Prospects and Approaches for Implementing Water Safety Plans at Thua Thien Hue Province in Vietnam

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Abstract
Water safety plans is implemented at Thua Thien Hue province, Vietnam. It provides better environment in water source area and safe water to people. It has made Thua Thien Hue water supply company more certain, confident and resilient for its service. The water supply company try to support other water supply companies in Vietnam for their implementing water safety plans with its experience.

Keywords
Water safety plans; water supply; water quality management

I. GENERAL INFORMATION ABOUT WATER SECTOR IN VIETNAM
Relevant organizations for water safety plans (WSP) are as follows:
(1) Ministry of Health (MOH)
(2) Ministry of Construction (MOC)
(3) Ministry of Natural Resource and Environment (MONRE)
(4) Ministry of Agriculture and Rural Development (MARD)
(5) Ministry of Planning and Investment (MPI)
(6) Ministry of Finance (MOF)
(7) People's Committee of each municipality such as province (PPC)

Regulations on water quality and basic legislation for WSP in Vietnam are as follows:
(1) National Technical Standards of Drinking Water Quality QCVN 01:2009/BYT of MOH
(2) National Technical Standards of Domestic Water Quality QCVN 02:2009/BYT of MOH
(3) National Technical Standards of Surface Water Quality QCVN 08:2008/BTNMT of MONRE
(4) National Technical Standards of Ground Water Quality QCVN 09:2008/BTNMT of MONRE
(5) National Technical Regulation on Domestic Wastewater QCVN 24:2008/BTNMT of MONRE
(7) Introduction of water safety draft Circular replace for the Decision No 16/2008/QĐ-BXD (Now collecting ideas from relevant agencies)

II. INTRODUCTION OF THUA THIEN HUE WATER SUPPLY COMPANY
Thua Thien Hue (TTH) province:
• Located in the central region of Vietnam
• Area: 5,009km²
• Population: 1.18 million
• Hue city, the capital city, and 8 districts
Location is shown in Figure 1.
Hue city:
- Located in the central TTH province
- Along the banks of Huong River
- Just a few kilometers inland from South China Sea
- Area: 71km²
- Population 950,000
- 27 urban wards

Thua Thien Hue Water Supply and Construction State One Member Company Limited:
- The transaction name: HueWACO
- Established in 1909
- A government owned enterprise
- 22 water supply systems and distribution networks
- Total production capacity: 170,000 m³/day
- Producing and supplying water to urban and adjacent rural areas in the whole province

Consumer characteristics
Customers’ awareness of safe water has been raised day by day. After the announcement of WSP, people take more interesting to water quality and are also considering drinking safe water directly at water tap.

III. AIM OF HueWACO
HueWACO aimed following matters when it attempted to implement WSP.
1) To improve the water production capacity.
2) To develop the company itself as one of the leading water supply companies (WSCs) in Vietnam.
3) To integrate itself into the region and the world gradually.
4) To provide clean, safe and tasty water.
5) To take efforts so that 140/152 wards and communes in TTH province will be accessible to water supply network until 2020, to cover 80% of the provincial population and 100% of Hue city inhabitants with 300,000m³/day of supply capacity.
6) To reduce the rate non-revenue water to 8% until 2020.
7) To provide satisfactory service to customers.
8) To guarantee high service efficiency.
9) To contribute to the improvement of life quality, community health and the socioeconomic and tourism development of TTH province.
IV. WATER SAFETY PLANS IMPLEMENTATION BY HueWACO

Purpose of implementing WSP
(1) Safe water supply meeting to QCVN 01:2009/BYT
(2) Stable and continuous water supply
(3) Customers’ satisfaction at water supply service
(4) Recognition as safe water among people and tourists

WSP implementation process
2001: HueWACO launched water safety programme as the precursor of WHO’s WSP.
2007: HueWACO approached WSP programme as attending WHO training course of WSP.
2007: HueWACO was selected as a pilot WSC for WSP in Phase 1 of WSP promotion program in Vietnam.
2007: Ministry of construction promulgated Decision No.16 for Water Safety Supply. This is the first important legislation for WSP in Vietnam.
2010: The WSP steering committee of TTH province was established.
2010: The WSP team of HueWACO was established.
2010: The WSP team prepared WSP manual which included hazard identifications, risk assessments, improvements, supporting programmes, etc.

Establishment of necessary working groups
Three working groups with different level were established to implement WSP.

