São Paulo Metropolitan Region

ROADMAP for URBAN WATER SECURITY

Prepared for:
Secretaria de Saneamento e Recursos Hídricos, Government of São Paulo

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FINAL FOR SECRETARIA: 18 May 2017

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THE AUSTRALIAN WATER PARTNERSHIP

CITATION

Cite this report as: Chong J and White S, 2017. Sao Paulo Metropolitan Region: Roadmap for Urban Water Security. Report prepared by the Institute for Sustainable Futures, University of Technology Sydney, for Secretaria de Saneamento e Recursos Hídricos, Government of São Paulo.

ABOUT THE AUTHORS

The Institute for Sustainable Futures (ISF) was established by the University of Technology Sydney in 1996 to work with industry, government and the community to develop sustainable futures through research and consultancy. Our mission is to create change toward sustainable futures that protect and enhance the environment, human wellbeing and social equity. We seek to adopt an inter-disciplinary approach to our work and engage our partner organisations in a collaborative process that emphasizes strategic decision-making.

DISCLAIMER

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Acknowledgements
This report and related program work is supported by the Australian Water Partnership, an aid initiative of the Department of Foreign Affairs and Trade bringing together public and private organisations from the Australian water sector with development partners in the Asia-Pacific.

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A note on terminology: categories of water security options

There are various categories of water security options and the labels are sometimes used interchangeably. In this report, the following terminology is used:

- **Supply infrastructure** – constructions that are used to capture, treat and transfer rainwater such as dams and inter-catchment transfer pipelines
- **System loss reduction** – management options that reduce the losses from the distribution network (reticulated water) system, such as pressure reduction, asset replacement, leak monitoring in the network.
- **Customer water efficiency** – programs that improve water efficiency on the customer side of the water meter, whether these are residential, commercial, public institution, industrial or other water users. These programs might include audits, retrofits, information provision and technical support, subsidized equipment, benchmarking programs, or labelling of appliances and fittings. Pressure reduction in the distribution network (to reduce system losses) can also have impacts on customer water efficiency.
- **Rainwater capture** – as distinct from larger scale supply infrastructure, "rainwater capture" usually refers to site-specific systems. These may range from an individual building to a commercial or industrial district.
- **Reuse** – these options are at large scale (e.g. reusing treated wastewater from a sewage treatment plant) or smaller scale (e.g. greywater treatment and reuse in an individual building or facility).

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1. INTRODUCTION

In 2014 and 2015, the metropolitan area of São Paulo, Brazil endured a drought more severe than in any period on record. As a city accustomed to plentiful and reliable summer rainfall, and with surface water storage capacity of about one year, São Paulo was not well prepared to respond to two consecutive seasons of extremely low precipitation and declining water availability. The city of more than 20 million inhabitants, the largest metropolitan center in the Americas and the southern hemisphere, came perilously close to a crisis situation of widespread water shortages.

During the drought the state government and SABESP, the state-owned water and wastewater agency, implemented a tariff reduction initiative to incentivize reduced consumption, and initiated a number of supply infrastructure projects that are now under construction or have since been completed. Some of these projects, such as one which will enable greater transferability within the distribution system and hence access to different sources, work to increase resilience. However, the tariff reduction measure, the cost and revenue implications for the water utility SABESP of the tariff reduction measure mean that such an option is unlikely to be feasible in future droughts. Furthermore, whilst the supply infrastructure construction costs are now largely sunk, operating costs, particularly those related to energy for pumping, are likely to be high. Transfer infrastructure could result in conflict with other users (such as hydropower) if other catchment areas simultaneously experience drought. Due to the topography and development of the area, there are limited feasible options for extending storage. The State Government of São Paulo and SABESP recognize that many urban water security options have not yet been explored, and that new approaches are needed to plan for and prepare for future droughts.

This report has been prepared by the Institute for Sustainable Futures (ISF), University of Technology Sydney. It has been developed from partnership exchanges between the Secretaria de Saneamento e Recursos Hídricos, the State Government of São Paulo and ISF, over several meetings and workshops in São Paulo (May 2014, March 2015, November 2015 and December 2016) and in Sydney (May 2015).

The December 2016 partnership exchange was supported by the Australian Water Partnership, an Australian Government-supported initiative. This exchange comprised three days of workshops and meetings conducted by ISF with:

- Secretaria de Saneamento e Recursos Hídricos
- SABESP – Companhia de Saneamento Básico do Estado de São Paulo S.A
- FIESP – Federação das Indústrias do Estado de São Paulo
- FAESP – Agriculture and Cattle Federation of São Paulo State
- ASESP – Assessoria Especial da Secretaria da Receita Federal do Brasil
- USP – Universidade de São Paulo.

