

Policy Note

National Water Sector Strategy and Climate Change

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Water Sector Strategy and Climate Change in Yemen: Policy Implications

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Executive summary:

This policy note has carried out an analysis of National Water Sector Strategy (NWSSIP II) from a climate change perspective. The aim is to explore the relevance of NWSSIP II under changing climate. In addition, this note is also grounded on a deliberate review of relevant climate change policy and thematic studies particularly on the water sector in Yemen to substantiate additional contextual underpinnings. This policy note concluded that the effects of climate change are manifest in Yemen and its impact on the water sector is evident. Several studies have shown that the water sector is highly vulnerable to climate change impacts for which the underlying adaptive measures are imperative and urgent. On the other hand, although NWSSIP II was updated in 2008 before which several climate change implications on the water sector were highlighted, it can be noted that that no clear reference has been indicated to such emerging challenges nor articulated adaptations were strategized in the updated strategy. Therefore, this policy note seeks to bring into the attention of policy-makers an emphasized action to deal with the additional challenge posed by a changing climate on the water sector through which the capacity of the concerned agencies to ensure sustainable management of water resources will be further constrained. In addition, this policy note intends to present relevant climate change implications advocating for appropriate policy response through proposing applicable revisions for considerations under the current NWSSIP II or otherwise taking note during the next cycle of the water sector policy analysis process.

Introduction:

Yemen is an arid Middle Eastern country, occupying an area of less than 527,970 square kilometres at the southern end of the Arabian Peninsula. In 2009, Yemeni total population reached 22.5 million, of which 51% male and 49% female and 76% of the total population are in the rural areas. Agriculture is the manifest for the majority of rural dwellers. Yemen has one of the highest annual population growth rates at 3%, which puts much pressure to the limited basic infrastructure and services such as water, education, health and access roads. Moreover, 42.8% of the population is under the age of 15 years old and youth population (15 – 24 years old) account for 23% of the total population. The economy is dominated by the oil sector, which accounts for 27% of the Gross Domestic Product and 70% of export revenues¹. The recent steep decline in oil revenues associated with the gradual depletion of oil reserves is causing severe fiscal difficulties; with the budget deficit growing to about 10% of GDP in 2009 ². Economy diversification recently became a priority and efforts are on-going to spur non-oil growth and create jobs in agriculture, fisheries, trade and manufacturing.

Agriculture sector in Yemen is labeled a traditional one. It mainly depends on primitive methods and wadi flows which make it vulnerable to extreme climate changes such as draught and floods. The sector also faces various challenges the most important of all is the scarcity of water resources. It absorbs almost 30% of the work force and accounts for 11.4% of Gross Domestic Product (GDP, at current prices) in the average during the period 2001-08. However, its exports did not exceed 1.2% of the gross non-oil exports in 2008. Arable land is estimated at 1.6 million hectares, of which the cultivated area is estimated at 1.3 million hectares. The agriculture land represents 2% of the total area of Yemen. Moreover, rapidly growing population increases demand of scarce natural resources - on water resources, foodstuffs and other products of natural resources. People exploit soil, vegetation and water without paying adequate attention to the sustainability of these resources. Unplanned expansion of urban centers in some areas exceeds the capacities of available resources to meet new demand. It also causes sanitation and waste management problems and puts pressure on civic/municipal services, in addition to loss of biodiversity and agricultural land.

¹ GoY National Accounts, 2009

² National Budget, 2011

As an arid country, with no permanent rivers, Yemen has limited rainfall available for use and the current trends in underground water extraction will result in many ground water reservoirs being depleted in less than 10 to 15 years. The National Water Resources Agency (NWRA 2005) estimates that the sustainable rate of water use in Yemen is about 2,500 million m³/year. In contrast, water is extracted at a rate of about 3,400 million m³/year, leaving an annual deficit of around 900 million m³. Yemen's water resources depend on rainfall, almost all of which is rapidly lost to evapotranspiration (ET). The rapidly increases in water abstraction and use mainly for agriculture have affected the water balance. The rate of groundwater overdraft is currently twice the recharge rate under which the vulnerability of water reserves depletion and underlying socio-economic consequences is rapidly growing. Thus Yemen already suffers from an acute water shortage mainly characterized by over-abstraction of groundwater across the country's water basins regardless of climate change.

