Drought Monitoring in Southeast Asia, it's Links to Sustainable Development Goals and Ongoing Initiatives

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Abstract

Impact of climate change is a major concern of Southeast Asia with the ASEAN region facing extreme weather conditions at frequent intervals and more specifically drought. Efforts are being made to minimize such impacts by strengthening the real-time monitoring capabilities to improve decision-making. Therefore, this paper provides a brief understanding of the ongoing regional initiatives towards drought management and the role of space technology. It also identifies the linkages between drought and SDG's to address some of the common regional concerns.

1. Background

Climate change have already started showing its impact on water resources from increased temperature and shift in precipitation patterns resulting in prolong droughts and floods. While there has been concerns on the depleting water resources, such conditions are further worsened by changes in precipitation patterns resulting in frequent dry spells. Studies in the recent years have shown that vulnerabilities to important regional water resources are also due to changes in both temperature and precipitation patterns. Therefore, the need of the hour suggests that at local and regional scales, policies needs to be evolved and technical measures needs to be taken to avoid or reduce the negative impacts of climatic change on the natural environment and society. Understanding the possible impacts of climate change on water resources is of utmost importance for ensuring its appropriate management and utilization.

Climate change in Southeast Asia has been recognized as one of the most serious challenges the region is facing today and is expected to impact hydrological processes such as precipitation and evapotranspiration. This, in turn, is already bearing its direct impact on stream flow and groundwater recharge. One of the evolving scenario in the region is the increase in frequency of drought. The El Nino of 2015-2016 have further exacerbated the situation with the region facing once of the most extreme drought situations in its history.

Drought contributes to significant socio-economic costs in the ASEAN region, disproportionately affecting poor and vulnerable communities. The most recent drought in 2015, amplified by a severe El Niño that began a year earlier, cut across large parts of the ASEAN region – triggering extended dry spells, water shortages, prolonged lean seasons, and food shortages that left no ASEAN country untouched. The prolonged drought forced many farmers into substantial debt, while numerous provinces across several South-East Asian countries were declared disaster zones. Drought has significant impacts on many sectors, including fish and aquaculture, forestry, and industry and each country experiences drought in different ways either a single drought situation or multiple drought situations. Around four fifth of economic impact of drought is from agriculture (UNESCAP, Asia Pacific

Disaster Report, 2015). Moreover, farming communities hit by drought also respond is different ways. Some may be able to absorb the shocks by migrating or drawing on their savings while for the poorest farmers, they may resort to erosive coping mechanism such as removing their children from schools, taking high interest loans or even selling off their assets.

2. Importance of space based information for drought monitoring

Space based information specifically satellite data can provide the occurrence, severity and extent of drought in a particular region. Due to its capability to retrieve surface parameters with high spatial and temporal resolutions over larger areas, a comprehensive view of the situation can be obtained for the affected area. Stress associated with vegetation can be easily detected from satellite data using various vegetation indices such as Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), Enhanced Vegetation Index (EVI) and others. While these information are useful for decision-makers to take effective decisions towards preparedness and response, it however provides farming community with early warning to take appropriate action towards adjusting cropping calendar as well as adopting drought resistant crops and water harvesting methods. Real-time monitoring of drought conditions using satellite data has become important in the recent past to improve the decision-making process of a country. Efforts have already been made to develop drought monitoring tools that can provide real-time information of conditions on the ground. Some of these tools are being explained in the subsequent part of this paper where geospatial data together with observed data are integrated to provide real-time drought conditions in the form of drought indices.

3. Drought and achievement of Sustainable Development Goals (SDGs) in ASEAN

In ASEAN countries, agriculture represents an important share of the national production; except for Singapore and Brunei Darussalam, agriculture represents approximately more than 5% of the gross domestic product (GDP). For Cambodia, Lao PDR, Myanmar and Vietnam agriculture accounts for 17 – 28% of the value-added GDP (WB, 2017). Even though the impacts of drought in the national economies are difficult to quantify, it has been estimated that in years when drought takes place, economic growth decreases by up to 1.7% of GDP (Loayza et al., 2009), and that impacts persists up to one year after the event affecting economic growth with reductions in GDP up to 0.6% (Fomby et al., 2013). These effects are directly related to SDG1 - End Poverty in all forms everywhere - as it challenges providing social protection to the most vulnerable groups, guaranteeing equal rights to economic resources and satisfying basic services, among which water is one of the most important and directly affected by drought episodes (Sena, A., Freitas, C. M. de, Barcellos, C., Ramalho, W. and Corvalan, C., 2016). SDG 8 -Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for al - relates to efforts in promoting local economies and reducing social and economic inequalities that are threatened by droughts since they have larger

impacts on the most vulnerable agricultural livelihoods (Sena, A., Freitas, C. M. de, Barcellos, C., Ramalho, W. and Corvalan, C., 2016).