Establishment of WSP steering committee of the province
Responsibilities of WSP steering committee of the province are supporting the provincial chairman to lead safe water supply, meeting demand of water drinking, domestic and another activities within TTH province area.
To establish the steering committee, HueWACO sent the report of the need to protect water source and the requirement of WSP to provincial people’s committee (PPC) in order to establish WSP steering committee of TTH province. Then PPC approved the decree to multiple stakeholders to implement supporting solutions for WSP. HueWACO held the workshop of WSP with the attendance of scientists, especially Hue scientists who shared their ideas on WSP.
Provincial WSP committee consists of the chairman of PPC as the head of the committee, the director of provincial department of health as a vice chairman of the committee, the director of HueWACO as another vice chairman of the committee, the manager of water quality management department of HueWACO as secretary and directors of relevant departments of province as members.

Establishment of WSP Board
Responsibilities of HueWACO WSP Board are as follows:
- Building up, training, deploying and checking up all departments and sections/unit to implement WSP effectively
- Organizing to check and assess WSP and carrying out improvement activities of WSP
- Periodically assess HueWACO’s satisfaction towards WSP
- Building up supporting program to implement WSP in each stage
- Advising and suggesting heads of the province and stakeholders to support WSP
HueWACO WSP Board consists of the director of HueWACO as the head of the board, a vice director of HueWACO as the assistant of the board, the manager of water quality management department as the secretary, managers of departments, water treatment plants, water supply branches and heads of water production factory as members.
**Establishment of WSP Team for each water supply system:**

Responsibilities of WSP Team are development, implementation and assessment of WSP for the water treatment plant. HueWACO sent the invitation to local multiple stakeholders to assign their staff as a member of the team. HueWACO let members be interested in WSP and explain them the objective, benefit, effectiveness of WSP implementation. HueWACO had a meeting to establish WSP team and made the commitment to protect water source. (Example: Decision for WSP team of Quang Te water Treatment Plant, number 545/2011/QD/XD-CN date August, 5th 2011)

WSP Team consists of the manager of HueWACO branch/water treatment plant as the team leader, a staff member of water quality management department as the secretary, a vice chairman of district/commune, the manager of health department of district/commune, the representative of customer whom the local government recommended and the head of water treatment plant as members.

**Analyzing hazards and prioritization of risk**

The objectives of this step are as follows:

1. To consider all aspects of the supply system including the catchment and water source
2. To identify all potential biological, physical and chemical hazards those are associated with drinking water supply
3. To identify the hazardous events that can result in hazards gaining entry to the water supply “What could happen here or what could go wrong here?”
4. To identify the control measures currently in place
5. To determine the risk potential of each hazardous event at each process flow step

Monitoring data from a period of operation and management has been used for each identification or assessment. Most of monitoring measurements have been conducted as external or internal reviews, consumer investigations and close water quality monitoring. A scoring matrix is tailored to evaluate each risk. Control measures and improving plans were considered based on the risk factor matrix. The matrix helps a WSP team to give score of each risk with its likelihood and impact level to human life.

**The case of HueWACO**

Hazards for Quang Te 2 water treatment plant (WTP) as the example possibly cause water pollution in Huong River as follows:

Building dams and reservoir in the upstream and downstream of Huong River causes eutrophication and low dissolved oxygen in water. Then water has bad smell, dirty color and higher concentration of metals such as manganese and iron and organic substances and increased microorganisms. Many kind of waste water are flown into the river. Domestic waste water from houses of people mainly living on boats and along riversides has been drained to Huong River directly. This hazard is the most affected to water source quality. Waste water from hospitals or industrial areas may include harmful substances. Mining of granite gravel, sand and gold discharge waste water into the river. Waste water from agricultural activities includes pesticides, fertilizers and other agricultural chemicals. Water hyacinth, aquatic weeds and algae, which can grow well with eutrophication, damage tourism because Huong River will be a stinking river. This is one of special hazards for TTH province. Popular algae are green algae, cyanobacteria and diatom. These algae often pass through sedimentation tank and remain in filter sand, and cause reduction of water production rate. The special polluting source in Hue city is activities of tourism, festival performance on Huong River. They are held every year and discharge a large amount of solid waste to the river directly.
Other hazards in the catchment area are flood and landslide by heavy rain. There are 4 to 5 floods along Huong River a year as average. It is also caused by deforestation in upstream area. Some hazards likely cause decline of water quality in the water treatment process. They are oil flotation from sand exploiting boats around the intake point, moss and oysters growing on the wall of plant basin, unstable movement of mixers, thickness or size of sand and anthracite carbon beyond permissible limit, dirty filter sand, unsuitable flow rate, scale deposited on the wall or the bottom, etc. More hazards are possible in distribution network. Pollution likely happen while installing new pipe or repairing pipe. Residual chlorine is likely decreased in pipeline network. The other risks for stable water supply are decline of facilities, flood, storm, drought, fire case and power failure.

