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Advisory Note 3.4: Auditing a Water Saving Society

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3. Demand Manage-ment

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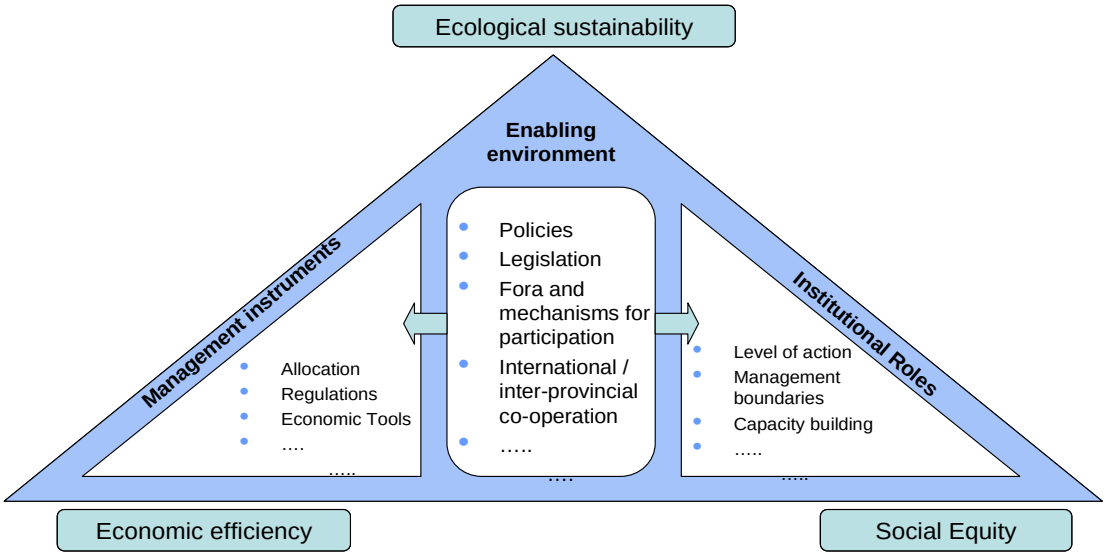
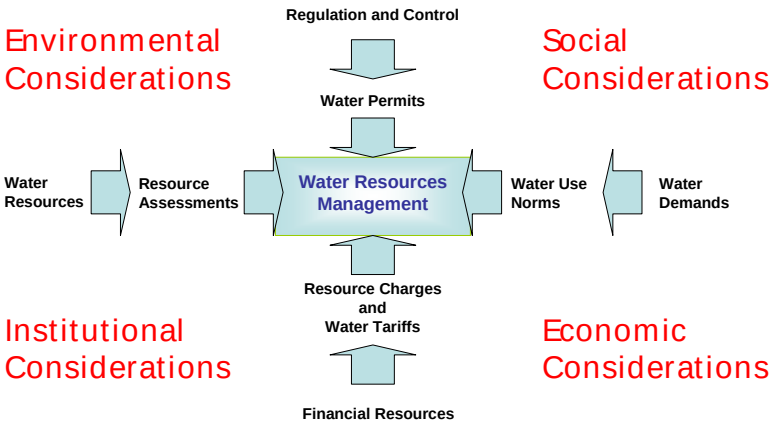
Integrated Water Resources Management (IWRM)

(Basics after Global Water Partnership)



Driving Elements of Integrated Water Resources Management



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Summary: This Advisory Note gives recommendations for how a water savings society might be audited, covering both the establishment of the society, and its achievements in saving water.

The document starts with an overview of a water savings society and typical water savings plans, as currently prepared at Municipality level. It then outlines the importance of auditing the achievements of the society, and provides guidance for the methods for doing this. It stresses the need to evaluate water savings at the municipality or river basin level as well as at the local level (individual water supply company or irrigation district) since many of the apparent 'losses' at local level are reused elsewhere.

The Advisory Note is structured as follows:

- Management of water savings society, particularly arrangements for auditing
- Contents of the water saving plan
- Approach for auditing
- Analysis of data, and impact of water saving society
- Conclusions

It is primarily aimed at Municipality and County level offices of the Water Resources Department, and at other bureaus at this level involved in water savings plans.

This document is one of a series covering topics on sustainable water resources planning, allocation and management. Details are given in the bibliography.

The Ministry of Water Resources have supported the Water Resources Demand Management Assistance Project (WRDMAP) to develop this series to support WRD/WAB at provincial, municipal and county levels in their efforts to achieve sustainable water use.

1 Introduction

1.1 Water saving societies

The concept of a water saving society has been strongly promoted in China since 2000, reflecting the severe water shortage in many regions which has become a bottleneck for economic development and has resulted in serious environmental degradation. The concept was introduced in recognition of the fact that there appears to be considerable waste of water, and many opportunities for increasing the productivity of water. For this reason, MWR has promoted a programme for establishing a water-saving society throughout China, and numerous pilot projects have been set up.

However, although it is evident that there is considerable scope for improving water resources management, it is not easy to achieve this in practice. It is also apparent that the programmes are not all evaluated as rigorously or systematically as is desirable. A stronger programme of auditing water savings societies would both highlight the achievements being made, and lead to recommendations for improving the implementation.

1.2 The need to audit a water saving society

The concept of a water saving society (WSS) is broad and ambitious. As well as specific objectives which can be monitored and audited, the overall concept needs to be evaluated to ensure that it is realistic: there are many potential benefits, but also some risks.

The targets for the 11th Five-year Plan are that the:

- water use per 10,000 yuan of GDP will be reduced by 20%,
- water use per unit of added industrial water output will be reduced by 30%
- agricultural irrigation water efficiency will be increased from 0.45 to 0.5.

