Lessons learned from long term water resources plans: top town vs. bottom up

Zhuping Sheng[1], Shaofeng Jia[2], Ari Michelsen[1], Shalamu Abudu[2]

Texas A&M AgriLife Research Center at El Paso, 1380 A&M Circle, El Paso, Texas 79927, USA

Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

Abstract: In this paper, the authors compare water planning processes for Houston, Texas, United States and Shanghai, China. Water plans in both cities were developed based on projection of water demands, assessment of water resources availability and supply capacity. The Houston used a bottom up approach to develop a regional water plan through consensus of representatives from stakeholder groups. In contrast, Shanghai used a top down approach in which the municipal government led the planning effort. The authors share lessons learned and experiences gained through planning processes as well as common institutional and policy constraints of the different approaches.

Keywords: Water plan, water conservation, water demands, water supply, water shortage.

1. Introduction

The continuing growth in population and economies of the large or mega cities is resulting in soaring water demands. Prolonged droughts, such as the 2011 drought in Texas and 2014 drought in California further increase stresses on regional water resources. More and more attention is being paid to water resources management and plans at different levels such as regional, state, national, and transboundary to address water demands. The most recent 2017 Texas State Water Plan for the year 2020 through 2070 was completed through a regional planning process in response to Senate Bill 1 enacted by the 75th Texas Legislative in 1997. The City of Houston with a population of approximately 2 million completed its water plan in 2001 as part of the water plan for Region H, one of 16 water regions designated by Texas Water

Development Board (TWDB) – the state's water supply planning and financing agency. What a coincidence that Shanghai in China, one of world's mega cities with a population of approximately 20 million, also released its guidelines in 2001 (Shanghai Bureau of Water Resources, 2001) for a comprehensive water resources plan, which covers flood protection, long-term water resources plan, water conservation, water quality protection, and water landscape (ecosystem) plan.

In this article we compare these two plans, identify similarities and differences between them, and share lessons learned through the planning process. We will start with the purposes of the two regional water plans, and then examine different components of the water plans.

2. Comparison of two water plans

a. Different purposes for regional water plans

The Texas water planning legislation was initiated in recognition of vulnerability of Texas to drought and to the limited existing water supplies available to meet growing demands as population and water uses increase. The State water plan is designed to meet the State's needs for water during times of drought (Texas Water Development Board, 2017). Therefore, the City of Houston water plan is essentially a drought contingency water supply plan to meet the needs of its urban area for the next 50 years.

Shanghai is at the provincial level (equivalent to State in the United States) in Chinese government structure. Therefore its water plan covers both urban and rural water uses. It follows national guidelines for comprehensive water planning at a regional level, which covers a much broader theme related to water, including water resources development and allocation, conservation, prevention of water hazards (e.g. flooding) and protection of the aquatic environment for next 20 years. The goal of the water resources development needs to meet the national water policy, i.e. the three red lines for control of total water use, water use efficiency and water pollution.

Even though they have different scopes of water planning, both cities are anticipated to face very similar challenges in water supplies in order to meet changing demands. Therefore securing adequate and reliable water supplies is the shared purpose for these two water plans under different circumstances: drought contingency for Texas and comprehensive water plan for Shanghai to national water policy requirements.

b. Planning approaches (top-down vs. bottom-up)

Texas has changed its water planning process from its earlier top-down approach since the 1950s to a new bottom-up approach in 1997. The Texas Water Development Board

(TWDB) divided the State into 16 regional planning areas. Each regional planning group, consisting of about 20 members and representing at least 11 interest groups, as required by Texas statute, includes agriculture, industry, public, environment, municipalities, business, water districts, river authorities, water utilities, counties, and power generation representatives and develops its own future water plan within the designated regional area based on consensus and public inputs. All of the regional plans are then sent to the TWDB for review and approval. The TWDB eventually compiles the state water plan to be used as a guide to state water policy, with information from the regional water plans and policy recommendations to the Texas Legislative. It involves public participation in each of the steps of the planning process. The City of Houston is included in the water plan for the region H, which includes all or part of fifteen counties in southeast Texas. The planning horizon is 50 years, currently 2020-2070. The plan is a 'living document' updated every five-years.

