the official agreements between Singapore and Malaysia. Cited from
E. S. Chia, "A Large-Scale Systems Engineering Perspective of Water Management in Singapore," INCOSE, 2008.

(46) Naturalization of NEWater=NEWater*0.02
Units: cubic meters per year [0,?]
A small amount of NEWater is naturalised in the reservoirs. Cited from Singapore Ministry of Environment and Water Resources, "Towards Environmental Sustainability," 2005.

(47) Net immigration=163000
Units: persons per year [0,500000]
This is estimated based on the population pattern from 2000 to 2012. Net immigration is the number of immigrants minus the number of emigrants.

(48) NEWater= INTEG (Used water to be treated- Naturalization of NEWater -Water supply from NEWater, Current NEWater capacity)
Units: cubic meters per year [0,?]

(49) "Non-domestic consumption per capita per year"=RANDOM UNIFORM(150,210,1)*0.001*365
Units: cubic meters per person per year

(50) Other outflows=SingaporeWater*0.05
Units: cubic meters per year
Unaccounted-water-flow is about 0.05 in Singapore. Cited from Ministry of Environment and Water Resources, "Towards Environmental Sustainability," ed. Singapore, 2005.

(51) Other outflows from local catchments=Water in local catchments*0.05
Units: cubic meters per year

(52) Outflow to the sea=Used water-Used water to be treated
Units: cubic meters per year

(53) Percentage of GDP to invest in the water sector=RANDOM UNIFORM(0.005, 0.01, 5)
Units: Dmnl
Assume that investments worth 0.5% to 1% of GDP is invested into the water sector, be it government funding or private funding.

(54) Percentage of rainfall lost=RANDOM UNIFORM(0.2, 0.4, 1)
Units: Dmnl [0,1]
Rainfall loss is mostly caused by interception by vegetation, infiltration into the soil, retention on the surface, etc.

(55) Percentage of reservoir water treated=RANDOM UNIFORM(0.8, 0.9,1)
Units: Dmnl [0,1]

(56) Percentage of used water treated=0.8
Units: Dmnl [0,1]

(57) Population= INTEG (Birth-Death+Net immigration, Initial population in 2000)
Units: persons per year [0,?]
This is an important variable with great impact in water demand and economic growth in the future.

(58) Precipitation= INTEG (Precipitation*Average rainfall increase rate, Initial rainfall in 2000)
Units: cubic meters per year

(59) Processing funding for desalination=
Funding allocation*0
Units: dollars per year
Plan 1 is that no funding will go into the water sector.

(60) Processing funding for local catchments=
Funding allocation*0
Units: dollars per year
Plan 1 is that no funding will go into the water sector.

(61) Processing funding for NEWater=
Funding allocation*0
Units: dollars per year
Plan 1 is that no funding will go into the water sector.

(62) Processing funding for underground storage=

Funding allocation*0
Units: dollars per year
Plan 1 is that no funding will go into the water sector.

(63) SAVEPER = 1
Units: Year [0,?]
The frequency with which output is stored.

(64) "Self-sufficiency in water"=(SingaporeWater-Imported water)/Total water demand
Units: Dmnl
Total self-sufficiency of water is achieved when this index is >=1.

(65) Singapore's GDP=GDP per capita*Population
Units: dollars per year

(66) SingaporeWater=
INTEG (-Other outflows-Total water consumption+Water pumped up+Water supply from desalination+Water supply from imports+Water supply from NEWater+Water supply from catchments-Water surplus-Water exports to Malaysia,Water supply from imports+Water supply from catchments-Water exports to Malaysia)
Units: cubic meters per year [0,?]

(67) Surface evaporation=Water in local catchments*RANDOM UNIFORM(0.1 , 0.2 , 8)
Units: cubic meters per year [0,?]
Assume that about 10% to 20% of the water in local catchments are lost due to surface evaporation.

(68) Time for local catchment expansion=RANDOM UNIFORM(2, 5, 5)
Units: years [0,?]
Based on the construction time of Marina reservoir and Punggol-Serangoon reservoir.

(69) TIME STEP = 0.125
Units: Year [0,?]
The time step for the simulation.

(70) Time to respond to inadequacy of water=1
Units: Year
Assume that both the public and the private sector in Singapore is very efficient in responding to inadequacy of water.

(71) Total domestic demand=Population*Domestic consumption per capita per year
Units: cubic meters per year

(72) "Total non-domestic demand"="Non-domestic consumption per capita per year"*Population

Units: cubic meters per year

(73) Total water consumption=IF THEN ELSE((SingaporeWater>Total water demand), Total water demand, SingaporeWater)

Units: cubic meters per year [0,?]

If there are enough water to meet the demand, then all the water demand is satisfied. Otherwise, Singapore could only consume whatever amount of water that is available in Singapore.