These are ambitious targets, and there is a need to monitor the achievement of them. The third of these bullet points is particularly significant, as agriculture is the dominant user of water in most of the country and since losses from one irrigation district are often used by others. Changes to agricultural water use can have profound and wider impacts on water resources.

A periodic audit of progress will quantify achievements against these overall targets as well as against specific local objectives. It will also help improve the methods for establishing a water saving society. The audit needs to be done by establishing a systematic annual programme for collecting monitoring data, and then undertaking a periodic audit using this data - typically every five years.

Water savings society implementation plans are prepared at municipality level and thus primary monitoring needs to be undertaken at this level. If, however, the river basin covers a larger area, further auditing needs to be done at a higher level. In addition, the audit needs to consider water saving at local levels by individual water abstraction permit holders.

It is relatively easy to audit compliance at local level, but local water savings may have other impacts at regional level and thus these also need to be evaluated. For example:

- What is the water saved used for, for example is the greater local efficiency in irrigation system used to increase the irrigated area with the same volume, or to allow for greater residual flows in the river
- What impact does any reduction in return flows (caused by water saving) have on downstream users/environment

1.3 Structure of this report

This document is aimed at officials at Municipality level and subsidiary offices, to provide guidance on monitoring and auditing Water Savings Societies. The report is structured as follows:

- Management of water savings society, particularly the arrangements for auditing
- Contents of the water saving plan
- Approach for auditing
- Analysis of data, and impact of water saving society
- Conclusions

2 Water Saving Society Construction

2.1 History of the concept of water savings society

China's water shortage in many regions has become a bottleneck for economic development, whilst at the same time there appears to be widespread waste of water resources in all sectors. In order to promote economic development and social equity, as well as ensure rational utilization of water resources and ecological sustainability, the central government has proposed the establishment of a resource-conserving and environment-friendly society. Accordingly, water saving and water conservation planning is being promoted at all levels.

Establishment of a water-saving society was first put forward in 2000 by the Central Committee of CPC in the 10th Five-year Program for Economic and Social Development. This was followed in 2002 by the revised Water Law which provides in Article 8 that the state shall carry out water saving and devote major effort to implementing water saving measures, popularizing new water–saving technologies and processes, and developing water-saving industry, agriculture, and services – in other words, to establish a water-saving society. This is a strategic measure for solving water resources problems and is an important government responsibility at all levels.

At end of 2002 MWR issued an instruction on implementation of pilot projects for water-saving society construction (circular 558), which provides that the purpose of pilot projects on water saving society is to gain experience before extending water saving societies more widely. This would enable establishing the legislation, administration, economic and technical policies as well as advocacy and education systems for establishing a water-saving society throughout China over the following ten years.

A further MWR document in 2003 (circular 634) indicated that the programme of pilot projects would be implemented in two stages. MWR would first implement pilot projects for large-medium municipalities and prefecture-level regions with serious water shortage or water pollution and which were suited for demonstration purposes in the Tenth Five-year Program period and early Eleventh Five-year Program period. In the second stage, pilot projects would be implemented in the provincial and river basin context, under the guidance of the provincial authorities.

Accordingly, 12 national level pilot projects were established during the Tenth Five-year Program period (2001-2005), at Zhangye Municipality in Gansu Province, Mianyang Municipality in Sichuan Province, Dalian Municipality in Liaoning Province, and elsewhere. A large number of provincial level pilot projects were started at the same time.

In early 2007, the National Development and Reform Commission (NDRC), MWR, and the Ministry of Construction (MOC) jointly issued the Program for Establishing a Water-Saving Society which set the goals for the Eleventh Five-year Program Period. These included that by 2010:

- all systems (preliminary) of legislation, administration, economic and technical policies, and advocacy and education for

a water-saving society would be established;

- good progress will be achieved in water saving technologies and management levels;
- water-saving awareness of all the people will be significantly improved;
- wastage of water resources will be effectively controlled;
- the water use per 10,000 yuan of GDP will be reduced by 20%,
- agricultural irrigation water efficiency will be increased from 0.45 to 0.5, and there will be no increase in total agricultural irrigation water use;
- the water use per unit of added industrial water output will be reduced by 30%; and
- water use efficiency of service trades will approach the level of world best practice.

During this period, 100 national level pilot water saving society projects were to be started which means about two pilot projects would be implemented in each province.

2.2 Current process for development and management

Promotion of a water-saving society is a prime responsibility of government, and is therefore led by a body chaired by the Government, usually by the executive head of the relevant water sector organisation. In some cases, where there is a serious imbalance between supply and demand of water resources, there may need to be a higher degree of coordination between various government departments, the government development and reform departments may coordinate other relevant departments in preparation of water-saving society construction plan.

At the central level, the NDRC, MWR and MOC issued a joint document to implement WSS planning. However, various different arrangements were followed at provincial level, to suit specific local circumstances.

The general process adopted in China for developing water-saving societies is as follows:

- Preparation of terms of reference and giving a clear commitment to relevant planning units;
- drawing up plans on basis of thorough research, technical coordination, expert advice and so on;
- technical review of the draft plan by relevant departments;
- coordination with relevant departments to ensure convergence with other planning;
- approval of plan, finalisation by the planning department presided, and issuance for implementation.

Consultation, and the development of a consensus through consultation, is a central component of the planning process. This should be regarded as the key to success for planning a water-saving society. If the relevant departments hold different views it will be impossible to gain approval of the plan from higher authorities, let alone implement it.

