WATER SECURITY ASSESSMENT FRAMEWORK WORK AT NATIONAL SCALE FOR SUSTAINABLE DEVELOPMENT

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Abstract
This paper aimed at demonstrating the application of water security assessment framework at national scale for sustainable national development. Water security dimensions in the literature were reviewed and identified as household water security, economic water security, urban water security, environmental water security and resilient water-related disaster security. It was discussed that national water security implied overall water security and it's a composite measure of the indices of the stated five water security dimensions.

Keywords: Water security index, national security, sustainable development

INTRODUCTION
Water security is defined as the reliable availability of an acceptable quantity and quality of water for health, livelihood, and production, coupled with an acceptable level of water-related risks (Gray and Sadoff, 2007). According to Global Water Partnership (2000), water security is a fundamental goal where every person has access to enough safe water at affordable cost to lead a clean healthy and production life, while ensuring that the environment is protected and enhanced. Also, Water Aid (2012) defines water security as reliable access to water of sufficient quantity and quality for basic human needs, small scale livelihoods and local ecosystem services, coupled with a well-managed risk of water-related disasters. According to Chamhuri and Ferdoushin (2014), UNESCO – IHP defined...
Also, water security is central to all other forms of security, including national security. It is recommended that nations should apply the water security assessment framework to assess their level of water security and hence national security for sustainable development.

Water security as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being and socio-economic development for ensuring protection against water-borne pollution and water-related disasters and for preserving ecosystems in a climate of peace and political stability.

From the foregoing, water security can be viewed as access to water of sufficient quality and quantity for healthy living, sustenance livelihood and production and, for socio-economic development while preserving the environment. The scope of water security can be localized or regionalized. This is to say that, it can be considered at different scales such as household, city, regional or national scale water security.

Water is a source of life, livelihoods and prosperity as well as an important input to almost all types of production such as agriculture, industry, energy, transports and hence, for sustainable national development (Chamhuri and Ferdoushin, 2014). This implies that assessing the water security of a nation is a logical way of assessing the nation's level of development.

There are diverse researches on the study of water security including AWDO (2013), Babel (2015), Shinde (2016) and Global water Partnership (2012) to mention a few. AWDO (2013) investigated water security in Asia and Pacific while Babel (2015) applied water security as a tool for sustainable water management. Shinde (2016) applied water security framework at a city scale. This study attempted to demonstrate the application of water security assessment tools at national scale to aid national sustainable development. Also, the approach adopted simplified the application of the framework.

**KEY DIMENSIONS OF WATER SECURITY**

AWDO (2013) and Global water partnership (2012) reported on dimensions of water security. According to AWDO (2013), five (5) key dimensions were identified as presented in figure 1 while Global water partnership identified three key dimensions, namely, social, environmental and economic dimensions.
Figure 1: Key Dimensions of Water Security (Source: AWDO, 2013; Chamhuri and Ferdoushi, 2014)

According to AWDO (2013), a single focus on any one of the key dimensions is insufficient to guide decisions on water security. The key dimensions are:

**Household Water Security (Key Dimension 1):** Household water security means provision of reliable, safe water and sanitation services to all people at household level. This security is a fundamental effort to eradicate poverty and support economic development.

**Economic Water Security (Key Dimension 2):** The second key dimension is economic water security which is a measure of the productive use of water to drive and sustain economic growth in food production, industry and energy sectors of the economy. In other words, economic water security implies that there is enough water to meet agricultural, productions for food and agro-allied industrial needs and, to generate hydro-energy to power the industries.

**Urban Water Security (Key Dimension 3):** As the population water resources increases, the environment is prone to pollution. For sustainability, urban water security indicators measure the creation of better water management and wastewater treatment and drainage services to support the teeming population. Urban water security is also measured by the term governance and management water security.

**Environmental Water Security (Key Dimension 4):** As nations seek socio-economic development, the environment is being degraded as a consequence.
Also, governments tend to prioritize rapid economic growth over environmental objectives. The environmental water security indicator assesses the health of rivers and measures progress for restoring rivers and ecosystems to health on a national and regional scale (AWDO, 2013). This is because the sustainability of development depends on these natural resources.

**Resilience to Water-Related Disasters (Key Dimension 5):** The sustenance of socio-economic development and growth of nations and regions should be a priority of governments. Apart from polluted environment, natural disasters that are water-related can also threat the sustainability of national or regional development. Examples of such disasters are drought and flood. The resilience (of communities in a region or nation) to water-related disasters is assessed with the indicator of resilience to water-related disasters. This implies that the building of resilient communities that can adapt to change and are able to reduce risk from water-related natural disasters must be paramount to ensure sustainable development.

**National Water Security**
National water security of a nation refers to the composite result of the five key dimensions of water security. This implies that for a nation to be water secured, the five dimensions of water security must be met as shown in figure 1.

**MEASURING WATER SECURITY**
A generalized conceptual framework model for water security assessment is presented in Figure 2. With the aid of Figure 2, the parameters of interest when measuring water security of a nation or region can be presented for each of the dimensions in Table 1. The selected parameters, indicators and variables were adjudged to be suitable for quantifying overall Water Security Index such that the results obtain would be specific, measurable, attainable, relevant and time-bound as shown in Figure 2. The Table one can be used to assess water security of a city, a region or a nation. However, it should be noted that each of the five dimensions is quantified first from all the parameters and variables considered as shown in the table before finding the Overall Water Security Index (WSI) as the composite of all the indices of the five (5) dimensions of water security.