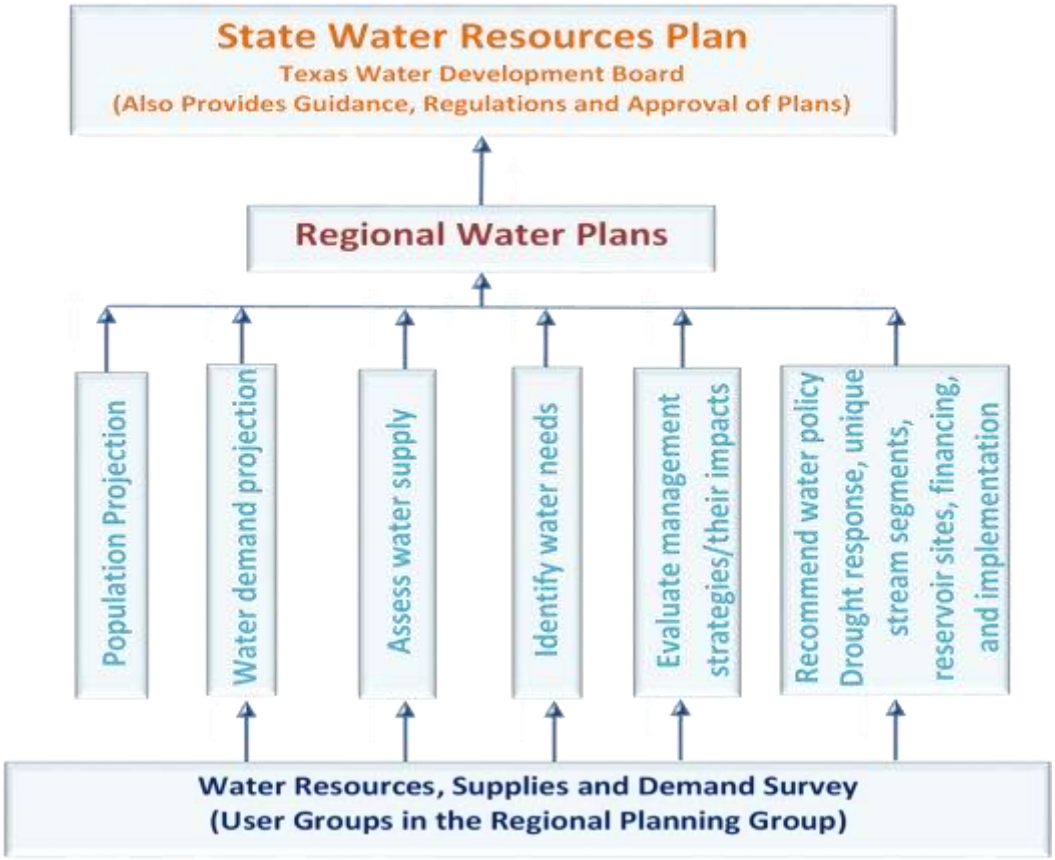

Figure 1 Bottom up process for development of water plan in Texas (modified from Sheng, Michelsen & Liu, 2015).

In contrast Shanghai used a top-down approach to develop its first comprehensive water plan based on guidelines and rules set by the national government. In 2001, the Shanghai Integrated Water Planning Guideline (SIWPG) determined water planning frameworks at three levels: a water resource general survey, water function zoning and detailed planning (Fig. 2). The detailed water plans include safety, resources, environment and landscaping plans (Fig. 2). The metropolitan government projected population growth, estimated increase in water demands and water availability, and then crafted strategies for future water supplies to meet water demands. The plan was further evaluated by experts from the Chinese Academies of Science and Engineering, national administration for urban development, and land and water resources management. Public input was encouraged, however not required. The planning horizon is 20 years, including short-term (5 years), mid-term (10 years) and long-term (20 years), different from 50 year of Texas water plan. The plan is also a living plan and will be amended each ten-year planning cycle.