However, in addition to government departments, other stakeholders should also be consulted. This is an area where it is expected that existing systems can be improved by seeking

the views of all sectors of the community. In addition to regular consultations with relevant organizations, news conferences may be held several times, preliminary plans will be advised to the main water supply units and water users, including non-governmental organizations and the wider public in advance in to obtain a wide range of opinion on the plan. This was done, for example, in Tianjin municipality which was the first provincial-level water-saving society pilot and is located in the seriously water-short Haihe River Basin and tested a variety of ways to mobilize broad participation of all sectors of the community.

Water price reform is an important part of the water savings program. This has a direct bearing on vital interests of the people, and of water supply enterprises. This is related to public welfare, but also to issues of monopoly in decision-making.

Internationally, more and more importance is given to public participation, to the need to develop water-saving plans on the basis of advanced concepts (derived from international and domestic experience), to the need to learn lessons from experience, and to the establishment of a formal advisory consultative mechanism with all the stakeholders and to ways to mobilize the active participation of the public. Not only does this enable the formulation of a comprehensive plan taking full account of the views of all parties, it can also lead to the establishment and improvement of scientific and democratic decision-making process.

There should be a consultation plan, outlining the proposed frequency and duration of consultation, the internal sectors to be consulted to complete the first draft, the public participation for consultation after the first draft, preparation of the amended draft for which approval is sought before carrying out a public consultation to seek public views on the revised programs, complete the planning, preparation for final approval.

Public participation is crucial when developing water-saving plans

2.3 General approach for audit of the water saving society

China has yet to establish a formal, standard system for audits of water-saving societies. Three alternative approaches have been followed:

- the auditing is organised and conducted by the next higher level of Government. This was common practice for pilot projects.
- The branch of local government which is responsible for planning, preparation and implementation hires a third party to do the auditing. This is the most common approach
- The people's congress at the same level does the auditing to the government. This is was the practice in Xi'an, for example.

A mid term evaluation is in progress for water-saving societies in the pilot areas.

As with the formulation of water savings plans, there should be public participation in planning audits.. Selection of the water-saving targets (especially qualitative indicators) should, to a very large extent, take account of the personal feelings of the people. The whole audit process should be accountable to the community.

The audit report should include the following:

- organization and selection of auditors
- audit procedures and methods;
- water-saving planning targets and current situation in the areas covered by these targets;
- Comparison of the current situation with the baseline and the planned situation for each target
- Identification of the reasons for differences;
- identifying the responsibilities for the differences;
- summarize experiences and lessons;
- recommendations for further action.

Amendments to the water-saving plan should be mainly based on the findings of the audit report. The report should be widely disseminated to relevant government departments and to the community.

3 Typical Water Savings Plan

3.1 Overview

Water-saving programmes should be designed to suit the local natural and geographical conditions and socio-economic conditions. But generally speaking, a complete water conservation plan should at least cover the following:

- **Analysis**: the current status of water resources, norms, uses and efficiencies, including historical trends and variations between locations, and comparisons with international best practice; identify water-saving standards and reasons for differences with the current status.
- **Guiding principles**: the framework of laws and regulations, and the policy guidance to be followed when

preparing water savings principles.

- **Water demand forecast** to suit the development objectives and level water efficiency to suit the planning horizon.
- **Potential for water-saving**: on the basis of comparative analysis estimate the water-saving potential for future years.
- **Water-saving targets**: set water-saving targets, such as water use efficiency and water norm. as needed to achieve the overall goal.
- **Implementation plan**: develop water-saving programme and alternatives, taking into account technological, economic, social, and environmental factors. Design implementation arrangements to achieve water-saving targets in order to achieve the overall goal of water conservation planning. In dry areas, consider the development of non-traditional water sources.
- **Environmental Impact Assessment**: undertake EIA for various water-saving measures (mainly engineering measures) if they are environmentally sensitive, identifying its environmental impacts, and actions needed for the reduction of negative impact on the ecological environment.
- **Evaluation**: t take a combination of qualitative and quantitative approach to analysis of the effects which are expected to be achieved after implementation.

Planning for the conservation of water should have a clear purpose. Two aspects of water conservation planning need of special attention:

- what is the purpose of water saving - for economic and social development, or at least partly for the ecological environment?
- water-saving measures should take into account the impact on the overall situation, such as large-scale anti-seepage engineering and field seepage in the upper and middle reaches of losses may adversely affect water availability to downstream users.

'Take immediate action: Save water'

3.2 Example of a Plan

This is an example of a water savings plan, as prepared by Chaoyang Municipality (Liaoning Province).

Overall targets

The overall objectives for 2010 are summarised as:

1. During the period of building a water saving society, the efficiency and benefits of water resources utilization shall be raised at an accelerating pace. When the GDP in Chaoyang Municipality reaches 46.5 billion Yuan in 2010, the water use quantity per 10,000 Yuan of GDP shall decrease from current 249 m^3 to 160 m^3 or below;

2. The industrial structure shall be adjusted to achieve a ratio of 20:50:30 between the GDPs of primary, secondary and tertiary industries (from a current ratio is 27:40:33);

3. water supply and water use management shall be strengthened so that the implementation rate for planned urban water use shall be raised from 78% to 100%;

4. WWTPs shall be built to achieve comprehensive pollution control and improve surface water quality. The water quality at the river reach passing through Chaoyang City shall reach Class III or above by 2010;

Targets for primary industry:

1. Boost water use efficiency and benefits, facilitate the process of agricultural industrialization and develop highly efficient and water saving agriculture and ecological agriculture. On the premise of expanded irrigation area, water saving irrigation and increased total grain output, the irrigation water use shall be reduced year by year. The comprehensive irrigation water use quota shall be reduced from 157 m^3 to 145 m^3 per mu. The irrigation quota for paddy field shall be reduced from 801 m^3 to 730 m^3 per mu; the irrigation quota for other grain crops shall be reduced from 170 m^3 to 145 m^3 per mu; the irrigation quota for vegetable field shall be reduced from 415 m^3 to 379 m^3 per mu; the irrigation quota for orchard shall be reduced from 160 m^3 to 130 m^3 per mu.