Farmers are the first to endure the effects of drought. This phenomenon jeopardizes food security in countries that already register undernourishment rates above 14% (ESCAP, 2016), and the livelihoods of a population strongly dependent on agriculture. Across the ASEAN region, Lao PDR has the largest share of employed population in agriculture (72%), followed by Cambodia (64%), Myanmar (53%) and Vietnam (42%) (ADB, 2017). Food security and nutrition is directly addressed by SDG2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture - relating to scarcity and contamination of foods due to scarcity and contamination of water driving food insecurity and malnutrition. Increased crop productivity through increased water availability for smallholder subsistence farmers should be main priorities to address this challenge.

Population in Lao PDR, Cambodia, Myanmar and Vietnam is expected to increase, and this demographic growth imposes pressure on agricultural production. Climate change adds a new dimension to the problem of satisfying the demand for agricultural products. Projections from probabilistic crop models and climate change projections have predicted a reduction of 1.4% in rice production—a staple crop in the region—by 2030 (Lobell et al., 2008). There is high confidence that climate change will impact crops negatively and that variability in crop productivity will increase (IPCC, 2014). Adaptation measures for the agricultural sector are a key factor in reducing these negative effects (IPCC, 2014).

Sena *et al* (2016) provides an analysis on the linkages between other SDG and populations exposed to drought, summarized as follows:

- SDG 3: Ensure healthy lives and promote wellbeing for all at all ages; related to reduced child mortality and disease incidence, and increased life expectancy rely on access to potable water. This goal is directly related to SDG 4 “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” as it allows access to primary and secondary education;
- SDG 5: Achieve gender equality and empower all women and girls; is in many cases challenged when work and local economies depend on women affected by drought or when families get disrupted as women take care of families while men migrate as a response to drought looking for work and income;
- SDG 6: Ensure availability and sustainable management of water and sanitation for all; related to access to water security and quality that depends on water availability, water treatment and hygiene, and services;
- SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all; relates to increased energy inputs from renewable sources, for example, hydro-power. Hydroelectricity generation is the main source of power generation in Cambodia and Myanmar and close to half of total production in Vietnam (ADB, 2017), while other countries have smaller shares the

whole region has plans for increasing hydro-power generation in this decade that will at least double their current output (EIA, 2014, 2015),

- SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation: mostly relates to the effects of prolonged droughts on agricultural value-chains that induce reduced production, consumption and investment capacity;
- SDG 10: Reduce inequality within and among countries; can be affected due to differentiated impacts of drought in time and across landscapes and response capacities;
- SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable; is directly related to access to basic services mainly water quantity and quality,
- SDG 12: Ensure sustainable consumption and production patterns; relates to productive systems that ensure sustainable provision of hydrological services resilient to the impacts of drought;
- SDG 13: Take urgent action to combat climate change and its impacts; relates to drought impacts on degradation and desertification patters that can be enhanced by climate change;
- SDG 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainability manages forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; related to the effects of desertification on reduced water availability and negative synergies with the frequency and intensity of drought events;
- SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels; related to effects of droughts on social violence enhanced by processes of social migration, urbanization, human and economic losses.

4. Ongoing initiatives of drought at regional level

Although efforts are been made to access tools and information such as the Agricultural Stress Index System, many countries however, do not have institutional capacity to integrate these knowledge products into their operational drought monitoring and early warning system as well as have limited knowledge on data access and interpretation. A further obstacle to effective implementation is a lack of inter-agency cooperation for sharing information or presenting it in ways that could be understood and used.

Therefore, Regional Drought Mechanism of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) (UNESCAP, Regional Drought Mechanism, 2010) was established taking the advantage of data and imagery from the region's spacefaring countries − such as, China, India, Japan, Thailand and others and shares it with other countries, especially those suffering from frequent and prolong droughts. This service complements World Meteorological Organization (WMO)'s Global Framework for Climate Services by providing more detailed, localized forecasts and monitoring that can be updated during the growing season. The aim is to give a comprehensive real-

time drought monitoring and early warning system and linking it to long-term climate scenarios with the seasonal climate outlooks. This would enable countries to use this for monitoring in-season crop stress and issuing timely alerts on the onset of agricultural drought over large areas allowing mid-course corrections and measures for drought mitigation. The mechanism also develops partnerships and works with national governments to clarify and build the institutional network required to ensure the early warning services reach the right people.

4.1. FAO Agriculture Stress Index System (FAO-ASIS)

ASIS (Agriculture Stress Index System) (FAO Agricultural Stress Index System, n.d.) monitors vegetation indices across global crop areas during the growing season and can detect hotspots all over the world where crops maybe affected by drought. ASIS allows countries to fine-tune parameters of the system based on detailed land use maps and national crop statistics. This would allow them to obtain timely and reliable information on the condition of food crops all over the world enabling them for mitigating the impact of agricultural drought.