The purpose of this report is to provide a high-level **Roadmap for Urban Water Security** for metropolitan São Paulo. It addresses:

- high-potential, cost-effective long-term initiatives to be implemented prior to drought to increase the overall resilience of the urban water system
- regulatory and institutional developments to enable funding for customer water efficiency initiatives
- a mechanism for planning contingency measures to be triggered as a drought progresses
- research, analytical and planning requirements to prepare a detailed action plan.

São Paulo: context for urban water security planning
This box identifies key contextual factors relevant for the Roadmap for Urban Water Security for São Paulo.

- **Fiscal and economic situation** – There are currently significant constraints on the extent to which the State Government of Sao Paolo can fund water security initiatives. However, funding and loans are currently being secured by SABESP for supply infrastructure. The financial and regulatory arrangements for financing cost-effective demand-side initiatives are discussed below.
- **Equity and access** – The city of São Paulo has a diversity of socio-demographic groups and levels of affordability. A significant proportion of the population does not have access to formal infrastructure services, including water and sanitation. The distribution of impacts and opportunities from water security initiatives is a key consideration for analysis.
- **Sanitation coverage** – Approximately 11% of metropolitan São Paulo is not covered by networked sewerage systems, and of the area that is, approximately 30% of sewage is not treated. There are interactions between the incomplete sanitation coverage, poor water quality and water security.

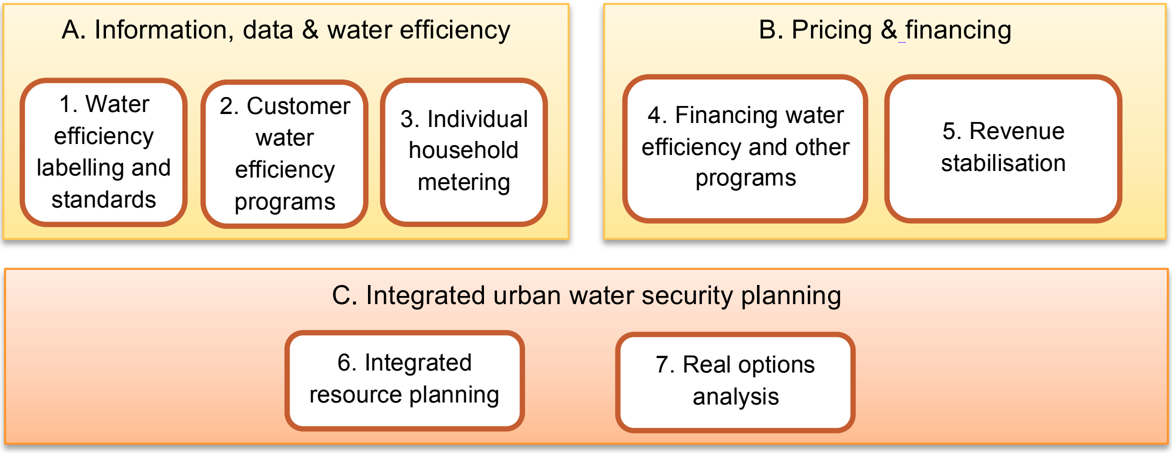
2. ROADMAP

The Roadmap for Urban Water Security in Sao Paulo comprises three priority programs:

A) **Information, data and customer water efficiency** to establish the basis of information provision for customers to make informed choices about water use and implement baseline customer water efficiency programs

B) **Pricing and financing** arrangements to facilitate funding of water efficiency and other cost-effective programs, whilst ensuring revenue stability during drought

C) **Integrated urban water security planning** that takes into account all options and all financial costs as well as other impacts of measures, and builds a portfolio of urban water security options that can be implemented during drought.