2. Facilitate the rehabilitation of facilities in the field, so that the effective water utilization coefficient for canal irrigated areas shall be raised from 0.45 to 0.55; the effective water utilization coefficient for well irrigated areas shall be raised from 0.65 to 0.70.

3. Develop water saving irrigation to raise the percentage of water saving-irrigation from 33% to 50% or higher.

Targets for secondary industry :

1. Boost industrial water use efficiency. By 2010 the water use quantity per 10,000 Yuan of GDP shall decrease from 128.6 m^3 to 90 m^3.

2. Enhance production processes and improve industrial water saving facilities. Industrial water recycling rate (including thermal power) shall increase from

88.1% to 90% or above; the water recycling rate for general industries (excluding thermal power) shall increase from 81% to 86% or above.

Targets for tertiary industry and domestic water use:

1. Ensure water use safety, raise residents' awareness of water saving and promote water saving appliances. In order to meet the increased domestic water demand due to improved living standard, the urban domestic water use norm will be increased from 78 l/person/day to 109 l/person/day while the rural domestic water use norm will be increased from 35 l/person/day to 50 l/person/day.

A water-savings plan would include comprehensive targets for domestic use

2. Facilitate the rehabilitation of urban water supply pipes to reduce the leakage rate from 23% to 15% or below.

3. Strengthen the protection and management of potable water sources and water supply facilities to make the reliability of potable water use reach 100%.

4. Facilitate the upgrading of appliances for domestic water use. The usage rate of water saving appliances for urban domestic water use shall increase from 55% to 85% or above while the usage rate of water saving appliances for rural domestic water use shall increase from 15% to 50%.

5. Install and replace 15,000 household meters per year; install and replace 1,000 meters per year for industrial, commercial and service sectors. Promote the installation and usage of intelligent water management system (IC cards). The intelligent water resources management systems must be installed for self-built water abstraction facilities which use 20,000 m^3 of water or above per year. The water metering rate shall reach 95% or higher;

Targets for ecological environment;

1. Strengthen the control of soil erosion and improve the ecological environment to reduce the soil erosion rate in Chaoyang Municipality from 48.5% to 43.5% or below.

2. Build urban WWTPs to make the urban wastewater treatment rate reach 70% or higher, the reuse rate in Chaoyang City reach 75% or higher and the reuse rate in Chaoyang Municipality reach 40%, so water resource recovery by wastewater treatment could be achieved.

3. Strengthen the control of surface water pollution. The percentage of water function zones meeting the standards shall increase from 49% to 80%, and the percentage of river length meeting the standards shall increase from 50% to 65%. The water quality in potable surface water protection zones shall be maintained at Class III or above; the water quality in potable groundwater protection zones shall be maintained at Class II or above.

Longer term targets are included in the plan - the targets for 2020 are:

1. The water use quantity per 10,000 Yuan of GDP shall reach 120 m^3 or below;

2. The comprehensive irrigation water use quota shall be reduced to 140 m^3/mu or below;

3. The effective water utilization coefficient for canal irrigated areas shall be raised to 0.6 or above; the effective water utilization coefficient for well irrigated areas shall be raised to 0.75 or above;

4. The water use quantity per 10,000 Yuan of GDP shall decrease from 80 m^3 or below;

5. Industrial water recycling rate (including thermal power) shall increase to 92% or above;

6. The urban domestic water use norm will be controlled within 202 l/person/day while the rural domestic water use norm will be increased to 60 l/person/day;

7. The leakage rate of urban water supply pipes shall be reduced to 10% or below;

8. The urban wastewater treatment rate shall reach 90% or higher, and the wastewater reuse rate shall reach 70% or higher;

9. The reliability rate of potable water use safety shall be maintained at 100% in Chaoyang Municipality;

10. The soil erosion rate shall be reduced to 32% or below.

By meeting these targets, Chaoyang Municipality should achieve a balance between water demand and supply in average years from 2020 onwards. Other municipalities will have slightly different targets and objectives, although they are likely to be similar in scope and concept. The monitoring and auditing programme outlined in subsequent chapters of this report should be designed to suit the needs of the particular programme, but should be sufficiently general that it allows conclusions from individual water savings society programmes to be synthesized across the province and nation.

3.3 The complexities of water saving in agriculture

Water saving in agriculture is more complex to achieve and to analyse than in the case of urban and industrial uses of water. The key is to reduce non-beneficial losses of water, which are only a small part of the total losses. Many of the losses can be reused elsewhere

Two cases where systematic approaches to measuring non-

beneficial losses have bee made are the Tarim Basin and the Hai basin.