On the other hand, Yemen is anticipated to experience steadily rise in temperatures, and an increase in variability of rainfall and in heavy precipitation events under climate change. Rainfall changes will be accompanied by changes in the intensity of wind and frequency of high temperatures and changed cloudiness. These are serious concerns as Yemen's economy which largely depends on its rural natural resources after oil and Liquefied Petroleum Gas (LPG). Moreover, more than 75% of the population is rural-based engaged in farming and pastoralism and hence highly reliant on favourable climatic conditions for their livelihoods.

Recognizing the sever challenges in the water sector in Yemen; the Government has taken some institutional steps which include strategic planning in the early 1990s, establishment of the National Water Resources Authority (NWRA) to implement an integrated approach for water resources management, a water law was enacted in 2002, the Ministry of Water and Environment (MoWE) was established in 2003, and the water by-law was approved in 2011. In 2004, the MoWE prepared the National Water Sector Strategy and Investment Programme (NWSSIP I 2005-2009), as a strategy, and action plan and investment program for the water sector. However, NWSSIP II was produced in 2008 as an update to the earlier version to accommodate issues more fully into an integrated water resources management framework, and serve as the basis for a sector-wide approach to financing under the donor-financed Water Sector Support Programme (WSSP). According to NWSSIP II, the overall goal for the water

sector is: *“To improve the Yemeni population’s sustainable and economically efficient use of the nations scarce water resources.”*

NWSSIP I and its updated version II sound to provide insightful implications and a basis contributing towards bridging the gap of the annual water deficit in Yemen. However, since new emerging challenges have increasingly become noticeable, and evident, NWSSIP II as strategic water-wide sector policy document may need to be explored for relevance under climate change context in Yemen. For this reason, a review was undertaken by this policy note to explore the NWSSIP II for relevance from a climate change perspective. Before going deeper in the analysis, it has been widely concluded that climate change impact on the water sector is evident. For instance, several studies have shown that the water sector is highly vulnerable to climate change impacts for which appropriate adaptive measures are urgent and imperative.

As such, whether or not NWSSIP II has been well-responding and recognizing the additional challenges imposed by a changing climate is the matter for a discussion, policy implication and recommendation under this policy note. A conservative approach with no regret strategy has been adapted by this policy note to ensure that the potential underlying consequences under pessimistic climate scenarios are particularly dealt with. It should be noted that appropriate climate change adaptations within the NWSSIP II, will maximize IWRM outcomes and optimizes the overall framework for achieving the aforementioned strategy goal particularly under climate-induced longer droughts and frequent weather event fluctuations. The following sections will explore the impact of climate change on the water resources based on relevant studies and reports, and analysis of NWSSIP for relevance under changing climate. Also, policy implications and recommendations will be presented.

Relevant climate change studies and policy frameworks in Yemen: Insights for adaptation

Climate change is the defining human development issue of our generation. It has also increasingly becoming as one of the major emerging developmental issues in Yemen. Its impact on the water sector has become evident. Several studies and reports (see below) have indicated that Yemen’s water sector is highly vulnerable to climate change impacts. The Government of Yemen has recognized climate change and as such the United Nations

Framework Convention on Climate Change (UNFCCC) was ratified on 21 February 1996 and immediately initiated a process to meet its commitments under the Convention. To provide a more relevant context, the following will explore a number of climate change studies and policies which set out a policy framework for water-sector adaptation:

First National Communication (INC 2001): Yemen INC identified the following vulnerable sectors which include: Water resources; agriculture; and coastal zones. It should be emphasized on the conclusion made by the INC that water resources have been considered to be the most vulnerable sector to climate change impacts as compounded by the country's severe water resource situation.