A) Information, data and customer water efficiency

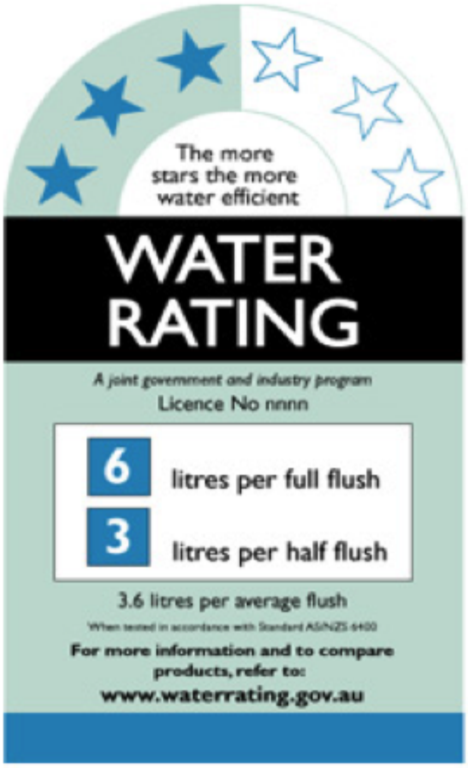
1. Water efficiency labelling and standards

Introducing a mandatory water efficiency labelling and standards scheme for water-using fixtures and appliances is an essential basis for implementing customer water efficiency programs crucial for São Paulo's water security.

Customer water efficiency programs for water use in buildings – residential, commercial and public institutions – rely on water efficiency information being available to consumers as well as to program implementers.

As a manufacturer and exporter of water-using fixtures, implementing such a scheme presents a potentially significant market advantage for Brazil. Countries are increasingly recognizing the value of using labelling and standards to increase urban water security, and as a result the global demand for water efficiency-labelled products is increasing. In particular, China, which is both a major exporter and consumer of water-using products, is currently developing a national "WELS" scheme.

Whilst most customer water efficiency schemes are implemented nationally, a pathway to implementation could be to introduce the scheme first in the state of São Paulo. Brazil already has experience in implementing a successful energy efficiency labelling scheme. Experience from Australia is that local manufacturing industries support and even champion such schemes. There are two types of benefits: firstly, reputation and social licence benefits during drought; and secondly, product differentiation advantages in both local and global markets.



Example faucet (left) and showerhead (right) labels from the Australian Water Efficiency Labelling and Standards (WELS) Scheme.

Source: http://isc-worldwide.com/certifications/water-efficiency/

2. Customer water efficiency programs

Implemented by SABESP since 2008, Programa de Uso Racional da Água (PURA) has achieved significant water and bill savings in public buildings, at relatively low cost. There is significant opportunity for extending this program to other public buildings as well as residential and commercial water-using sectors. Customer water efficiency programs, implemented over time with the possibility of scaling up during drought, will substantially increase the resilience of São Paulo's urban water system.

Through PURA, SABESP provides training and technical support to public building managers and contracts plumbers to repair leaks and replace inefficient water fittings. The program has achieved water savings across a range of public building types, including schools, hospitals, prisons, and federal, state and local government office buildings. Based on approximate calculations, from the combined perspective of SABESP and its customers, PURA is a cost-effective program, with the unit cost (Brazilian Real per m^3) of water saved lower than the unit cost of most of the major supply infrastructure projects constructed since the drought. This is illustrated in an indicative way in Table 1, in which two customer water efficiency options, including PURA, for which data have been measured, and the toilet retrofit program, which has been modelled, are listed alongside two supply or emergency supply options. Note that these results are indicative, and for the two supply options it has been assumed that the net increase in system yield equals the capacity of transfer.

Such customer water efficiency programs are crucial for improving the water security of a metropolitan area. Whilst they can be implemented during drought periods, a major advantage of longer-term implementation is that lowering demand and the rate of usage slows down the rate at which dam supply levels drop. This 'buys time' during a drought and increases resilience, as illustrated in Figure 1.

The PURA savings have been significant, but to date the program only targets a small proportion of public buildings. Whilst these were identified as the ones with the greatest potential for savings, there is still likely to be significant potential for further savings from extending the program to other buildings as well as other sectors. The program is highly cost-effective relative to typical supply options.

Option for demand reduction	**Yield (m^3/s)**	**Unit cost (BRL/m^3)**	**Notes and assumptions**
Residential toilet retrofit	15	0.5	Based on SABESP modelling per household. 215 L/household/day savings, BRL416 cost per household for 20,000 households. Scale up to 6m households.
PURA (commercial buildings efficiency)	13	2.8	Cost based on actual costs BRL100m for 2,935 buildings and a saving of 900,000 - 598,000 m^3/month = 302,000 m^3/month = 3.6 Mm^3/a. Scale up assuming 5% of connections are commercial i.e. 5% of 6.6m = 0.33m and scale up total savings.
Option for supply or emergency supply	**Yield (m^3/s)**	**Unit cost (BRL/m^3)**	**Notes and assumptions**
Paraíba do Sul transfer scheme	5	1.0	Unit cost based on BRL800M capital cost, and 10% annual operating costs. Yield based on increasing system yield by 5 m^3/s.
Upper Guaçu scheme	4	6.3	Unit cost based on BRL4B capital cost, and 10% annual operating costs. Yield based on increasing system yield by 4 m^3/s.