"*The Tarim basin is a river basin under stress in a desert area of northwest China. The objectives of the Tarim Basin II Project were to increase farmers' incomes sustainably while reducing water allocations, and to restore environmental flows to the "green corridor," an area of natural beauty and lakes that had dried up three decades before, because of massive irrigation development upstream.*

Satellite imagery gave a clear picture of the pattern of beneficial and non-beneficial ET in the basin and was used along with other methods to assign reduced water quotas to water user groups and to the riverine environment. The knowledge of ET also allowed the project to identify the most productive investments that would save water to achieve optimal basin-level water efficiency, including engineering, agricultural, and management investments. Canals were selected for lining if their leakage was mainly going to non-beneficial ET. This was often the case because the leakage was contributing to high water tables and salinity, and water was being lost to capillary flux and ET from the ground surface in areas around the canals. Canals where losses were mainly returning to the river or groundwater systems were not lined. Under the project, geo-membrane lining along with concrete was used and nearly zero seepage was achieved. The differentiation of ET at the crop and farm level allowed the project to draw up land and water management plans and inventory the ET requirement of each crop, and even to give advice to individual farmers on ways to improve ET management". (World Bank, 2006)

Similarly In the Hai basin, "*The Project will introduce a new practical approach to water savings in irrigated agriculture using remote sensing and ET management rather than only focusing on irrigation systems efficiency improvements, which has been the approach in China in the past. Improving irrigation system efficiencies does not necessarily save water and in fact can often increase the amount of consumptive use (ET) of irrigated agriculture by eliminating leakages which were returning to the surface or groundwater systems and utilizing that water for more crop production. "Real" water savings focuses on reduction in ET which can be accomplished through a combination of irrigation technology, agriculture and management measures.*

The objective is to reduce the ET at the county level to target levels and then maximize the production and value of production per unit of ET. There is a wide range of water productivities (Yield/ET) for each crop type depending on irrigation, agriculture and management practices".

These two cases have used sophisticated remote sensing techniques to quantify the components of the water balance, and hence water savings. In the future, this is likely to become far more common, but in the short term simpler methods will remain in use. However, the methods will still need to address the same basic issues. Thoresen et al (2009) compare three methods - remote sensing, water balance and crop coefficient methods for calculating crop consumptive use. These methods resulted in differences in estimates of consumptive use of up to 15%, and the remote sensing method was estimated to be accurate to within 5% on a seasonal basis.

Given the magnitude of savings that are envisaged for water saving societies, these estimates of accuracy highlight the problems in quantifying savings.

4 Approach for auditing

4.1 Introduction

The water savings society needs to be audited periodically, typically every five years, but the basic data needs to be collected and compiled every year. This will need to be checked, analysed and reported on every year, in order to provide a systematic basis for the audit. Short-term variations and also inaccuracies in data and the relatively small changes likely to result from water savings society establishment mean that annual audits are not justified and may even be misleading

A water saving society aims to make use of water resources as a whole more sustainable. This requires an approach which looks at resources in a comprehensive manner, and not just at usage with an individual urban water supply or irrigation district. Local savings have to be viewed in this wider context in order to ensure that they are real savings and contribute to sustainable use of the resource, rather than just being a local saving.

This means that WSS needs to be audited at three levels:

- water resource systems – abstractions and return flows,
- water distribution systems – water supply companies, irrigation districts and industries, and
- end-users.

This audit depends on a rigorous process of monitoring and evaluation. These are distinct but related activities: monitoring is continuous, and involves collecting data for range of key indicators; whereas evaluation is carried out periodically, on the basis of monitoring data. It should be noted that perceptions of success may vary, but outcomes need to be assessed quantitatively

It is relatively easy to evaluate performance within an individual distribution system. Appropriate performance indicators can be defined – for example

- Total water delivery
- Total losses

Examples of performance indicators for end users include:

- Value added per productive water unit
- Per capita domestic water use

It can be expected that there will be short term fluctuations and climatic variability may be a confounding factor, but longer term monitoring should reveal progress. The audit will reveal specific areas where water wastage is occurring and actions which could be taken to improve the situation.

In addition to auditing progress towards water saving and environmental sustainability, a systematic WDM audit programme will help service delivery organisations to

- Become more innovative, flexible, adaptive and responsive
- Communicate with and be accountable to beneficiaries

- Learn from experience and take corrective action

Auditing impact on water resources is more difficult as it requires consideration of return flows. Some of these are invisible (losses to groundwater) or diffuse (losses from surface irrigation). Although river flows and groundwater level are the key indicators, it is not easy to relate changes in these to specific individual activities and hence identify relevant corrective actions

4.2 Targets and indicators for water saving

Overview of indicators

The achievements of a water savings society can only be monitored if the objectives of the society are clearly defined, and if there are appropriate indicators for measuring these achievements.

The choice of indicators is important to make sure that the audit is realistic and effective. It is generally recommended that indicators for monitoring should be *Specific, Measurable, Achievable, Realistic and Timely*. If data cannot be collected, or is too time-consuming to be collected, or if it is not specifically related to the water saving society it will be difficult to interpret it as a measure of the water saving society. In selecting the indicators, the methods for collecting the data should also have been identified. As far as possible, specific data collecting programmes should be avoided as they are time-consuming and distracting.

Data which is already collected for other purposes, such as WAP management, irrigation management, WSC operation etc should be used wherever possible. It will, however, need to be checked for consistency, and this may require some spot checks or verifications of some data sets.

Standard forms should be developed to ensure data is compiled consistently and in a comparable format.

The indicators listed below are tentative, and should be adjusted according to the specific targets of the water savings plan. The plan itself should in fact include details of the indicators to be used, and the means by which data relating to them will be collected, analysed and used.

These should be divided into quantitative and qualitative indicators in accordance with the nature of the target.