**Improving plans**

Table 1. shows improving plans of HueWACO against frequent hazards.

<table>
<thead>
<tr>
<th>Identified hazards</th>
<th>Control measures</th>
<th>Improved Plan</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of clean water in Summer</td>
<td>Increasing capacity and advance the water treatment plants</td>
<td>(1) Quang Te 2 WTP expansion from 27,500 m³/day to 82,500 m³/day</td>
<td>2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) Newly constructed WTPs; Nam Dong 3,000 m³/day, Song Nong 1,000 m³/day</td>
<td>2008-2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3) Upgrading of received WTPs from the national program of rural clean water</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and sanitation such as Loc Binh, Quang Ngan, Quang Cong and A Luei.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4) Advancing of Da Vien WTP to increase capacity from 14,000 m³/day up</td>
<td>2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>to 30,000 m³/day</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5) Building Loc An WTP with capacity 8,000 m³/day</td>
<td>2012-2013</td>
</tr>
<tr>
<td>Low water pressure at the network end</td>
<td>Installing pressurizing stations</td>
<td>Installing water pressurizing pump stations and chlorine adding facility</td>
<td>2008-2012</td>
</tr>
<tr>
<td>Decline of water quality</td>
<td>Supervising water quality strictly</td>
<td>(1) Equip jar tests, turbidity meter, pH meter to each water treatment plant</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) Setting online water quality monitoring system at Quang Te, Da Vien, Tu</td>
<td>2008-2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ha, Hoa Binh Chuong and Nam Dong WTP and 7 distribution network systems</td>
<td></td>
</tr>
<tr>
<td>Unstable electric power</td>
<td>Installing power generator</td>
<td>Power generator at Van Nien Pumping Station, Quang Te, Da Vien, Tu Ha, Hoa</td>
<td>2000-2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Binh Chuong WTP</td>
<td></td>
</tr>
<tr>
<td>Unstable source water quality</td>
<td>Enhancing water quality monitoring</td>
<td>Increasing monitoring frequency of iron, manganese and odor</td>
<td>2009-2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Using powdered activated carbon, soda and pre chlorination</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Building the chemical storage houses including dosing facilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storage of powdered activated carbon, chlorine and soda</td>
<td>2009-2012</td>
</tr>
<tr>
<td>Oil floatation</td>
<td>Removing oil from the water</td>
<td>Setting up buoy to stop oil coming to intake facility</td>
<td>2008</td>
</tr>
<tr>
<td>Deposited scale in water distribution pipe</td>
<td>Setting up criteria</td>
<td>Turbidity &lt;0.2 NTU, Fe&lt;0.05 mg/L, Mn&lt;0.002 mg/L</td>
<td>2003</td>
</tr>
<tr>
<td></td>
<td>Advanced treatment</td>
<td>Applying new chemicals such as PAC, soda, polyene, powdered activated carbon,</td>
<td>2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>manganese sand for filtration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cleaning reservoir and distribution pipe</td>
<td>Cleaning reservoir once/year, distribution network once/3 years and emergency</td>
<td>2008-2009</td>
</tr>
<tr>
<td></td>
<td>Advanced skill of water treatment</td>
<td>Training operators on water treatment skill</td>
<td>2010</td>
</tr>
</tbody>
</table>

**Operational monitoring**

Monitoring condition at each stage of water supply is necessary to reliable WSP. We decided monitoring items and critical limit to operate appropriately. Table 2. shows an example. Effective monitoring relies on establishing “what will be monitored”, “how it will be monitored”, “where it will be monitored”, “when it will be monitored” and “who will do the monitoring”. In other words, we have to show monitoring items, monitoring methods, monitoring points, its frequency and responsible person. We have made tables to show these things clearly. Table 3. shows an example.
Monitoring instead of VWS.