TABLE 1 Relative unit cost and yield for two customer water efficiency and two supply and emergency supply options, based on the assumptions indicated. Note that the unit cost for the two supply options assumes that they would increase the overall system yield by the same amount as their rated, estimated transfer capacity – this unit cost is likely to be an underestimate.

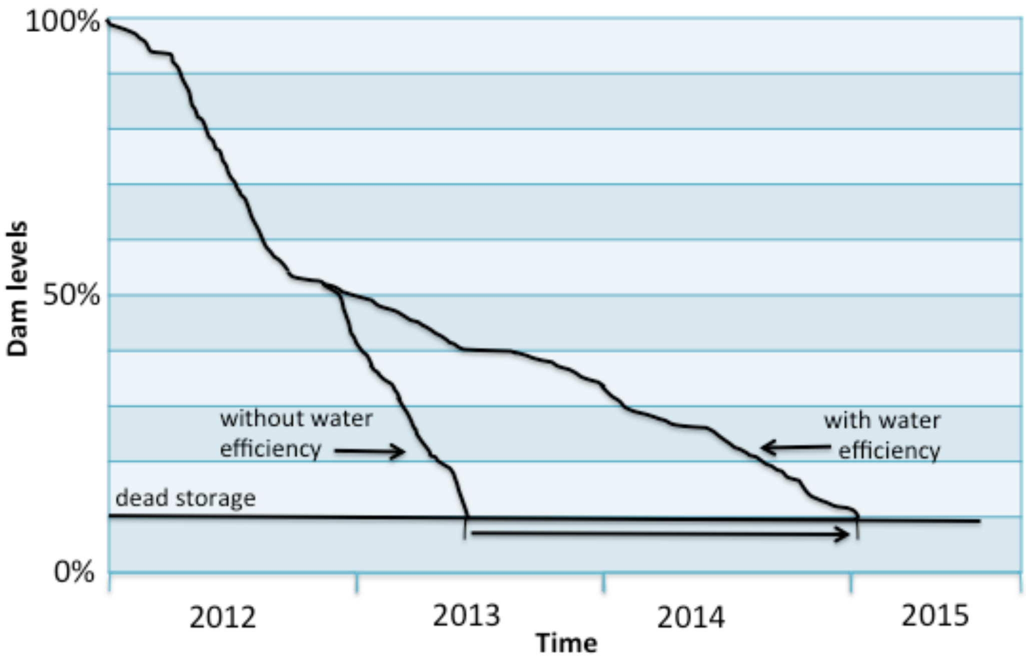


FIGURE 1 Indicative depletion curve for storages, demonstrating the effect of 'buying time' through efficiency measures, reducing demand and slowing the depletion rate.

One aspect worth noting is that water efficiency programs that are voluntary often have relatively low take-up rates, due to a range of market failures, including split incentives (benefits and costs accrue to different parties), inappropriate pricing (water is not priced at the real cost) and the payback gap (the difference in return on investment expectations between customers and utilities or government) (Dunstan et al. 2008). The PURA program has been very successful because it provides a strong price incentive for the public building managers to participate. If the program was able to be extended, then it would require strong incentives (grants, technical support) to guarantee uptake. This would not affect the overall unit cost, when taking into account costs not just to the utility, but value to customers and the government.

There is evidence from Australia that appropriate incentives are necessary. This evidence is found in the difference between the take-up rates and water savings from a showerhead rebate program (NSW Sustainable Development Authority Smart Showerhead Program), and the take-up rate and savings from a full retrofit program (Sydney Water Every Drop Counts Retrofit Program). In the latter case, a greater level of incentive was provided and transaction costs were significantly reduced, and the take-up was nearly 500,000 houses with a cumulative saving of over 10 Mm^3/a (0.3 m^3/s). In the former case, the program resulted in less than 100,000 participants and lower savings per household (Turner et al. 2014).

In the Millennium Drought that impacted Australia 1997–2009, many cities accelerated their water efficiency programs, and introduced new programs to reduce demand and slow the rate of depletion of storages (White et al. 2016). In some cases, probably made the difference between reaching dead storage or not.

3. Individual household metering

Water usage meters for individual households (such as within multi-residential condominium buildings) significantly expand the reach and savings from water conservation programs, whether educational or incentive-based.