4.2. Regional Drought & Crop Yield Information System (RDCYIS) for Lower Mekong

Drought is an increasingly frequent phenomenon in the Lower Mekong Region (Cambodia, Lao PDR, Myanmar, Thailand and Vietnam). Whereas seasonal flooding cycles have a number of positive impacts on the region's agriculture and ecosystems, drought events bring primarily negative impacts on ecosystems, agriculture, and socio-economic conditions, of the farming communities. A regional geospatial needs assessment conducted by SERVIR-Mekong during 2014-2015, and subsequent consultations with regional and national institutions highlighted the need for reliable information on past, present, and forecast drought conditions and related crop yields. As a result, the Regional Drought and Crop Yield Information System (SERVIR-Mekong, n.d.) for Lower Mekong was developed with the sole purpose of monitoring and forecasting drought conditions in the five Lower Mekong countries of Cambodia, Lao PDR, Myanmar, Thailand and Vietnam. They system was developed with the aim of improving governance and decision-making in the water and agriculture sectors.

This integrated web-based information system is intended to:

- improve the operational, technological, and institutional capabilities to prepare for and respond to droughts in the Lower Mekong region;
- support local decision-makers in drought monitoring, analysis, and forecasting;
- provide policy makers and growers with current and forecast drought indices to facilitate decision-making within the current growing season; and
- provide ecological and financial forecasting information to inform seasonal cropping decisions. Subsequent functionality may include additional information relevant to decisions at sub-seasonal or multi-year temporal scales.

4.3. Mekong River Commission Drought Management Programme (DMP)

The MRC's Drought Management Programme (DMP) (Mekong River Commission, n.d.) is being implemented with the aim to assist the riparian countries by preparing vulnerable communities for increasingly frequent and severe drought events through monitoring, analysis and implementation of regional drought adaptation and mitigation strategies. The DMP includes developing a greater understanding of the region's drought conditions as well as analysis of drought risk and vulnerability for regional drought projection and mitigation policy. The drought monitoring tools will allow countries towards early detection of drought to identify and understand the key patterns and causes of drought and ultimately improve their long-term agriculture plans as well as proactive and emergency responses to drought events. Through this programme, MRC is taking collaborative actions by embarking on broad views and adaptable strategies to address the multifaceted issues pertaining to drought and its effects on agriculture, water and land use.

4.4. Flood and Drought Management Tools (FDMT) Project

United Nations Environment Programme (UNEP) together with Danish Hydrologic Institute (DHI) is developing the Flood and Drought Management Tool (FDMT, n.d.) that would respond to a need for improved capacity of managers operating in transboundary river basins to recognize and address the implications of changing climatic scenarios and land-use on water resource management. It is currently being piloted in the Chao Phraya Basin in Thailand. The project developed a methodology for basin organisations and local users to allow integration of information on climate variability and change including floods and droughts, into planning across scales: Integrated Water Resources Management (IWRM) planning, Water Safety Planning (WSP) and Transboundary Diagnostic Analyses (TDA) and Strategic Action Plans (SAP). The products generated through this tool enable stakeholders at the transboundary and national basin to local levels, to compile information, from models, indicators and existing planning approaches to develop future planning scenarios that are robust, resilient and pragmatic. The methodology involves tools that enable users to carry out baseline assessments using readily available satellite data, impact assessments through the analysis of the data, planning options and a means for disseminating information to relevant groups or individuals.

5. Conclusions

The ASEAN member states have acknowledged the importance of the Integrated Water Resources Management (IWRM) approach in achieving water security and are currently working on six key water management issues including water supply management; irrigation management; storm water management; flood management; water pollution management; and sanitation management, at the national level. While ASEAN has already made a good progress towards implementing the SDGs, the need to achieve the path of sustainable development would require ASEAN to further engage in joint thinking that goes much deeper to address the underlying causes. Successful delivery of SDGs will require strong systems approach at the regional, national and local levels, across the sectors and

involving various stakeholders including public-private stakeholders. While recognizing the urgent need to address issues such as drought, the Chairman of the 9th ASEAN-UN Summit 2017 declaration in his statement "reaffirms its support to the UNESCAP-ASEAN Joint Study on Drought and Poverty Alleviation that aims to address the necessity of deepening understanding of early warning, preparedness and prevention of such disasters that occurs due to climate change and climate variability together with geographic shifts." The study tends to promote risk sensitive policies and interventions based on drought monitoring and assessment both in-season and long-term will thus contribute to a culture of resilience while also exploring the ways in which impacts to poor farmers can be mitigated.

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