Drought monitoring and impacts assessment in Brazil: The CEMADEN experience

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ー特別寄稿ー
ICHARM は世界各地の専門機関と連携しつつ、各種活動を推進しています。2017 年 11 月には仙台の世界防災フォーラムでテクニカル・セッションを主催し、そこにブラジル・CEMADEN から Dr. Marengo Jose Antonio が参加しました。このたび、この CEMADEN の取り組みに関する記事を投稿いただきました。

- Special contribution -
ICHARM promotes various activities in collaboration with professional organizations around the world. In November 2017, ICHARM organized a technical session at the World Bosai Forum in Sendai, in which Dr. Marengo Jose Antonio participated from Centro Nacional de Monitoramento e Alertas de Desastres Naturais (CEMADEN) of Brazil. As a research institute tackling challenges in the same field, CEMADEN kindly contributed an article on their activities to this volume of ICHARM Newsletter.

Drought monitoring and impacts assessment in Brazil: The CEMADEN experience

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Brazil has been affected by intense drought events during the recent decades: Northeast Brazil (NEB) in 2010- 2018; Southeastern Brazil in 2014-15; Amazonia in 2005, 2010 and 2016, among the most important. The drought that has been affecting NEB for the past 6 years[1,2,3,4] has led to discussions about demands for improvements in drought policy and resilience to drought, - as well as management at the federal and state levels in the region of the drought - as a socio-economic environmental problem. Although drought is a recurrent phenomenon in NEB, it is perceived that risk and vulnerability are still high, particularly in its semiarid rural areas. There is a need for actions in which the scientific and the decision makers communities can work together on drought issues, focusing on reducing vulnerability.

Drought impacts are crucial for many social and economic activities in Brazil and on demand from the President´s Cabinet regularly requested information about its impacts to support and provide guidance for emergency mitigation measures. In Brazil the National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN), a R&D Institution linked to the Minister of Science and Technology, routinely deliver this information at federal level. For instance, since more than 70% of energy supply come from hydroelectric power plants we weekly present scenarios of the reservoir levels of the main basins where the plants are located. We also regularly deliver information about the reservoirs used to water supply. Since the 2014/2015 drought in the Brazil southeast we monitor the biggest reservoirs used in the metropolitan regions of São Paulo and Rio de Janeiro. Drought also impacts South and Midwest of Brazil, which are the main agricultural producing regions, and we develop models to forecast its impacts in the crops production.

Specifically, regarding the impact of agricultural droughts in municipalities in the NEB, CEMADEN provides, on a municipality base, remote-sensing-based drought indices besides other hydrometeorological data that allows the identification of the most critical areas affected by the drought. CEMADEN performs the evaluation of the phenological cycle of the main agricultural crops of the region (maize and beans) using a remote sensing-based index with a spatial resolution of 250 meters. Such initiative aims to meet the requirements established in the Presidential Decree No 8,472 for the Agricultural Yield Guarantee Programme (Garantia Safra Program, GS) of the Ministry of Agricultural Development (MDA). The GS Program aims to guarantee a minimum allowance to subsistence agriculture farmers when affected by drought or rainfall in excess.

To perform the drought monitoring and impact assessment, CEMADEN has developed and used drought indicators that combine surface observation-based drought index (Precipitation anomalies, Standardized precipitation index – SPI, Potential evapotranspiration and soil moisture) and remote sensing-based index (Vegetation Health Index -VHI, 4 km and Vegetation Supply Water Index - VSWI, 250 m). Recently, CEMADEN also developed the Integrated Drought Index (IIS) which combine the SPI and VSWI anomalies. The SPI is calculated considering the scales of 3, 6 and 12 months, while VSWI anomalies are calculated on the monthly scale. The ISS is calculated on the monthly scale and computed at the municipal level in the entire country (Figure 1).