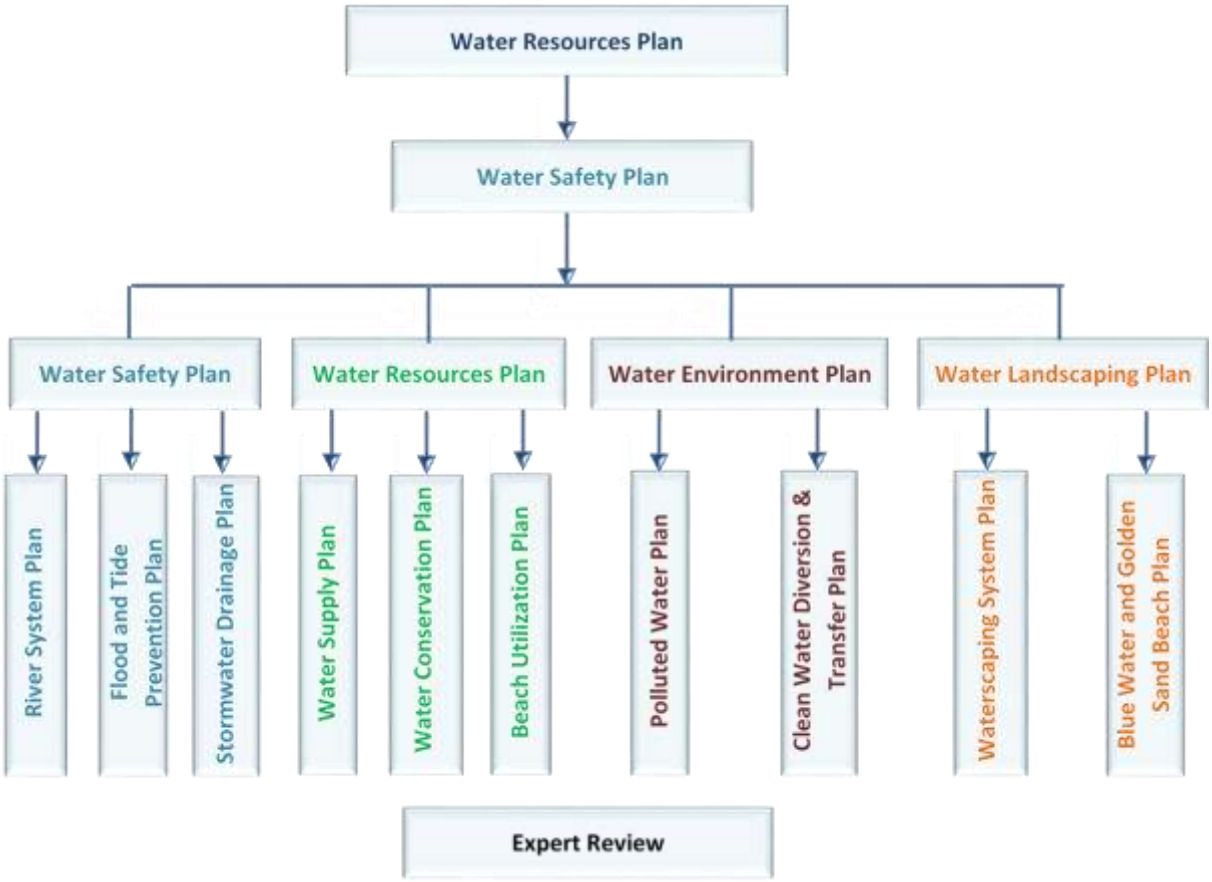

Figure 2. Water planning frameworks proposed in Shanghai Comprehensive Water Planning Outline [Zhang & Tang, 2012; Sheng, Michelsen & Liu, 2015]

c. Components of a water plan

In general, water plans include the following components: purposes/objectives of the plan; population projection, forecast of water demands, assessment of future water supply, identification of water needs and management strategies, and recommendation of policy changes and implementation of the plan. A comparison of the contents of the two water plans is listed in Table 1 (Sheng, Michelsen & Liu, 2015).

Table 1 Comparison of components of two water plans (modified form Sheng, Michelsen & Liu, 2015).