National Adaptation Programme of Action (NAPA 2008): The major impacts of climate change in Yemen, as reported in the INC 2001, represented the starting point for the NAPA policy framework which includes the following:

- Increased water scarcity and reduced water quality – leading to increased hardship on rural livelihoods;
- Increased drought frequency, increased temperatures, and changes in precipitation patterns – leading to degradation of agricultural lands, soils and terraces;
- Deterioration of habitats and biodiversity – leading to expansion of desertification;
- Reduced agricultural productivity – leading to increased food insecurity and reduced income generating activities;
- Increased sea levels – leading to deterioration of wetlands, coastal mangrove migration, erosion, infrastructure damage, and seawater groundwater intrusion;
- Increased climatic variability – leading to the possibility of spread and growth of vector borne and water borne diseases; and
- Impacts on coastal zones – leading to a loss of tourism activity due to sea level rise including loss of beaches.

Also, NAPA reported that proper measures to address causes, impacts, responses for the most vulnerable areas which include agriculture, water and coastal zone are essential to ensure adaptation under climate change.

Assessing the Impacts of Climate Change and Variability on the Water and Agricultural Sectors and the Policy Implications (2010): The study indicated that climate change impacts on the water balance would be different for different areas but the major risks will include further reduced water availability, particularly in lowland areas if the weather turns hotter and drier, and floods due to possible heavier rainfall.

Mapping of Climate Change Threats and Human Development Impacts in the Arab Region (2010): The report indicated that Yemen is highly vulnerable to climate change induced increased water scarcity and reduced water quality.

World Development Report (WDR 2010: Development and Climate Change): The report explored the impact of climate change on development. In addition to other notes, the report recommends water management to better adapt to climate change threats.

UNDP Human Development Report (HDR 2007/2008): Fighting climate change: Human solidarity in a divided world: The report indicated that climate change will affect rainfall, temperature and water availability for agriculture in vulnerable areas (Yemen was included). The report also called for taking insights from NAPAs and other climate studies for integration into national strategies as appropriate measures of adaption.

Intergovernmental Panel on Climate Change, Fourth Assessment Report (IPCC 4AR 2007): According to the IPCC third assessment report, MENA, which includes Yemen, is one of the regions which is most vulnerable to the impacts of climate change on water resources, and it is considered among the regions with the highest level of water scarcity in the world.

Millennium Development Goals (MDGs) Yemen Assessment Report (2010): The report stated that “it is expected that climate change will have multiple and adverse effects on the fundamental pillars of sustainable, environment, economic and social development. It also undermines the country’s ability to reach the MDGs and other

development targets, not the least poverty reduction and environmental sustainability. Maintaining environmental sustainability requires combined efforts to address challenges related to climatic changes and conservation of natural resources particularly energy, water and soil.” In addition, the report has also pointed out to the livelihood vulnerability to extreme climate changes such as draught and floods.

Fourth Socio-economic Developmental Plan for Poverty Reduction (DPPR 2011-2015): Climate change, under the Fourth Five-Year Developmental Plan, was identified as one of the emerging issues which require adequate adaptation measures. The 4th DPPR indicated that the current situation of the water sector has been recognized as unsustainable due to a number of challenges which includes climate change impact and how to adapt to it. In addition, the present water scarcity could be aggravated by droughts and hotter weather and a change in rainfall patterns.

Second National Communication (SNC 2011: a draft): the SNC draft report indicated that water resources are considered perhaps the most vulnerable sector to climate change in Yemen. The key finding of the SNC draft report is that groundwater across the piloted aquifers which include Surdud, Sana’a, Sadah, and Aden Basins are vulnerable to climate change.

It can be noted that all of the aforementioned reports and studies indicated that climate change is evident, and the water sector in Yemen is highly vulnerable to climate change. The vulnerability of the water resources is compounded by the tremendously sensitive water sector to any unfavorable climate conditions such as longer and frequent droughts, and temperature increase. According to NAPA, and based on Intergovernmental Panel for Climate Change (IPCC) projections, temperatures across the country are expected to rise anywhere between 1.4 and 2.8 degrees Celsius by 2050. Precipitation and cloud cover patterns are more uncertain, and rainfall variability is likely to be more pronounced, i.e. it is projected to decrease by about 24% or increase by about 35%, depending on the global circulation model used to generate the scenarios. Given the uncertainty presented by current climate models, the precise extent of the vulnerability of rainfall is not known and needs to be further assessed. However, there is concurrence among the above-mentioned studies that Yemen is anticipated to experience steadily rise in temperatures, and an increase in variability of rainfall and in heavy precipitation events under changing climate.