Overall water-saving targets

Overall targets need to be set, such as those listed below. These will be derived from the detailed indicators in the following sections. Indicators might include:

- GDP per unit of water, on the basis of regional total use of water and regional GDP
- utilization of water resources: the volume of water actually used as a proportion of available resources, expressed as a percentage
- Percentage of total water abstracted which is metered
- Total water abstracted expressed as percentage of abstraction permit volume
- non-traditional water resources expressed as percentage of total quantity of water used

- Overall water use (aggregate for all uses and sectors) per permanent resident

Agricultural water-saving targets and indicators

The key indicators for agricultural water saving are irrigation coefficients, norms, water use and productivity, as described below:

- utilization coefficient of irrigation water: the net water requirement of crop as a percentage of the total amount supplied at the headworks;
- field water use coefficient: crop water requirement as a percentage of amount of water to enter the field;
- irrigation water norm: the standard amount of water for a crop in a certain location and stage of socio-economic development which is used as a basis for determining irrigation quotas or entitlements (and which in aggregate will match the abstraction permit volume);
- irrigation water productivity: productivity of water expressed as crop yield (kg dry matter) per unit water supplied, and the net value of production (RMB) per unit water supplied.

These indicators as summarised in Table 1, which could form the basis for evaluating an agricultural water saving plan.

Most of the data required is or should be collected as a matter of normal irrigation management practice, and can then be analysed to provide an assessment of WSS progress. It is important that 'actual' data is collected accurately and not assumed to be the same as the norm. It is suggested that this is done at lower levels as well as for the whole ID, at least on a sample of villages, townships or WMS command areas. The data should be available, and systematic analysis and reporting can be done quite simply.

Irrigation is the largest user of water and typically has the highest losses, thus there is the greatest potential for water saving. However it is important to remember that these losses may be available for reuse downstream and thus are not true losses. The impact of this reduction in downstream availability also needs to be assessed.

Hence in addition to the figures above, which will indicate the degree of local water saving that has been achieved, it is also important to assess the regional and environmental impact of this local saving. Return flows can sometimes be measured accurately, but this is not usually the case.

Remote sensing methods are now available and used in some parts of China which can enable direct measurement of productive and unproductive evapo-transpiration, and hence the magnitude of real water savings, but these are not yet generally applicable.

Table 1: Indicators for monitoring agricultural component – per irrigation district

Indicator	Unit	Actual	Baseline	Target 2015	Target 2020	Data source	Analysis to be done
Area irrigated	*(mu)*					WMD	1. Water per unit area
Crop type (grain, fruit, vegetable, etc)	*(% area)*					WMD / township	1. Water per unit area by crop 2. ∑crop requirement.
Crop production (grain, fruit, vegetable, etc)	(*RMB*)					WMD	1. Crop budget 2. RMB per unit water (by crop)
Water supply Norm, allocation, supply	*(m^3)*					WMD	1. η=∑crop req./supply 2. allocation/supply 3. return flows/losses
Rainfall	(mm)						1. Effective rainfall and net irrigation req.
Field Coefficient	(%)					sample area monitoring	1. η_{field} = ∑crop req / WUA supply 2. Volume/cost of water saved
Canal Coefficient	(%)					WMD records	1. η_{canal}, = Supply to WUA / Supply to ID 2. Volume/cost of water saved
Irrigation utilization coefficient	(%)					WMD records	1. η_{system} = ∑crop req / Supply to ID 2. Volume/cost of water saved
Livelihood (income)	(RMB)					Township	RMB/capita

Industrial water-saving targets and indicators

The key indicators for industrial water saving are production quantity/value, abstraction permit volume (major industry), norms (medium/small industry), actual water use, losses, wastewater volume and recycling, and investment in loss reduction, recycling and reuse, as described below. These are summarised in Table 2, and listed below.

- industrial output value per unit of water used.
- reuse of water as proportion of total industrial water consumption.
- proportion of industrial wastewater which is treated to meet wastewater discharge standards.
- Industrial waste water reuse as a proportion of the total sewage treatment and water reuse.
- industrial unit output per unit water (according on the specific product)

Data collection and analysis should be done for each major industrial enterprise (eg, defined as any industry which uses more than 1% of the total allocation in the county), or for each type of industry, where there are a number of small similar units.

The data will be needed in any case for the water abstraction permit (WAP) management process for large industries and this will provide an input to WSS auditing. Small industries take water from a WSC, in which case a system should be put in place for collecting this data annually from representative industries. These will need to be aggregated to provide a total for industry in the county and municipality.

Table 2: Indicators for monitoring industrial water component

Indicator	**Unit**	**Value of indicator**				**Data source**	**Analysis to be done**
		Baseline	**Actual**	**Target 2015**	**Target 2020**		
Industrial production	(RMB) (unit)					Industry	RMB per unit water (norm and actual)
Water supply (WAP, norm, allocation, actual)	(m^3)					Industry / WSC / WAP	η=delivery/ norm Volume saved
Losses	*%*					Industry	Volume saved
Wastewater Total % recvcled % treated	*(m3)*					Industry / WSC	Volume saved
Investment Leak control Recycling	*(RMB)*					Industry	RMB/m^3 saved

Urban water-saving targets and indicators

The key indicators for urban water use are listed below

- leakage rate for urban water supply networks, expressed as percentage of total water not charged for
- the use of water saving devices as a proportion of the total number of devices.
- number of users of the public water supply with meters as a proportion of the total number of users.
- waste water treatment rate in cities and towns, expressed as a proportion of the total volume of waste water
- reclaimed water use rate, expressed as a proportion of urban waste water which meets water quality standards for the purposes specified for reuse.
- The average daily water quota per person calculated as total consumption divide by the number of permanent residents.

The water saving targets in the urban water supply sector are often defined as reduction in pipe network losses. Water balance approaches are followed to determine the real losses in water supply areas through the estimation of unaccounted for water through the billing and revenue process and the estimation of losses between the main WSC primary system and the household units (pre-meter). The actual breakdown process could be different for different situations since in some cases whole apartment blocks are metered whilst in other situations, individual household units are monitored.