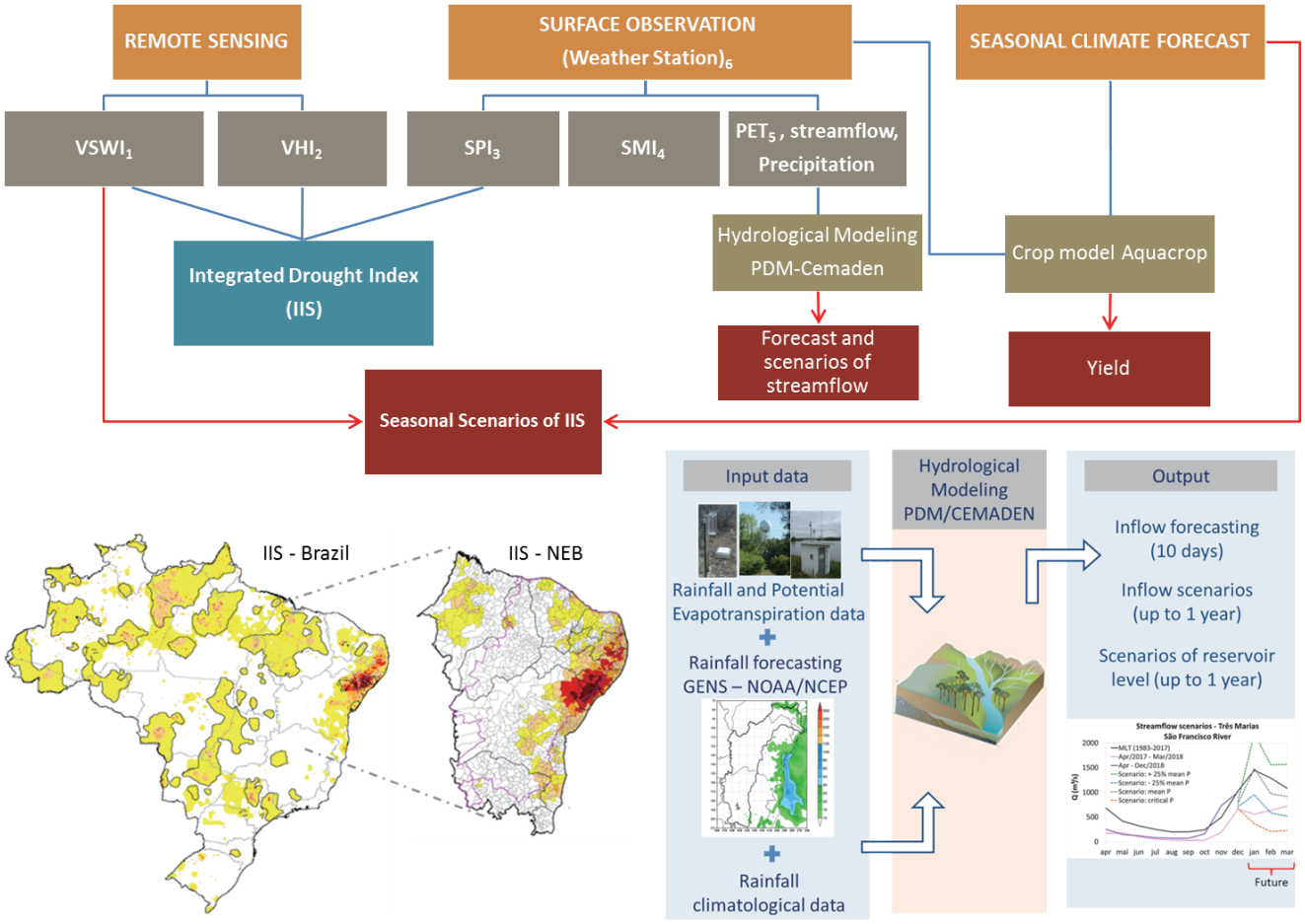
In support of drought analysis, a network of soil moisture sensors was established from 2014 to 2015 by CEMADEN, in order to monitor soil water in NEB. Soil moisture is currently being monitored at 595 locations, in depths ranging from 10 to 40 cm[5]. This information is used to support the development of tools and numerical models to characterize and quantify the risks associated with drought conditions. Regarding crop yield scenarios, the model AquaCrop[6] has been used for crop yield forecasting in the Brazilian semiarid using a combination of meteorological observations and seasonal climate forecasts as input data[7]. Future developments aim at coupling sub-seasonal forecasts of weather variables to the model and generate scenarios of yields for shorter time scales.

Concluding Remarks

Beyond that, CEMADEN implemented, in 2014, a monitoring network for the upstream basins of the Cantareira reservoirs, the main water supply system of the Metropolitan Region of São Paulo State, Brazil. Due to the continuity of rainfall below the historical average in the Southeast region, CEMADEN has been developing and updating a monitoring and prediction system (Figure 1) for the Cantareira system, and also for Três Marias, Emborcação, Furnas Mascarenhas[8], all reservoirs located in southeastern Brazilian and,

more recently, for Serra da Mesa reservoir, a hydroelectric power generation system located in Central Brazil . For the reservoirs located in the semiarid, CEMADEN has been developing similar monitoring system and simulation of the water balance. The information is available in bulletins since January 2015 for Cantareira Water Supply System, September 2015 for the NEB and February 2017 for Três Marias hydropower reservoir (http://www.cemaden.gov.br).

The multidisciplinary scientific and technical team of CEMADEN generates knowledge, results and products for drought monitoring that are relevant in the decision making processes concerning mitigation actions at the federal government level. From the drought indicators, the magnitude or intensity, onset, duration, and impacted area can be estimated. These drought characteristics are relevant for the impact assessment, as well as to prediction of drought impacts, which plays an important role in drought risk management. The identification of areas and municipalities along with the drought event characterization, together with its impacts assessment is of utmost importance in order to guide local actions by the Federal Government. Then, the most vulnerable populations may receive support in due time and to ensure that public expenses are prioritized where more resources are needed. Additionally, the identification of the areas most affected is crucial to support managers in decision making in terms of adaptation measures.



[1] Vegetation Supply Water Index - Calculated by CEMADEN using NDVI and LST (MODIS NASA). Since 2002 and spatial reolution of 250 m.
[2] Vegetation Health Index - Source: STAR/NOAA/NESDIS
[3] Standardized Precipitation Index - Since 1961 and 1998 with spatial resolution of 25 km and 5 km, respectively.
[4] Soil Moisture Index
[5] Potential Evapotranspiration
[6] Source: CEMADEN, CPTEC/INPE, ANA, INMET

Figure 1. Flow chart of CEMADEN Monitoring and Forecasting drought Impact

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