As indicated earlier, Yemen is anticipated to experience steadily rise in temperatures, and an increase in variability of rainfall and in heavy precipitation events under climate change. Yemen rainfall patterns have recently shown increasing extremes. For instance, rainfall has decreased considerably leading to major agricultural losses, losses of livestock and water shortages. On the other hand, flooding was clearly observed in 1996 and during the period 2005-2008. Flooding in Hadramout in 2008 resulted in estimated damage and losses of \$1.64 billion USD.³

Under warmer climate conditions, these weather features are likely to be further aggravated. In addition to the likelihood that rainfall may decrease (or increase) over much of Yemen, the timing of rainfall, the intensity of individual storms, the delay between falls and the frequency of inter-annual variability may all change. Rainfall changes will be accompanied by changes in the intensity of wind and frequency of high temperatures and changed cloudiness. As a Least Developed Country (LDC), and as outlined earlier, Yemen suffers from several development challenges and priorities, making it highly vulnerable to climate change-related impacts such as drought, extreme flooding, pests, and sudden disease outbreaks, changes of rainfall patterns, increased storm frequency/severity and sea level rise.

These are serious concerns as Yemen's economy which largely depends on its rural natural resources after oil and Liquefied Petroleum Gas (LPG). Moreover, more than 75% of the population is rural-based engaged in farming and pastoralism and hence highly reliant on favourable climatic conditions for their livelihoods. The potential impact of climate change on the development in Yemen is expected to turn the current challenges further complicated constraining the Government capacity to achieve sustainable development and the MDGs. As water resources are expected to experience further decline under changing climate, such impact will certainly results in several underlying multi-sectoral consequences such as reduced agricultural productivity and increased food insecurity, increased livelihood hardship, and poverty expansion. In addition, as far as this policy note is concerned, progress on MDG, particularly; Goal 7- Ensure Environmental Sustainability will be far complicated under changing climate.

³ Damage, Losses And Needs Assessment October 2008 Tropical Storm and Floods, Hadramout and Al-Mahara, Republic Of Yemen; 2009

Following this discussion, the review which has been undertaken by this policy note seeks to ensure that this understanding is reinforced within water sectoral policies and strategies particularly NWSSIP II. Therefore, this policy note emphasizes on a number of valuable insights indicated by the aforementioned reports, studies and policies that climate change impact on the water sector is evident for which appropriate adaptive measures are urgent and imperative. Also, the aim is to optimize the perspective of IWRM within the water sector strategies under changing climate. This will ensure that measures responding to additional, climate change-related risks (i.e. greater rainfall variability, unreliable recharge of aquifers, longer and frequently dry periods, and increasing damage to infrastructure from extreme weather events) are satisfactorily taken up for considerations.

NWSSIP II and Climate Change

This section will explore that the National Water Sector Strategy and Climate Change in Yemen. The case under this policy note is National Water Sector Strategy and Investment Programme (NWSSIP II). This section therefore intends to substantiate an evidence to answer the question of whether or not NWSSIP II has been well-responding and recognizing to the additional challenges imposed by a changing climate. As indicated earlier, this followed a conservative approach with a no regret strategy to ensure that the potential underlying consequences under pessimistic climate scenarios are particularly dealt with. The matter raised under this policy note is necessarily valuable and insightful for initiating a discussion, providing policy implications and recommendations for consideration by relevant policy-makers and stakeholders.