The indicators presented in Table 3 could form the basis for a water saving plan in a WSC.

Table 3: Indicators for monitoring urban water component

Indicator	Unit	Value of indicator				Data source	Analysis to be done
		Baseline	Actual	Target 2015	Target 2020		
Population / users *[by category]*	Person					WSC	
Water supply WAP, norm, allocation, and actual delivery	(m^3/user)					WSC	
Losses In WSC In HH/entity	*%*					WSC	
Wastewater return flow Treated reused	*(%)*					WSC	
Investment Leak control Treatment	*(RMB)*					WSC	RMB/m^3 saved /treated
Fee collection Assessed collected	*RMB*					WSC	

Regional indicators of water saving

Local water saving may not result in overall water saving, and may lead to a change in use rather than a reduction in consumption, so it is also necessary to identify regional targets. It is not possible to quantify return flows with any degree of accuracy, so this assessment needs to be based on actual conditions in the rivers and aquifers at key locations. The number and location of these key monitoring locations needs to be carefully defined.

In all cases the values for each of these indicators will vary in both time and space: groundwater levels at a specific date can be averaged across the irrigation district and compared with equivalent data for previous years. River flow data will need to be aggregated in some way before it can be compared with historic data. The method of aggregation will depend on the environmental flow requirements (for example) annual total volume, minimum monthly volume, absolute minimum.

Table 4: Indicators for regional water saving

Indicator	Unit	Value of indicator				Data source	Notes
		Baseline	Actual	Target 2015	Target 2020		
River flows	*m^3/s*						
Depth to groundwater	*m*						
Surface water quality	*Class*						
Ground water quality	*Class*						

Implementation arrangements - qualitative indicators

There are a wide number of factors for successful establishment of water saving societies which cannot easily be quantified. Qualitative targets and indicators need to be defined for these, which include issues such as:

- Regulations, policies and incentive systems: do these exist, do they support water saving sufficiently, are they easy to comply, do they stimulate the formation and implementation of comprehensive procedures;
- Coordination with other departments related to water management and water conservation: is this smooth and efficient;
- Extent of public participation in the development of the plan, consultations and refinement of the plan, monitoring and updating plan targets and methods;
- Market mechanism for resource allocation, and process for the gradual improvement of the system;
- Price mechanism: basis for cost recovery, pricing systems, collection and management arrangements; mechanisms work properly;

- Financing channels: government, private investment policy;
- Public awareness, including the establishment of water-saving education and training system, publicity, water users association (formation and strengthening), culture of water-saving, etc.

Progress measured by qualitative indicators will be collected each year but will need to be further investigated in the 5-yearly audit, to ensure that data collected is consistent and realistic. This data is subjective and slightly uncertain, so it is important to be careful in the way it is obtained and presented.

Table 5: Qualitative indicators

Topic	Indicator	Baseline	Actual	Target 2015	Target 2020	Notes
Regulations	Existence of relevant regulations					
Organisations	Arrangements for cooperation Definition of responsibilities					
Public Participation	Systems of consultation Participation in planning and auditing					
Market mechanism	Price linked to market value; trading permitted					
Pricing system	Prices based on costs Social protection					
Finance channels	Collection and management arrangements					
Mass awareness	Campaigns held, evidence of understanding					

4.3 Responsibilities

The audit should not be undertaken directly by the organisations implementing the water saving plan, but it should be independent. This will make the audit more impartial, and it will be easier for the auditors to make constructive recommendations if they are not part of the planning and implementation team. The audit is not intended to critical, with objectives of finding faults and apportioning blame. It is intended to be a constructive exercise, to help improve the planning and identify more efficient ways of meeting the objectives. The auditors should have free access to data, and the WSS implementation teams should feel threatened or inhibited in sharing their data and knowledge. It is indeed important that the auditor can draw on data provided by water-using organisations, but they will also need to undertake additional data collection to support or verify the data.

Three approaches are commonly used in China. The audit can be done by:

- the next higher level of Government. .
- by a third party hired to do the auditing by the implementing agency.

- The people's congress at the same level.

It is important that the audit is trusted, and thus the procedures and responsibilities needed to be agreed in the plan itself, which is developed in consultation with all relevant stakeholders.

5 Water Savings Society Audit

5.1 Introduction

The five-yearly audit of a water savings society should be developed from the annual monitoring data and reports, and should systematically compare the progress against the targets laid down in the water savings plan. Supplementary data may be needed to complete the analysis, but the bulk of the data should be in the annual reports.

The audit report should contain more analysis of the progress made, constraints to meeting the targets and any changes to approaches needed to ensure successful implementation.

5.2 Analysis of findings

The detailed findings need to be analysed, both by sector and overall, to assess the actual achievement in terms of water savings and of progress towards a water savings society.

Agricultural water use

Agriculture is the dominant user of water. A key indicator of progress is the total volume of water diverted for agriculture, also expressed as a percentage of total water use. Water saving can influence return flows as well as diversions, so the changes in these return flows also need to be assessed.

It is important to improve the productivity of the water consumed whilst protecting livelihoods of farmers. This can best be expressed as a combination of net output value per cubic metre of water and per farming household. This is because reductions in water use may decrease household incomes even if the productivity of water is increased. In this case, support with alternative employment or other compensation is needed.

Agriculture in the dominant user of water

As intermediate steps in this assessment, the analysis should consider the changes in

- Cropping pattern (changes from subsistence to cash crops, subject to local food security targets)
- Irrigation methods and efficiency (at field level)
- Irrigation infrastructure (canal lining and control structures, and canal conveyance efficiency)
- Irrigation return flows (to rivers and aquifers)
- Irrigation management systems (main system scheduling, village level management)

There can be large changes in rainfall between years, which will affect irrigation water use, and thus actual rainfall must be allowed for in the analysis of each year's data.