For instance, Household Water Security Index (HWSI) is a function of the water security indices of the four indices considered: Water Availability (WAV), Water Accessibility (WAC), Conforming to Water Quality Standard (CWQS) and Hygiene and Sanitation (HS) express as:

\[
HWSI = (WAV + WAC + CWQS + HS)/4
\]
Similarly, Overall Water Security Index for the five dimensions is obtained as:

\[ OWSI = \left( \frac{HWSI + EWSI + EnWSI + RWRDWSI + WGWSI}{5} \right) \]  

(2)

Where: 

- \( HWSI \) = Household WSI
- \( EWSI \) = Economic WSI (obtained as described for HWSI in equation 1)
- \( EnWSI \) = Environmental WSI
- \( RWRDWSI \) = Resilience Water-Related WSI
- \( WGWSI \) = Water Governance WSI

\( EWSI, \ EnWSI, \ RWRDWSI \) and \( WGWSI \) are to be obtained as described for HWSI in equation 1)

Figure 2: Conceptual Framework for Water Security Assessment (Source: Babel 2015 and Shinde 2016)

From equation (2), the value of WSI obtained is expressed as numerical value the WSI is interpreted using a scoring system from 1 to 5 developed by AWDO (2013) as shown in Table (2).

**Table 2: Interpretation of WSI**

<table>
<thead>
<tr>
<th>Level of WSI</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Water Insecure</td>
</tr>
<tr>
<td>2</td>
<td>Low Water Security</td>
</tr>
<tr>
<td>3</td>
<td>Medium Water Security</td>
</tr>
<tr>
<td>4</td>
<td>High Water Security</td>
</tr>
<tr>
<td>5</td>
<td>Very High Water Security</td>
</tr>
</tbody>
</table>

**WATER SECURITY AND NATIONAL SECURITY FOR SUSTAINABLE DEVELOPMENT**

Figure 3 below shows that water security is central to all forms of security, inclusive of national security. Hence, national security for sustainable development implies that water security assessment should be a paramount interest of governments at national level.
<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Parameters</th>
<th>Indicators</th>
<th>Variables</th>
<th>How to measure</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household Water Security</td>
<td>1) Water Quantity</td>
<td>Water Availability</td>
<td>Per capital water use</td>
<td>Total Water Consumption/Population</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>2) Water Quality</td>
<td>Conforming to water quality standard</td>
<td>Access to quality water supply</td>
<td>Number of low quality supply cases/Total Number of Supply</td>
<td>%</td>
</tr>
<tr>
<td>Sanitation</td>
<td>Hygiene and Sanitation</td>
<td>Hygiene and Sanitation</td>
<td>Water borne disease factor</td>
<td>Hospitalised cases of water borne disease/total hospitalised cases</td>
<td>%</td>
</tr>
<tr>
<td>2) Economic Water Security</td>
<td>Commercial/Industrial</td>
<td>Economic value of water</td>
<td>Commercial/Industrial Water Productivity</td>
<td>Total revenue/total water used</td>
<td>Naira/m³</td>
</tr>
<tr>
<td>Agriculture</td>
<td>Economic value of water</td>
<td>Agricultural Water productivity</td>
<td>Total revenue/total water used</td>
<td>Naira/m³</td>
<td></td>
</tr>
<tr>
<td>3) Environmental Water Security</td>
<td>1) State of water sources</td>
<td>State of natural water resources</td>
<td>Surface water quality factor</td>
<td>Dissolved oxygen concentration/Permissible limit (3mg/l)</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>2) Pollution of water sources</td>
<td>State of pollution</td>
<td>Wastewater discharge factor</td>
<td>Amount of treated wastewater/Total wastewater generated</td>
<td>%</td>
</tr>
<tr>
<td>4) Water-related disaster resilience</td>
<td>1) Disaster resilience</td>
<td>Resilience to disaster</td>
<td>Coping potential factor</td>
<td>Investment in disaster response mechanism/Total budget</td>
<td></td>
</tr>
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<td>-----------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Water Security</td>
<td>2) Mitigation intervention</td>
<td>Disaster mitigation interventions</td>
<td>Urbanization factor</td>
<td>Total open space % (green)/ total area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2) Water Policy</td>
<td>Meeting policy targets</td>
<td></td>
<td>Policy objective % deliverables/ Set policy Targets</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: Illustration that Water Security is central to all forms of security (Source: Warner and Johnson, 2007; Babel 2015)
CONCLUSIONS
Water security was reviewed and presented in a simplified format such that it can easily be applied by researchers for assessing water security status of nations or regions. Five dimensions of water security were reviewed in the literature and comprised of household water security, economic water security, urban water security, environmental water security and resilient water-related disaster security. It was discussed that national water security index is the overall water security index and it is a measured of the indices of the stated five water security dimensions.

It is recommended that nations should apply the water security assessment framework to assess their level of water security and hence national security for sustainable development.

REFERENCES