The process through which NWSSIP I was updated is characterized by broad stakeholder participation. The strategy is structurally divided mainly into: Introduction; Overview of the NWSSIP Update (Chapter I); The Integrated Water Resource Management (IWRM) Programme (Chapter 2); The Urban Water Supply and Sanitation (UWSS) Programme (Chapter 3); The Rural Water Supply and Sanitation (RWSS) Programme (Chapter 4); The Irrigation and Watershed Management Programme (Chapter 5); and a Conclusion. The aforementioned Chapters of NWSSIP II will be reviewed to reflect on the subject matters concerned by this policy note. Greater attention will be devoted to Chapter II being the core of the water sector strategy approach.

- ***Overview of the NWSSIP Update (Chapter 1):***

Under this Chapter, key sector issues were highlighted. However, it can be noted that climate change has not been identified as one of the issues affecting the water resources in the country. As mentioned earlier, several studies have indicated that the impact of climate change on the water resources is evident, and proper adaptation measures were proposed. Nevertheless, the IWRM approach was emphasized stressing on integrated, decentralized and bottom up actions designed to restore critical groundwater balance. To ensure greater effectiveness of the integrated actions, the emerging challenges under climate change which will be intensifying the sensitivity of the groundwater balance need to be well-accounted for.

- ***The Integrated Water Resource Management (IWRM) Programme (Chapter 2):***

Under this Chapter, the IWRM framework was further elaborated to ensure sustainable development and planning, allocation, and monitoring of water resources in the country. Under this Chapter, NWSSIP has proposed several actions to address the water resources stress in the country including alternative water sources (i.e. desalinization, water harvesting), and improved information management, and institutional capacity, and water basin co-management. Although these actions can be seen as essential under changing climate, the context and scale limits are situated within the scope of actions necessarily required for restoring the increasingly depleting underground water resources in the country regardless of climate change. As for the context, it can be noted that the background policy analysis in which the indicated actions were proposed has never highlighted climate change as an emerging challenge to the water sector in Yemen.

On this regard, for instance, the word “climate change” has never been shown either in this Chapter or throughout the NWSSIP II document. In addition, as mentioned earlier, the non-renewable groundwater is being mined at a rate that exceeds the recharge leading to acute water shortage mainly characterized by over-abstraction regardless of climate change. Under such circumstances, the scale of these actions apparently is not adequate for adaptation as the existing acute water shortage will be extremely compounded under changing climate. As the water sector is the most vulnerable to climate changes in Yemen, intensification of the hydrological cycle and

subsequently frequency and intensity of extreme events, sea level rise, increased evaporation, unpredictable precipitation, and prolonged and more frequent droughts are just a few demonstrations of such direct impacts on availability and quality of water. As such, climate change will directly affect the recharge rates and the sustainability of renewable groundwater for which particular contextual policy adjustments and proper scaled-up adaptation measures are necessarily critical.

Nevertheless, since the IWRM -as the sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental objectives- has been internationally and locally recognized as an instrumental management system framework to ensure sufficient water resources of adequate quality on a sustainable basis, it appears to offer greater flexibility and adaptive capacity in the context of climate change. The Intergovernmental Panel on Climate Change (IPCC 2001) recognized the potential of IWRM to be used as a means of reconciling varied and changing water uses and demands, besides presenting relevant adaptive capacity than conventional water resources management approaches. The key water resources management functions (i.e. water allocation, Monitoring; flood and drought management, information management, basin planning, and stakeholder participation) within an IWRM framework are instrumental for building up adaptive capacity to cope with climate change. But, in order to ensure building up such adequate adaptive capacity, it is critical that climate change in water governance be considered in the context of reducing livelihoods vulnerability for sustainable development.

Since the context and scale of the existing IWRM framework under NWSSIP II indicates that it is not satisfactorily responsive to the emerging climate change challenges, appropriate adaptive insights need to be incorporated. For instance, climate change implications on water resources in coastal areas need to emphasize and integrated. There are also data limitations, as climate data in Yemen are poor and erratic, and only useful to build a general picture. The current meteorological records in Yemen are weak. Given the uncertainty over climate models, early warning systems, together with improved data collection and sharing, public awareness and stakeholder involvement are among the key local preparedness measures to adapt to climate change. Therefore, adequate local capacity needs to be developed for climate monitoring and analysis through targeted training and setup of appropriate

meteorological station. As such, community preparedness and access to climate information need to be enhanced through development of a community-based early warning system in coordination with relevant agencies.