The State Government of São Paulo and SABESP recognized the value of metering with the passing of regulations requiring all new residences (including individual apartments within a condominium building) to be individually metered. Whilst the cost of retrofitting existing buildings is higher than installing meters in new buildings, it is still potentially a cost-effective way to increase water security if one considers, firstly, the potential water savings, and secondly the economies of scale in a large program.

By providing individual meters, it is possible to charge households on a volumetric basis, and as they face this direct price signal rather than paying a share of a building charge, they may be encouraged to reduce consumption. As they have information about their water use, this will also enable households to identify leaks on their premises.

B) Pricing and financing arrangements

4. Financing customer water efficiency, rainwater collection or reuse programs

Customer water efficiency programs, and potentially rainwater collection and reuse measures, are cost-effective ways to increase urban water security and reduce costs in the long run. However, there are institutional, regulatory and governance barriers to securing funding for such demand-side programs. There are opportunities for setting price regulatory arrangements to enable funding for demand-side projects.

Urban water utilities have natural monopoly characteristics, and as a result the conventional approach to price regulation is guided by the aim of limiting this monopoly power. Approaches to regulating prices usually require a utility to forecast demand over a set period, and then to justify the prudent capital expenditure and hence revenue required to meet this demand. Prices and tariffs are then set to achieve this revenue, usually with a regulated rate of return on capital assets.

A key limitation of this conventional approach is that whilst a utility is required to consider prudent expenditure on supply options, the utility faces a disincentive to invest in options on the demand side because reduced demand results in reduced revenue. Pricing regulation allows for the utility to recoup the costs and a rate of return on built infrastructure. However, under many utility price regulatory systems, including the one used in São Paulo, demand-side programs such as customer water efficiency programs that reduce usage but also revenue are not considered on the same level as supply options, even if they ultimately increase water security much more cost-effectively. As a result, without prudent investment in customer water efficiency programs, the overall cost of the water service system to customers is higher.

A further limitation of this approach is that only direct cost and revenue considerations are taken into account. Other benefits of options (such as equitable service provision, or reduced environmental pollution), or risks and costs (such as vulnerability to energy costs) are not taken into account.

To overcome these regulatory barriers, and to achieve a least-cost, resilient water system in São Paulo, a key approach is to develop price regulatory systems around the following key principle: that what is being provided to the customer is not a volume of water per se, but the services which accrue from a secure, reliable water supply – such as drinking water, and the ability to wash clothes, and to operate cooling towers or industrial infrastructure. Applying this principle would mean that customer water efficiency options that enable the same services to be provided, but at lower cost and with less water use, would be considered in the same way as supply options.

In practice, these could be implemented by:

1) Mandating the utility to achieve water conservation or use targets

This could be done by requiring the utility to meet progressive, long-term consumption per capita targets. At the same time as legislating this target, the existing price regulatory structure could be broadly maintained, but with measures which ensure that the utility can set prices which enable it to recoup the cost of water-efficient programs if they are considered cost-effective. This approach was applied in Sydney Water's 2005 Operating Licence.

2) Requiring the analysis method to consider both supply- and demand-side options

Price regulatory settings mostly require utilities to forecast demand based on population and other demographic and economic factors, and then estimate the prudent *supply* options required to meet this level of demand. The utility could instead be required to apply a method that considers and compares *both* supply- and demand-side options on the basis of cost-effectiveness (Riel/m^3) to determine which set of options is least cost. The full range of impacts of different options would need to be considered, including the value of resilience during drought, equity, and other public health considerations. The demand forecast would not be set independently of customer water efficiency programs. This approach (Integrated Resource Planning) is outlined in Section 8.

In the case of 1) or 2), what is also essential is that the utility be allowed to set prices to recoup the cost of demand-side programs through revenue. This requires:

3) Changing price regulation rules to allow the utility to treat demand-side options as being equivalent to infrastructure options in terms of cost pass through and return on capita

Allowing the utility to include expenditure on demand-side programs to be "capitalized" would allow the utility, firstly, to include the cost in their calculation of revenue requirements for price setting; and secondly, to include a "rate of return" on the demand side.

One possible method is to apply a "Totex" approach. This removes the incentive towards capital expenditure by replacing the operational and capital expenditure model with a combined expenditure total. This approach has been applied in the energy industry in the United Kingdom; however there are multiple pros and cons which would need to be carefully considered in the São Paulo context.

5. Revenue stabilisation

A levy or other mechanism to raise revenue to be allocated to improve water security is a key approach to ensure sufficient funds to implement drought response measures and stabilize revenue during a drought – as well as in preparation for a drought.