(74) Total water demand=Total domestic demand+"Total non-domestic demand"

Units: cubic meters per year

(75) Used water= INTEG (Total water consumption-Outflow to the sea-Used water to be treated, 5.08e+08)

Units: cubic meters per year

(76) Used water to be treated=MIN(Used water*Percentage of used water treated, Maximum capacity of NEWater plants)

Units: cubic meters per year [0,?]

This is constrained by the actual capacity of the NEWater plants

(77) Water exports to Malaysia=Water supply from imports*0.12

Units: cubic meters per dollar [0,?]

Up to 12% of the imported water has to be sent back to Johor as part of the agreement. Cited from K. C. Goh, "Water Supply in Singapore," Greener Management International, vol. 42, pp. 77-86, Summer 2003 2003.

(78) Water in local catchments=

INTEG (Inflow+Naturalization of NEWater-Other outflows from local catchments-Surface evaporation-Water supply from catchments, Current reservoir capacity)

Units: cubic meters per year [0,?]

(79) Water pumped up=

IF THEN ELSE(SingaporeWater>Total water demand, 0, MIN(Total water demand-SingaporeWater,Water stored underground))

Units: cubic meters per year [0,?]

Assume that when there is a shortage of water, water stored underground will be pumped up.

(80) Water stored underground=

INTEG (Inflow of excessive rainfall+Water surplus-Water pumped up, 0)

Units: cubic meters per year [0,?]

(81) Water supply from catchments=
Percentage of reservoir water treated*Water in local catchments
Units: cubic meters per year [0,?]

(82) Water supply from desalination=Desalinated water
Units: cubic meters per year

(83) Water supply from imports=Imported water
Units: cubic meters per year

(84) Water supply from NEWater=NEWater*0.98
Units: cubic meters per year

(85) Water surplus=IF THEN ELSE ((SingaporeWater-Total water demand)>=0,MIN(Maximum capacity of underground storage
-Water stored underground,(SingaporeWater-Total water demand)),0)
Units: cubic meters per year

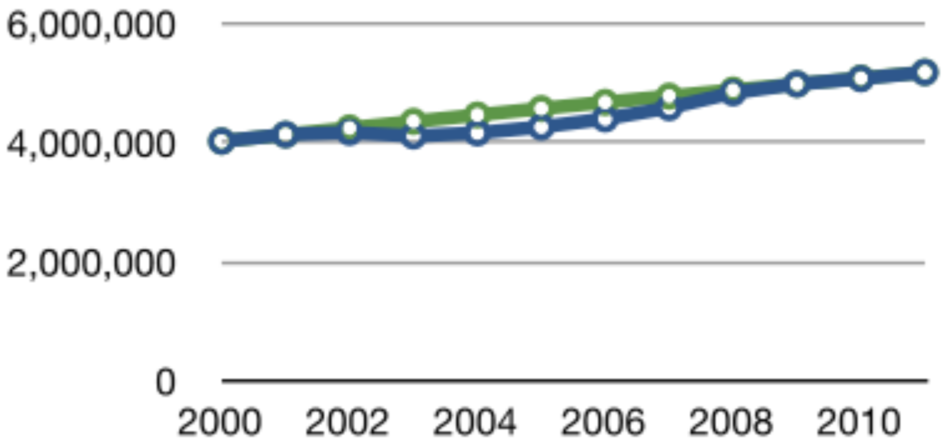

Fig. S2 Comparison of real population and simulated population in *SingaporeWater*

Table S2 Weights of the criteria

Goal	Adequacy	Self-sufficiency	Cost	Weight vector
Adequacy	1	1	7	0.467
Self-sufficiency	1	1	7	0.467
Cost	1/7	1/7	1	0.067
		= 3	CI = 0	CR = 0

Table S3 Weights of the alternatives under Scenario 1

Adequacy	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	1/3	1/5	1/7	1/3	0.047
Plan 2	3	1	1/5	1/5	1/3	0.077
Plan 3	5	5	1	2	5	0.438
Plan 4	7	5	1/2	1	3	0.307
Plan 5	3	3	1/5	1/3	1	0.13
				= 5.28	CI = 0.07	CR = 0.063

Self-sufficiency	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	1/3	1/5	1/4	1/4	0.055
Plan 2	3	1	1/3	1/4	1/2	0.105
Plan 3	5	3	1	1	3	0.336
Plan 4	4	4	1	1	3	0.346
Plan 5	4	2	1/3	1/3	1	0.157
				= 5.16	CI = 0.04	CR = 0.036

Cost	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	7	5	5	3	0.488
Plan 2	1/7	1	1/3	1/4	1/6	0.04
Plan 3	1/5	3	1	1/3	1/5	0.073
Plan 4	1/5	4	3	1	1/3	0.131
Plan 5	1/3	6	5	3	1	0.269
				= 5.28	CI = 0.07	CR = 0.063