Training and water quality

to protect

Agency (VWSA) and by international organizations such as Japan International Cooperation Agency (JICA) and World Health Organization (WHO) were also carried out.

Table 2. Monitoring item, critical limit and action

<table>
<thead>
<tr>
<th>Monitoring point</th>
<th>Items</th>
<th>Critical limit</th>
<th>Corrective action</th>
<th>Preventive action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catchment area</td>
<td>Waste water and rubbish</td>
<td>None</td>
<td>Inform the WSP Board</td>
<td>Propaganda on environmental protection</td>
</tr>
<tr>
<td>Intake point</td>
<td>Odor</td>
<td>Light smell</td>
<td>Water Treatment with Powder Activated carbon</td>
<td>Propaganda on environmental protection</td>
</tr>
<tr>
<td>Receiving well</td>
<td>pH</td>
<td>7 – 7.5</td>
<td>Adjusting the dosing of Soda</td>
<td>Storage of soda</td>
</tr>
<tr>
<td>Mixing tank</td>
<td>Floc</td>
<td>Big and clear shape</td>
<td>Jar test and Chemical dosing exactly</td>
<td>Training operators on water treatment skill</td>
</tr>
<tr>
<td>Sedimentation tank</td>
<td>Turbidity</td>
<td>&lt;= 20% NTU of raw water turbidity</td>
<td>Discharge settled water into sludge treatment Chemical dosing exactly</td>
<td>Monitoring floc frequently</td>
</tr>
<tr>
<td>Filtration tank</td>
<td>Turbidity</td>
<td>&lt;= 0.2 NTU</td>
<td>Backwashing Monitoring the water level of the filter</td>
<td>Checking interval record</td>
</tr>
<tr>
<td>Reservoir</td>
<td>Residual chlorine</td>
<td>0.5-0.7 mg/l</td>
<td>Stopping distribution pump if R-Cl&lt;=0.3 or R-Cl&gt;0.7 Jar test again and adjust chlorine dosage</td>
<td>Checking filtered water quality frequently</td>
</tr>
<tr>
<td>Distribution network</td>
<td>Iron</td>
<td>Manganese</td>
<td>Fe &lt;= 0.05 mg/l Mn &lt;= 0.020mg/l</td>
<td>Cleaning the pipeline</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Monitoring schedule

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Catchment</th>
<th>Water treatment plant</th>
<th>Distribution network</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water source</td>
<td>Raw water</td>
<td>Settled water</td>
</tr>
<tr>
<td>Every day</td>
<td>A, B</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Every week</td>
<td>A, B, C</td>
<td>A, B</td>
<td>A</td>
</tr>
<tr>
<td>Every month</td>
<td>A, B, C</td>
<td>A, B, C</td>
<td>A</td>
</tr>
<tr>
<td>Every year</td>
<td>A, B, C, D</td>
<td>A, B, C, D</td>
<td>A</td>
</tr>
<tr>
<td>Once/2 years</td>
<td>A, B, C, D</td>
<td>A, B, C, D</td>
<td>A</td>
</tr>
<tr>
<td>Initial time</td>
<td>E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: items of groups are as follows:
A: pH, turbidity, odor, taste, residual chlorine, temperature (6)
B: Cl, COD, NO{2}, NO{1}, NH{4}, hardness, Mn{2}, Fe, total coliform, fecal coliform (10)
C: Aldrin, TDS, As, Al, SO{2}, conductivity, alkalinity, PO{4}, F, Al, Cu{2}, CN, Pb, Hg, ... (27)
D: Cr, Zn, Benzene, Toluene, THMs... (67)
E: 44 items according to surface water source standard, 23 items according to ground water source standard

Frequency of monitoring should be decided with conditions of each item. Frequency of items which are not changed remarkably can be reduced. Frequency of items which are changed and related to risk more should be increased. We will propose such flexible frequency of monitoring instead of fixed frequency in the regulation.

Supporting programme

Activities to support development and implementation of the WSP have been carried out. HueWACO held OJT and OFFIT training courses to advance water treatment and water quality skills for operator and community activities to propagandize water source protection. It also held internal workshop on WSP implementation and building WSP manual, and organized workshops, seminars on WSP. HueWACO built the training yard to detect leakage points. HueWACO had planned supporting programme as shown in Table 4.