Requirement/Context	Houston (Region H)	Shanghai
Objectives/purposes	Drought contingency	Part of the comprehensive water resources plan
Population projection	TWDB recommended & modified by the planning group as needed	Based on national census & adjusted as needed to account for migrant residents
Projection of water demands	Projection based on per capita water use for urban water and surveys of other water users	Living/residential water use: per capita based on population; Agricultural and forest water uses, industrial uses as well as ecosystem water needs based on survey
Assessment of water supplies	Survey of current water supplies & project future water supplies	Survey of current water supplies and projection of future water supplies
Identify water shortage/surplus	Difference between water supplies and demands by user group under drought conditions	Identify needs for additional water supplies by comparing water demands and supplies.
Identify management strategies and evaluate impacts of each strategy	Water conservation, surface water transfer, reuse of reclaimed water, aquifer storage and recovery; economic-social, environmental impacts	Specific plans for water conservation; Storm water discharge, wastewater treatment, clean water diversion & transfer to meet the requirements of national water policy: three red lines
Recommend changes in water policy	Potential changes to regional water planning guide and rules as well as state water policy	Amendments to the water resources planning guidelines and rules by the central government
Implementation	By water providers with loan from TWDB: State Water Implementation Fund for Texas (SWIFT)	Shanghai Bureau of Water Resources
Monitoring and post assessment	Financial and implementation report	Included in the plan

As shown in Table 1 both plans are targeting to meet future water demands. Population projections are provided by the government agencies, which are used to assess future water demands based on survey on water uses for each sector/user group. Water supplies are estimated based on the survey of water suppliers. The water needs or shortages are identified by comparing water demands and water supplies available, specifically for drought in Texas. Alternative strategies are then identified and evaluated based on their economic-social and environmental impacts. Two different mechanisms are used to implement recommended strategies: utilities/water provides with loan from the State agency vs. appropriated funds from the government agency.

For example both cities have experienced land subsidence, which further limits availability of groundwater for municipal water supplies. At the same time, the share of surface water for future supplies were increased in different ways. Shanghai is expected to increase its surface water share by using more river water from Taihu Lake and Yangtze River to solve water shortages due to lack of local water sources and poor surface water quality. While the Houston area is planning to expand surface water supplies through interbasin transfers from the Trinity River and Lake Livingston to Lake Houston to convey 1.5 billion cubic meters of water per year to solve projected water shortages due to limited water quantity.

Though Shanghai used a different framework for its comprehensive water plan, the water supply plan shows a great deal of similarity in context with the Texas water supply plan.

d. Water conservation: top strategy but with different objectives

In term of strategies for future water supply, water conservation is a top choice. However they use different criteria and guidelines for urban and agricultural water conservations measures. For urban residential water uses, Houston resident is using 134 gal per capita per day or 507 liter per capita per day (lpcpd), while Shanghai reaches 117 lpcpd for living or 222 lpcpd for overall uses. Current and project water uses varies between different sectors as shown in Figure 3. In each plan the potential for water conservation were assessed for different sectors base on economic incentives, social and environmental impacts, and national policy for Shanghai.

e. IWRM /conjunctive uses – one of the options

The Texas water plan uses the term “integrated” for its water plan, however the plan components are really conjunctive uses of surface, groundwater and reclaimed water rather than full context of Integrated Water Resources Management (IWRM). The Shanghai plan does follow the context and framework of IWRM, however it largely lacks

public participation. In Shanghai, the Bureau of Water Resources is in charge of implementation of proposed strategies. In Houston, regional water providers/utilities implement strategies with financial assistance (loans) from the Texas Water Development Board. Components of IWRM can be seen in Table 1.

Figure 3. Distribution of water uses among different water use categories.

3. Conclusions

In summary, continued population growth and economic development of large cities are changing patterns of water demands and water supplies worldwide. Different approaches to planning and managing water resources have been used. The planning process in two cities, Houston (Region H) and Shanghai were compared to contrast two different methods, namely the bottom-up (Houston) vs. the top-down (Shanghai). While there were many similarities in their water plan, such as water resource conditions and the resulting water management strategies adopted, there were significant differences

in planning approached. As highlighted in the paper, we noticed the following differences:

- Planning purposes: drought contingency vs. comprehensive water resources plan;
- Degree of integration: water supply focus vs. safety-supply-environment-landscape;
- Approach to planning: top-down vs. bottom-up; and
- Finance for implementing management strategy: water utilities/providers with loan from the State agency vs. appropriated funds from the government agency.

No single planning process will solve all of the water planning and management issues. Integrated Water Resources Management approach provides a good framework for regional water resources planning and its appropriate applications are recommended. There are valuable lessons to be learned from each of the approaches taken. Additional research is recommended to further evaluate advantages and disadvantages of different planning approaches, and identify barriers that prohibit for adequate utilization of each approaches.

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