Such systems will empower the local communities across water basins in generating valuable climate information that assist raising their awareness about the livelihood hazards and risks associated with changing climate besides enhancing preparedness to cope with and adapt to such hazards which include floods, prolonged droughts accordingly. However, such insightful climate change implications need to be institutionalized, and proper adaptation planning has to be considered as an essential part during the early stages of the policy analysis process to optimize the effectiveness of the IWRM system framework ensuring that climate-resilient water resources are adequate supplied on a sustainable basis. Therefore, climate change adaptation planning needs to be accounted for in order to gain enhanced basis for integrating insightful measures under the current framework through which climate-resilient IWRM in Yemen can be ensured.

The Urban Water Supply and Sanitation (UWSS) Programme (Chapter 3):

The goal of this programme is to increase urban water supply and sanitation coverage while keeping services affordable to the poor, safe, sustainable and properly regulated. Under this Chapter, the strategy explored measures to address the challenges and issues to improve the systems' reliability of urban water supplies and services. Such measures include improving the efficiency, and investment to expand household coverage by the urban water supply system. Although these measures are essential to reduce the vulnerability to climate change, it may not be adequate in Yemen that is ranked as one of most ten water stressed countries in the World particularly under changing climate. Urban water supply intermittent is more frequent in Yemen, and therefore demand-side management alone may not be effective to substantially improve the system's reliability. Regardless of climate change, investment should have been also promoted to be channeled into constructing adequate urban water storage capacity to ensure reliable water supply.

Nevertheless, urban water supply will experience additional challenge under climate change due to fluctuating weather events, rainfall, drought, and steadily temperature increase, and eventually affects the hydrological cycle,

and underground water upon which the urban water supply system is fully reliant. As such, the reliability of the systems for urban water supplies and services can be severely affected under changing climate. For instance, prolonged, and more frequent drought periods under changing climate imply that adequate water storage capacities should be incorporated into the system designs to ensure reliable climate-resilient urban water supply. But, it can be noted that since climate change has not been identified as a challenge that hinders achieving the programme goal under NWSSIP II, consequently such adaptive measures were not promoted. Therefore, proper adaptation measures need to be incorporated into the current urban-water supply system designs in order to increase its resilience under changing climate.

The Rural Water Supply and Sanitation (RWSS) Programme (Chapter 4):

The goal of the programme is to provide safe, sustainable, affordable and equitable water along with appropriate sanitation. Three objectives are targeted: (1) to increase access for the entire rural population; (2) to keep services sustainable and affordable; (3) and to ensure that agencies operating in the sub-sector deliver efficient, least cost projects on a demand-driven basis. In order to achieve the aforementioned objectives, NWSSIP II proposed a number of actions such as alternative water sources which seems to be well-standing for the purpose it mainly intends to achieve. Regardless of climate change, Yemen's water resources are increasingly depleting, and the majority of rural dwellers have no adequate access to safe drinking water. About one third of wells drilled for rural water supply run dry, alternative sources for rural water supply sounds to be a viable measure contributing towards addressing the severe water stress across the rural areas in Yemen. Although key rural water sub-sector challenges were indicated (for which actions were proposed), climate change has not been identified as one of the emerging issues that further constrain the programme in achieving the stated goal.

It worth-noting that alternative water sources such as rainwater harvesting can effectively be contributing towards achieving the programme objectives particularly goals One and Two if climate change risks have been factored in. Most of rural livelihoods in Yemen are rain-fed based. From a livelihood perspective, the risks of climate-induced water stress are projected to have multiplying effects on several sectors including rural farming, livestock, and household domestic activities. Without factoring climate change implications (i.e. the current water stress will be

compounded by increasingly variable rainfall patterns, prolonged droughts, leading to net rainfall groundwater recharge decline, rain-fed agriculture productivity decline, food insecurity) into the current programme, uncertainty involved under changing climate would render the proposed actions far less viable. Climate change induced water stress is a key entry point to reinforce the water security perspective in rural rain-fed areas in Yemen. Therefore, climate change implications need to be incorporated to ensure that rural water supply programme under NWSSIP II is climate-resilient.