A key concern for utilities is reduction in revenue during a drought. Water conservation programs would reduce demand during drought. By applying the principles of service provision outlined in Section 4.2 above, the net cost to consumers, even if revenue was recouped by the utility in subsequent periods, could still be made less than the cost of more costly supply infrastructure.. Nevertheless, revenue stabilisation and revenue raising during the course of a drought itself is a key challenge for utilities. In the case of São Paulo, the revenue reduction was further exacerbated by the application of the feebate mechanism.

Revenue stabilisation levy

A levy on water users (with appropriate conditions to ensure affordability and equity) would be an effective means of building up over time funds which could be applied to stabilize revenue during a drought – in effect as a source of funds to implement drought response mechanisms.

As well as being applied as an insurance mechanism, the levy could also be used to invest in long-term, relatively low-cost customer water efficiency programs that ultimately increase resilience during drought. These are *preparedness* programs (see Section 6).

Revenue cap to replace price cap

A further mechanism to stabilize revenue, both long-term and during drought, would be to apply a revenue cap (rather than a price cap). The regulator would require the utility to demonstrate the required revenue amount (over a fixed regulatory period). The utility could then set prices on a yearly basis to meet the revenue projections. Whilst this shifts the regulation from price to revenue, elements of price regulation would still be required to meet equity and other social objectives.

This approach has been applied in the electricity industry in the state of New South Wales, Australia.

C) Integrated urban water security planning

6. Integrated resource planning

Crucial to a secure, affordable water system for São Paulo is the consideration of *all* options, whether these be supply infrastructure, recycling, or demand-side (water efficiency) measures. Integrated resource planning (IRP) is an established approach to identifying and analysing options against a range of criteria, including water saved/supplied, cost, and environmental and equity implications, in order to identify the *portfolio* of options that are resilient to drought, cost-effective, and most appropriate for São Paulo.

Integrated Resource Planning (IRP) is a planning process that was first developed in the electricity supply industry, and it has been increasingly applied in the urban water sector. The IRP process is a systematic and rigorous way to:

- consider and compare both demand-side measures (e.g. customer water efficiency, reuse, rainwater, and system loss reduction) and sources of supply, to prioritize those measures which contribute most cost-effectively to water security
- consider both centralized (e.g. large dams) and distributed or local (e.g. rainwater tanks, small-scale reuse) sources of supply

- balance economic, social and environmental objectives.

IRP generally involves establishing scenarios of climate, making detailed forecasts of demand, developing a wide range of options, assessing demand- and supply-side options on an equal basis, and deciding how to meet objectives at least cost while accounting for sustainability impacts and uncertainties.

The full IRP approach is well documented in Turner et al. (2010). The essential steps are:

- Step 1: Plan the overall process
- Step 2: Analyse the situation – forecast demand and estimate available supply
- Step 3: Develop the response – individual options and portfolios
- Step 4: Implement the response
- Step 5: Monitor, evaluate and review.

A further key advantage of applying IRP to urban water is that it enables consideration of both wastewater objectives and water supply objectives, as well as impacts across the total water cycle (including flooding and drainage management).

In São Paulo, an IRP approach would allow for a comprehensive analysis of reuse options within a portfolio of instruments. Currently, there would appear to be potential because rates of sewage treatment are low, but in addition to risks to public health and environmental quality, a direct water security implication is that due to untreated discharge and pathogen pollution, water sources associated with the Billings reservoir were not a source of water during drought. However, whilst industrial reuse of treated wastewater has been implemented in certain relatively small-scale schemes (such as Aquapolo), as these customers also have unmetered access to private wells. An IRP approach would enable consideration of different combinations and scales of options, to test and identify feasibility. Issues addressed would include:

- potential for transport savings from localized systems.
- Testing the feasibility of groundwater metering or pricing, such as at trial scale, during drought
- water quality of groundwater
- regulating reuse in terms of security, quality and public health
- The sustainability of groundwater extraction.

A possible recycled water contingency option would involve small-scale plants in commercial and possibly residential buildings (condominiums). Whilst there are costs involved with plumbing, these may be outweighed by the benefits in drought (see Real Options analysis below). Further, São Paulo's manufacturing industry is likely to be well placed to manufacture the treatment equipment required.

7. Real options analysis and "readiness to implement" as a core approach to drought preparedness and response

Real options analysis and readiness approaches deal with uncertainty. They are based on the principles of adaptability, and involve staged and adaptive methods of planning and implementing water options to allow maximum flexibility. São Paulo has already taken a readiness approach to some major options as contingencies for the next drought. There are opportunities to apply real options analysis to customer water efficiency and reuse options for the next drought.