Supporting programmes by a domestic organization Vietnam Water Supply and Sewerage Association (VWSA) and by international organizations such as Japan International Cooperation Agency (JICA) and World Health Organization (WHO) were also carried out.
**Supporting by JICA**
From 2003 to 2009, HueWACO accepted the support by JICA with Yokohama Waterworks Bureau (YWWB). Its contents were as follows:
- Training and developing human resources
- Developing operational handbooks
- Supporting essential machines and facilities
- Upgrading capacity of water quality management
- Holding seminars and workshops on safe water supply
- Upgrading capacity of water distribution network management
- Building maps to detect the low water pressure and low residual chlorine area
- Building the map of monitoring points in water source area to check polluting source
- Upgrading capacity of satisfying customers’ requirements
- Upgrading capacity of human resources development and personnel administration
- Training of trainers (TOT) course on teaching and facilitating skill

**Supporting by VWSA and WHO**
VWSA and WHO held the training course of WSP. It included providing documents, conducting WSP and how to carry out WSP. WHO held TOT course on WSP. HueWACO sent staff members to those programmes.

**Table 4. Supporting programmes by HueWACO**

<table>
<thead>
<tr>
<th>Programme</th>
<th>Purpose</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human resources training</td>
<td>Advancement of water treatment and water quality management skill</td>
<td>Making a plan in May every year, Listing required participants, Place: Quang Te WTP, Contents: Jar test, corrective action, analytical method of turbidity, pH, residual chlorine, etc.</td>
</tr>
<tr>
<td>Operation and maintenance of equipment, instrument and systems</td>
<td>Advancement of calibration and maintenance skill</td>
<td>Practice of calibration method</td>
</tr>
<tr>
<td>Community activities</td>
<td>Advancement of awareness of protecting water source, Advancement of water treatment and water quality management knowledge for students</td>
<td>Making a plan in February/March every year, Place: Quang Te WTP, Grasping the number of student in high school, Cooperation with water quality management department and planning department</td>
</tr>
</tbody>
</table>

**Management for incident**
When hazard occurs, WSP team carries out emergency plan or corrective action with process:
1. Reporting to WSP board of HueWACO
2. Holding the meeting with members
3. Analysing cause and proposing corrective and preventive action
4. Making an action plan
5. Execution of actions
6. Evaluating the result
7. Recording and documentation complying with ISO 9001:2000

**Reviewing and improving WSP**
WSP team holds internal review. Members of the team check records of water quality testing of each stage, visit site to check technical items of equipment with critical limit, check corrective
actions for risks occurred. They will improve WSP manual according to the method of ISO9001:2000 when they found something wrong or mistake. Now HueWACO is trying to review WSP with quality assurance (QA) tool developed by WHO.

V. BENEFITS, CHALLENGES AND LESSONS LEARNED

Benefits

Institutional benefits
Communication and collaboration among WSP team members, stakeholders and customers has been improved. Now many customers inform HueWACO about water leakage which they found. Local authorities inform HueWACO about water source pollution. Department of health gives HueWACO water quality information regularly. These relationships were built by implementing WSP. Communication among staff of HueWACO has been improved too. Then collaboration between some departments of HueWACO can be carried out easier than before.

For staff members of HueWACO, awareness of service to customers, knowledge of water supply system and understanding WSP have been increased. Now they understand key points of water supply operation as follows:

- Water supply has to meet the national standards of drinking water quality by MOH.
- Water treatment process is controlled according to ISO9001:2000.
- Water source should be protected from pollutants.
- Water quality test is done according to SOPs complying with ISO/IEC17025.

HueWACO and some stakeholders hold study tour and contest of water source pollution for students and pupils. Through these activities, staff of HueWACO, stakeholders, students and pupils changed their attitude to safe water. Many staff members of HueWACO consider that they should understand WSP and introduce it to people. Now bill collectors are telling customers about safe water.

Capacities of some water production were increased by building and advancing plants. But total number of staff members for operation in treatment plants is not changed. Dosage of chemical become more appropriate by reviewed operating process. Then we have saved cost for production.