The Irrigation and Watershed Management Programme (Chapter 5):

Under this programme, the goal is a profitable, economically efficient, equitable and sustainable agriculture. Four objectives are targeted: (1) to strengthen institutions to play their role in promoting efficient water use; (2) to promote sustainable agriculture through water resources protection and allocation; (3) to increase farmer incomes through increased water use efficiency; and (4) to enhance resource sustainability and quality through watershed management. In other words, this programme seeks to ensure sustainable agriculture mainly through water use efficiency and protection and watershed management. Although these measures are essential to ensure sustainable use of water resources for agriculture, it may not be adequate under changing climate particularly across rain-fed areas in Yemen unless proper adaptation planning insights are incorporated.

The water stress has been the limiting factor for sustainable rain-fed and irrigated agriculture in Yemen. Regardless of climate change, groundwater is experiencing rapid decline and it is projected that most of the key aquifer will run dry particularly due to the current trends of water resource use. Water decline will be rapidly accelerated under climate change implying further water stress for agriculture leading to additional agricultural productivity and livestock production decrease, food insecurity increase. Therefore, in order to make sure that the programme will have the potential to fulfill its indicated goal, additional appropriate adaptive measures are essential to ensure that irrigated and rain-fed agriculture are climate-resilient in Yemen.

Policy Implications and Recommendations

Based on the aforementioned discussion, this policy note concludes by presenting the following two key policy implications and pertinent recommendations for consideration by relevant policy-makers and stakeholders:

1. NWSSIP II was developed as an updated to NWSSIP I in order overcome challenges and improve the Yemeni population's sustainable and economically efficient use of the nations scarce water resources. The strategy seems to stands very well for the purpose it intends to achieve. The employed IWRM framework is quite relevant to ensure sustainable use of water resources in a country with severe water crises. Nevertheless, the strategy has lacked the basis for considering the emerging threats posed by climate change. Although, several studies have shown that the water sector is highly vulnerable to climate change impacts for which appropriate adaptive measures are urgent and imperative, it can be noted that neither reference was made to such studies or their insightful implications. NWSSIP II was updated in 2008, and several climate change implications with regards to water sector had been highlighted. However, climate change has not been identified as an emerging challenge in NWSSIP II nor articulated adaptation was strategized. Throughout the NWSSIP II, the word "climate change" has never shown. Therefore, this policy note suggests that insightful climate change implications from such studies need to be accounted to ensure climate-resilient water sector strategy.
2. The IWRM is instrumental to ensure sufficient water resources of adequate quality on a sustainable basis, besides offering greater flexibility and adaptive capacity in the context of climate change. However, the context and scale of the existing IWRM framework under NWSSIP II points out that it is not adequately responsive to climate change impacts. As such, building on its flexibility and capacity, insightful climate change implications need to institutionalized, and proper adaptation planning can be capitalized on for consideration as an essential part during the early stages of the policy analysis process to optimize the effectiveness of the IWRM system framework to ensure climate-resilient sufficient water resources with adequate quality on a sustainable basis. Therefore, this the policy note suggests that climate change adaption planning needs to be accounted for in order to gain enhanced basis for integrating insightful measures under the current framework through which climate-resilient IWRM in Yemen is ensured and optimized.

Conclusion

It can be concluded that the climate change impact on the water sector in Yemen is evident due to its high vulnerability. In addition, the context and scale of NWSSIP II indicates that it is inadequately responsive to climate change impacts. Therefore, capitalizing on the flexibility and capacity of the IWRM to optimize the effectiveness of NWSSIP II, climate change implications need to be accounted for either through applicable revision or proper adaptation planning during the early stages of next policy analysis and development's cycle of NWSSIP in order to ensure climate-resilient, sustainable and economically efficient use of the nations scarce water resources

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