There may also be large differences between households, which are masked by overall averages. The impact on household incomes needs to be considered for representative households, to ensure that for example, it is not only the small percentage of households who can afford high-tech solutions (such as drip irrigation) who are able to cope with the changes in water availability. Agriculture is also a source of employment for others (for example for cotton harvesting), and thus the impacts on employment opportunities should be assessed.

Industrial water use

Industry is the most productive use of water, although the value varies considerably according to the type of industry. The volume of industrial water use is likely to increase both in absolute terms and as a percentage of water use, but the there is a target to increase productivity of water (expressed both as Y/m3 and as Y/employee). This can be achieved by a combination of

- Process improvements
- Leakage control
- Recycling

These should all be quantified so that trends in net water use (allowing for return flows) can be assessed.

Water quality of effluent is also important, as this may be highly polluted.

Water use productivity can be increased through leakage control.

Domestic water use

Domestic water use is a basic requirement which cannot be quantified in economic terms, but increases in use are generally beneficial in terms of human health, so appropriate net norms need to be set to meet these requirements. The target in a water saving society is to meet these basic needs as efficiently as possible – by reducing leakage and other unaccounted-for water, improving efficiency within households. The analysis of progress towards a water savings society needs to consider

- Actual delivery of norms to each household (considering variations between household types, and losses within households)
- Losses within the WSC (ratio between bulk supply and deliveries to household)
- Wastewater treatment
- Investment in leakage control and waste water treatment, and collection of tariffs
- Regional water saving

All water uses and losses are inter-related, so the analysis needs to conclude with an assessment of the overall impact on water use in the river basin or sub-basin. This should be presented as changes in river flows and in groundwater levels at key locations, taking account of all the factors considered in the sectoral assessments above.

Ground and surface water quality should also be covered.

Implementation issues

Water saving depends on a number of background factors which need to be assessed. These include policies and regulations, and also public awareness and understanding. It is only if these are in place that actual water saving can be achieved. These can only be assessed in qualitative terms, but changes in actual use need to be interpreted in the context of these changes in the enabling environment. This may for example indicate that further institutional change may be needed to achieve the actual water saving targets in each sector and overall.

Reasons for not achieving targets

The review of indicators should immediately indicate whether the targets have been achieved. If the targets are not met, there can be two reasons:

- the programme has been implemented, the planned activities have been undertaken, but the WSS has not achieved the targets;
- the programme has not been effectively implemented, so that some targets are not addressed

The first reason is potentially very complex and may require detailed analysis of the targets and the activities needed to achieve them, focusing on tackling the specific causes of the water use pattern. Past experience on the basis of a prior audit or experience from elsewhere should help to ensure that the targets and methods are achievable. However, there may be well be some targets which are more difficult to achieve than had been anticipated. The focus of the audit should be to analyse any such

problems and identify improved methods to resolve them.

The second reason should be avoided at the planning review stage, on the basis of a prior audit or experience from elsewhere to ensure that the programme has been designed in a rational and implementable manner. However, water saving is complex activity which depends on a lot of coordinated actions and cooperation between organisations which may take longer than expected to achieve.

5.3 Recommendations

The audit should not only indicate what progress is being made towards meeting the targets of the water savings society, but it should provide recommendations for improving the process.

If either progress towards the targets or the impact on the regional water resources situation is less than planned, then the reasons behind this will need to be examined and analysed rigorously so that remedial actions can be proposed.

The audit report should present the key findings and recommendations. It should incorporate all data collected in the annual monitoring reports, assess what progress has been made towards meeting the targets, and suggest improvements to the water savings plan needed to speed up progress towards the targets.

If problems are identified, such as that activities are being successfully undertaken but are failing to meet the water savings objectives, then a more fundamental review of the plan is needed. This need not be included in the audit report, but the report should indicate what further studies are needed to ensure that the water savings targets can be achieved.

It is important to assess both the accuracy of the data and the sensitivity of the conclusions to data uncertainty. Even with good infrastructure, accurate measurement of water can be difficult.

6 Conclusion

China's water conservation planning and water-saving social construction planning has been carried out thoroughly, but the assessment of achievements in water-saving has not been done in such detail.

This document aims to provide general guidance on how to audit water-saving societies: this should be the next step for the construction of a sustainable and effective water-saving society. It includes discussion of the selection of appropriate water-saving targets and indicators, and arrangements for carrying out the audit in a sound manner.

Continuous assessment of water-saving plans, so that they can be revised to be flexible, relevant and, appropriate is needed. According to changes in the external environment, and macro (National) targets, as well as local socio-economic development and ecological changes, the objectives and water-savings plans may need to be revised.

Under normal circumstances, water conservation plans should be reviewed, amended or re-enacted every five years in time with the country's National Economic and Social Development Five-Year Plans.

China's auditing system for water-saving is still in its infancy: there have been some research results, and are some preliminary attempts. This advisory note aims to stimulate further ideas, and to encourage systematic auditing.

Document Reference Sheet

Glossary:

WSS Water saving society

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Related materials from the MWR IWRM Document Series:

Thematic Paper 3.1	Water Saving in Irrigated Agriculture
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Thematic Paper 3.3	Active Leakage Control as a Key Component in Increasing Efficiency in Urban Water Supply

Where to find more information on IWRM – recommended websites:

Ministry of Water Resources: www.mwr.gov.cn

Global Water Partnership: www.gwpforum.org

WRDMAP Project Website: www.wrdmap.com

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