Real options analysis is a core approach to contingency planning that allows water managers to deal with the uncertainty about the timing and severity of the next drought. The approach was developed by the finance industry. It is built around the principle that as an option does not have to be fully realized (e.g. in the case of water infrastructure, construction completed and operational) for it to add value to an investment portfolio (in the case of water systems, by improving water security). Rather, it needs to be possible to realize the option within a specified length of time when required. There were nascent attempts to apply this principle during Australia's Millennium Drought (White et al. 2008).

A key example is a “readiness to construct” strategy for supply infrastructure. Stochastic modelling and scenario analysis is applied to determine a *staged* approach to implementation, triggered when indicators of drought severity are met – such as declining water storage levels. Each stage of infrastructure implementation is progressed in time if drought persists, but there is an option of halting implementation if the drought ends, thus avoiding potentially significant costs. These can be financial costs, and depending on the option, environmental and social costs.

For example, the analysis might reveal that at 50% dam storage levels, tenders need to be issued for design; if the dams drop further to 40%, design must commence. Contracts are developed in such a way that the government is not obliged to progress with construction if the drought ends and dam levels rise. It is likely to be much less costly to compensate the design company for their time in preparing a design, than it would be to progress with infrastructure if it is no longer needed.

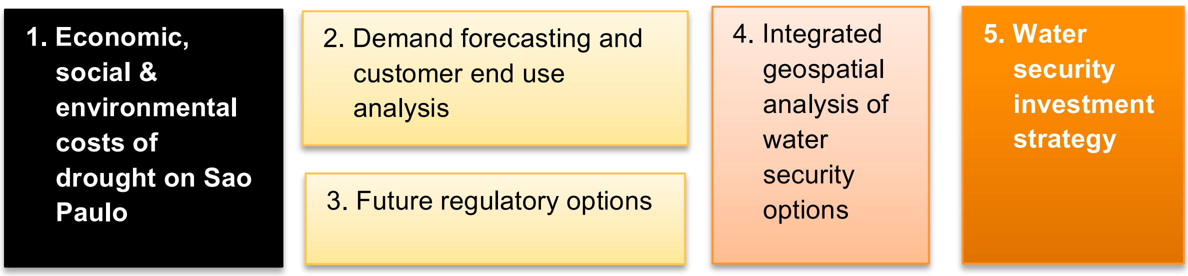
In the case of São Paulo, significant investment has occurred on supply infrastructure to create a situation of “readiness” for the next drought – for example, by creating the potential for inter-catchment transfers. These will only be “turned on” if required, due to high energy costs.

There is great potential for conducting real options analysis to identify the potential for **accelerated customer water efficiency** (see Section 2 above) **and recycled water** (see Section 5 above) options as contingencies for the next drought.

3. NEXT STEPS: ANALYTICS AND RESEARCH

To implement the long-term Roadmap for Water Security outlined above, ISF in discussion with the Secretaria de Saneamento e Recursos Hídricos has identified the following five core research and analytical needs:

1) Calculating the economic, social and environmental costs of the 2014–15 drought on Sao Paulo, to demonstrate the criticality of planning for future drought in Sao Paulo
2) Accurately forecasting demand and customer end uses to form the baseline for identifying and prioritizing potential water savings long-term and during drought
3) Developing future regulatory options, including for price regulation, to balance revenue and water security goals
4) Conducting integrated geospatial analysis of water security options, including customer water efficiency, rainwater and reuse options
5) Drawing on the above four studies to develop a water security investment strategy.



1. The economic, social and environmental costs of drought on São Paulo

An analysis of the economic, social and environmental impacts of the 2014–15 drought on the São Paulo metropolitan area will provide a powerful exposition of the need to plan for future drought in São Paulo, as well as the evidence base to motivate for and inform water security planning. The World Bank, who has conducted studies into the economic costs of drought in other locations, has also suggested this might be a priority study.

A framework will be developed to identify, analyze and quantify the impacts of the drought on:

- costs of producing water (pumping, treatment)
- costs on business (e.g. production losses, retail)
- public health impacts
- impacts on the financial market – investor confidence
- electricity prices
- food security.

This analysis would involve:

- extensive stakeholder consultation to identify and inform the quantitative analysis of impacts
- economic modelling of the multiplier effects on business and industry discussion of any ongoing risks (financial, health) as a result of the drought
- a focus, not only the total costs, but also on analysing who bore the costs in terms of socio-economic distribution of impacts among different water users and industry groups, and different geographic areas of São Paulo.