Operational benefits
HueWACO improved or updated system infrastructure according to improving plan as follows:

- Advanced and expanded laboratory
- Building new water treatment plants
- Setting up power generators
- Setting up buoy to stop oil coming into the intake
- Improved and upgraded pipeline networks
- Setting up water pressure increasing stations
- Setting fish tank to detect pollution
- Installing on line water quality monitoring system in WTPs
- Installing SCADA system to control water treatment process in WTPs
- Applying new materials such as PACl, powdered activated carbon
- Applying new technology at WTPs such as lamella, dissolved air flotation, hypochlorite generator, UV disinfection
Water quality management system has been well improved with matter above and more activities. Monitoring points in water source area were decided suitably to monitor polluting sources pointed in the developed map. Water quality map of distribution network helped to find pipes to be replaced. We had no operational monitoring at each process before so that we could not detect hazards timely. Now, we monitor operational items at each process with risk management so we can detect hazards timely. We can take corrective action properly and rapidly with the result of monitoring. Costs and expenditures for monitoring are fully supplied to minimize hazard occurrence.

Documents are managed well with ISO 9001:2000. HueWACO has developed 27 SOPs by ISO/IEC 17025 and 15 recording forms by WSP, 22 WSP manuals for each water supply system and 16 operational handbooks on water treatment and water quality management. We are trying to evaluate WSP with QA tool by WSP team as an informal internal auditing at each water supply system. Documentation is evaluated by internal and external audit for ISO systems.

**Policy benefits**

The most important benefit of WSP is to ensure community health. Water supply service is improved as well as follows:

- People can access clean water for 24hours.
- People can drink tap water directly.
- Severity of waterborne disease outbreaks has not occurred in the latest years.
- Customer’s complaint on water quality is reduced.

Longer-term impacts that we expect to see as WSP implementation progress are as follows:

- Water price will be stable.
- Severity of waterborne disease outbreaks will not occur.
- Water service coverage will be 99%.
- People can access safe and tasty water anytime.
- Stakeholders will communicate with HueWACO easier and closer.

High water loss rate is one of major cause to decline water quality in distribution network so that investment to upgrading pipeline has high priority however it requires huge investment. WSP implementation is a remarkable evidence of good management of water supply utility for foreign donor or investor. Good implementation of WSP gives more chances to find investment or financial support. HueWACO has received projects funded by foreign countries such as JICA and Asian Development Bank (ADB).

HueWACO has increased knowledge and experience on WSP implementation with national workshops, overseas workshops and seminars, training courses by WHO and VWSA and studying by HueWACO itself. It is expected that HueWACO will support otherWSCs to implement their WSP. Now we are ready to share our knowledge and experience with other WSCs in Vietnam.

WSP provides us cost saving and time saving by reducing risk and hazard. Then HueWACO can increase number of consumers and service coverage easily. It will contribute to complete one of strategic objectives of TTH province. Social and economic development of the province will be promoted by improving public health condition.

**Challenges**
People’s confidence to drink tap water directly is still not high rate. The custom of using boiled water is popular for long time. It is not easy to change their custom. So we challenged making action plan to propagandize safe water to people more effectively.

Water source protection is a challenge with cooperation between multiple stakeholders especially WSP team members. Catchments and raw water source are still not controlled so perfectly. Due to industrialization, urbanization and climate change, water resources have been threatened in terms of pollution and shortage. So we are making action plan to survey and inspecting water source. Survey at upstream areas of Huong River and Bo River includes studying the effect of livestock and the amount of pesticides sprayed in agricultural area.

As WSP implementation continues, we expect that stakeholders can control more challenges as follows:

- Satisfying higher demand/ requirements of water consumers
- Establishing qualified and skillful human resources
- More attention on WSP process by provincial authorities
- Adequate government policy and legislation on WSP
- Advantage of WSP steering committee of the province to strengthen cooperation and sharing responsibly among all stakeholders
- Proposals to government organizations for improving WSP regulations
- Countermeasures against sea water level increasing by climate change
- Limitation of water tariff in accordance with the cost-benefit principle

**Lessons learned**

- Strong leadership is very important to implement WSP effectively.
- Developing enough preventive measures is necessary to improve safe water supply.
- Operators must be informed with full information for operation.
- Staff members of WTP should be skillful by appropriate training.

**VI. CONCLUSION**

Responsibility for WSP is not by any individuals but by organizations. All stakeholders must be involved in WSP activities to make WSP effective. It is the important difference from operation of water supply before. Now we found that WSP is a strong tool to make a water supply system tough and reliable.

HueWACO is the leading water supplier on WSP in Vietnam however its success is still limited. We still need supports by other organizations to improve WSP more and more. In the same time, HueWACO will share its experiences to other water utilities within country and region and help their WSP implementation. We would like to contribute to make water supply utilities in Vietnam more resilient as much as other countries.