Table S4 Local and global weights under Scenario 1

	Plan	Adequacy (0.467)	Self-sufficiency (0.467)	Cost (0.067)	Global weights
1	Status quo	0.047	0.055	0.488	0.08
2	Invest in underground	0.077	0.105	0.04	0.088
3	Invest in desalination	0.438	0.336	0.073	0.366
4	Invest in NEWater	0.307	0.346	0.131	0.314
5	Invest in local water catchments	0.13	0.157	0.269	0.152

Table S5 Weights of the alternatives under Scenario 2

Adequacy	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	1/3	1/6	1/7	1/3	0.046
Plan 2	3	1	1/3	1/3	1/2	0.105
Plan 3	6	3	1	2	6	0.452
Plan 4	7	3	1/2	1	2	0.266
Plan 5	3	2	1/6	1/2	1	0.131
				= 5.20	CI = 0.05	CR = 0.045

Self-sufficiency	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	1/2	1/4	1/5	1/4	0.057
Plan 2	2	1	1/3	1/4	1/4	0.084
Plan 3	4	3	1	2	1	0.314
Plan 4	5	4	1/2	1	2	0.3
Plan 5	4	4	1	1/2	1	0.244
				= 5.20	CI = 0.05	CR = 0.045

Cost	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	8	5	4	4	0.51
Plan 2	1/8	1	1/3	1/4	1/6	0.038
Plan 3	1/5	3	1	1/2	1/5	0.076
Plan 4	1/4	4	2	1	1/3	0.12
Plan 5	1/4	6	5	3	1	0.256
				= 5.24	CI = 0.06	CR = 0.054

Table S6 Local and global weights under Scenario 2

	Plan	Adequacy (0.467)	Self-sufficiency (0.467)	Cost (0.067)	Global weights
1	Status quo	0.046	0.057	0.51	0.082
2	Invest in underground	0.105	0.084	0.038	0.091
3	Invest in desalination	0.452	0.314	0.076	0.363
4	Invest in NEWater	0.266	0.3	0.12	0.272
5	Invest in local water catchments	0.131	0.244	0.256	0.192

Table S7 Weights of the alternatives under Scenario 3

Adequacy	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	1	1/3	1/2	1/6	0.067
Plan 2	1	1	1/3	1/3	1/6	0.063
Plan 3	3	3	1	2	1/5	0.182
Plan 4	2	3	1/2	1	1/5	0.127
Plan 5	6	6	5	5	1	0.56
				= 5.16	CI = 0.04	CR = 0.036

Self-sufficiency	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	1	1/3	1/2	1/6	0.068
Plan 2	1	1	1/3	1/2	1/6	0.068
Plan 3	3	3	1	2	1/5	0.184
Plan 4	2	2	1/2	1	1/5	0.116
Plan 5	6	6	5	5	1	0.563
				= 5.12	CI = 0.03	CR = 0.027

Cost	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Weight vector
Plan 1	1	8	4	3	3	0.46
Plan 2	1/8	1	1/3	1/5	1/4	0.043
Plan 3	1/4	3	1	1/2	1/2	0.104
Plan 4	1/3	5	2	1	1/3	0.156
Plan 5	1/3	4	2	3	1	0.237
				= 5.20	CI = 0.05	CR = 0.045

Table S8 Local and global weights under Scenario 3

	Plan	Adequacy (0.467)	Self-sufficiency (0.467)	Cost (0.067)	Global weights
1	Status quo	0.067	0.068	0.46	0.094
2	Invest in underground	0.063	0.068	0.043	0.064
3	Invest in desalination	0.182	0.184	0.104	0.124
4	Invest in NEWater	0.127	0.116	0.156	0.178
5	Invest in local water catchments	0.56	0.563	0.237	0.54

Results from the trade-off analysis

Table S9 Average self-sufficiency index and cost index under Scenario 1

	Plan 1 Status quo	Plan 2 Invest in underground	Plan 3 Invest in desalination	Plan 4 Invest in NEWater	Plan 5 Invest in local water catchments
Self-sufficiency Index	0	0.4	1	0.45	0.4
Cost Index	0	30	25	23	10

Table S10 Average self-sufficiency index and cost index under Scenario 2

	Plan 1 Status quo	Plan 2 Invest in underground	Plan 3 Invest in desalination	Plan 4 Invest in NEWater	Plan 5 Invest in local water catchments
Self-sufficiency Index	0	0.4	1	0.8	0.65
Cost Index	0	28	20	15	10

Table S11 Average self-sufficiency index and cost index under Scenario 3

	Plan 1 Status quo	Plan 2 Invest in underground	Plan 3 Invest in desalination	Plan 4 Invest in NEWater	Plan 5 Invest in local water catchments
Self-sufficiency Index	0	0.9	1.2	1.2	5
Cost Index	0	18	10	8	10