2. Demand forecasting and customer end use analysis

There are two reasons for developing robust demand forecasts, based on reasonable levels of disaggregation of data. Firstly, the dynamics of sector (residential, business, system losses) water use, and end-use (toilet, cooling tower, laundry, etc.) water use are essential background data for accurate forecasting, and therefore supply–demand planning. Secondly, this information is also required to undertake planning and design of water efficiency programs, enabling the 'conservation potential' or the volumes of water that can be practically and cost-effectively reduced through investment in water efficiency and through regulatory measures. The current proposals and planning are based on experiences in other locations, which will have a different context.

A useful demand forecasting exercise can be undertaken with reasonably basic data, including household survey data, market research data on fixtures and appliances, and demand data (customer and bulk production data). Greater accuracy can be obtained through metering trials, but these can be undertaken as supplementary activities.

This work package would include:

- collation, analysis and synthesis of available demand data and market research data
- a household and business survey to determine stock data
- the development of an accessible (easy to deploy) base case demand model based on end use and sector data, and climate correction
- identifying integration possibilities with yield and supply models – to create an integrated supply–demand planning capability
- identifying opportunities for spatial data to be incorporated
- developing a supplementary model for estimation of conservation potential by end use, with capability to estimate impacts on water use, financial and economic costs and benefits, sewage generation, nutrients and energy use
- development of capacity building materials to support the development and deployment of demand forecasting and supply–demand planning models.

3. Future regulatory options for urban water service delivery São Paulo

As experienced by São Paulo during the drought, extreme climate events are changing the ways in which urban water systems need to be managed and developed. There is a timely opportunity (as identified in Section 4) for examining the regulatory framework for urban water management in São Paulo, and what future regulatory options might improve the resilience of the water system.

This project will focus on analysing urban water price and revenue regulatory arrangements. These will be based on best-practice regulatory design principles (e.g. Sinmetro et al 2008, OECD 2012) as well as the principles underpinning the Human Right to Water and Sanitation (United Nations 2010). These will be developed in conjunction with key government and utility stakeholders and they will include:

- the long-term interests of all customers
- affordability and accessibility
- flexibility for incorporating emerging technology
- resilience to changing climate and uncertain weather
- proportional and bounded
- consideration of both supply- and demand-side options.

The project will identify and analyse the feasibility of different price regulatory models (e.g. capitalisation of demand-side expenditure) for SABESP.

This work will intersect with analysis already planned by the São Paulo government on establishing a regulatory regime for the water quality of reuse water.

4. Integrated geospatial analysis of customer water efficiency, rainwater capture and localized reuse options for São Paulo

Due to variations in the network system, users and end-uses and topography, the opportunities for customer water efficiency, localized reuse (e.g. building-scale reuse) and rainwater capture within existing infrastructure will vary geographically across metropolitan São Paulo.

This project will inform the design of future programs through a geospatial analysis to identify the locations of highest priority customer water efficiency, reuse and rainwater capture.

The analysis will consider:

- implementation costs
- supply resilience to drought
- discharge impacts and water quality improvements
- public health, environmental and water security advantages of reuse
- energy use
- the potential for nutrient capture and reuse.

The analysis will involve:

- considering alternatives of long-term gradual implementation, the readiness potential for “scaling up” these options rapidly during drought, and a combination of both long-term and rapidly-implemented options
- applying real options principles to compare “readiness to implement customer water efficiency, rainwater storage and reuse programs” with existing supply contingency measures (e.g. cost of commencing inter-catchment transfers) and emergency pressure reduction
- identifying portfolios of options and where possible estimating full costs according to IRP principles (see Section 5), considering financial costs as well as social and environmental costs.
- comparing options and combinations of options in different climate and drought scenarios.

5. Real options São Paulo drought resilience investment strategy

The components of this work package include:

1) **Real options analysis and staging of drought response options**
   A comprehensive real options analysis and “readiness” strategy for all detailed options, including accelerated customer water efficiency programs. The real options strategy will comprise a set of trigger points for drought response, and cover all aspects of operationalization, including contracting, financing, design, construction, operation and regulatory changes.

2) **Communications and public engagement lessons**
   Drawing from experience of the previous drought and experiences in other locations, key lessons and actions for drought communications and public engagement

3) **Funding and investment strategy**
   This strategy will identify and provide an initial design for potential sources of funding for drought response and preparedness, including a drought preparedness fund and other sources.

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