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Space-system-based disaster management support

UN-SPIDER: Strengthening Drought Early Warning Systems in Central America and the Dominican Republic

Note by the Secretariat

Like other regions of the world, Central America and the Caribbean are experiencing more frequent and more severe droughts, which are exacerbated by El Niño events like the current 2015-2016 episode, which is one of the strongest in recent decades. As a way to promote the use of space-based information to contribute to drought management efforts in these regions, UN-SPIDER, which is a programme implemented by the United Nations Office for Outer Space Affairs, is conducting a pilot project with government agencies of the Dominican Republic, El Salvador, Guatemala and Honduras; and with regional and international organizations as a way to strengthen drought early warning systems through the incorporation of the routine use of space-based information, namely maps depicting vegetation indexes that have been derived from satellite imagery.

The present document presents a description of this project, its aims, the efforts already conducted as part of the project and the status on ongoing efforts.

I. Background

1. Since the end of 2014, and fuelled by the current El Niño event, Central America and the Dominican Republic have been facing severe droughts that have forced countries to implement a variety of measures to assist vulnerable communities. In response, the Government of Honduras established an Inter-Agency

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Drought Committee and a more technical Inter-Agency Drought Panel. At the more regional level in Central America, governments have already recognized a particular region as the one most prone to droughts and have labelled it the Central American Dry Corridor. In the Dominican Republic the drought is also having a severe impact on agriculture and the levels of dams and reservoirs is extremely low.

2. Due to the fact that this type of hydrometeorological events are manifesting themselves in a more frequent and in a more intense fashion in recent decades; governments are beginning to conduct efforts in more systematized fashion as a way to track their extent and their impacts. Along these lines, governments have established inter-institutional efforts as a way to identify and implement measures to control food insecurity and malnutrition. Traditional Early Warning Systems for Drought (EWS-D) have relied on rainfall anomalies and on the observations gathered at specific places by the employees of ministries of agriculture and local authorities as a way to compile information on the impacts in the agriculture and livestock sector.

3. As a way to promote international cooperation in the peaceful uses of outer space for economic, social and scientific development, in particular for the benefit of developing countries; the United Nations Office for Outer Space Affairs dedicates efforts to strengthen the capacity of developing countries to use space technology for development by helping to integrate space capabilities into national development programmes.

4. Additionally, as a way to raise awareness on the use of space-based technologies in agriculture and food security, the Office for Outer Space Affairs launched in the year 2015 a specific publication entitled “Space for Agriculture Development and Food Security — Use of Space Technology within the United Nations System”.[1] The publication features how United Nations organizations use space-based technologies in their efforts to ensure access to sufficient nutritious food for all. It raises awareness on examples of tools that are offered by the space community to help in the monitoring of crops, livestock, forestry, fisheries, and aquaculture. The publication stresses the relevance of the use of such space-based technologies by farmers, foresters and decision makers in their efforts to achieve sustainable food production and to respond to related challenges, such as adverse weather conditions, droughts, floods, desertification and land degradation, vegetation fires, and disasters triggered by natural phenomena.

5. In its resolution 61/110, the General Assembly established the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) as a programme within the United Nations Office for Outer Space Affairs to provide universal access to all countries and all relevant international and regional organizations to all types of space-based information and services relevant to disaster management to support the full disaster management cycle, and agreed that the programme should be implemented by the Office for Outer Space Affairs of the Secretariat.

[1] Available at: www.unoosa.org/pdf/publications/Space_for_argicultural_development_and_food_security.pdf.

6. Since 2009, UN-SPIDER has conducted Technical Advisory Missions to six[2] Member States in Central America and the Caribbean. These missions have spearheaded the support that UN-SPIDER is providing to some of these countries in the context of drought. Being aware of the manifestation of more frequent and intense droughts in these regions in the last decades, taking note the capacity of El Niño events to trigger or exacerbate droughts in these regions, and having considered the fact that the International Charter Space and Major Disasters does not provide support to Member States in case of droughts; UN-SPIDER has engaged its Regional Support Offices and a network of international and regional partners to develop step-by-step procedures that government agencies in these Member States could use to generate complementary and relevant information on the effects of drought on vegetation and crops. The Office for Outer Space Affairs is also developing agreements with various providers of Earth observation data and information to facilitate their access for such issues.

7. Responding to the request of advisory support on behalf of government agencies in the Dominican Republic, El Salvador, Guatemala and Honduras, and taking note of the fact that the Office for Outer Space Affairs is committed to contribute to the implementation of the Sendai Framework for Disaster Risk Reduction; UN-SPIDER began in 2015 a pilot project to Strengthen Early Warning Systems for Drought (SEWS-D) with several international and regional partners to support government agencies in these Member States. The aim of this pilot project is to strengthen such systems through the incorporation of the use of space-based information and the strengthening of national drought policies. The project will include the generation of step-by-step procedures, called Recommended Practices, on behalf of regional and international partners and RSOs. These will be used by government agencies in these countries to generate complementary information on the evolving effects of droughts in vegetation and crops. The project will also promote other products and services developed by partners, it will facilitate the exchange of lessons learned through regional expert meetings, and is geared to strengthen national drought policies.

8. This pilot project is framed in the context of the recently launched Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) that calls for the use of space and in situ information to contribute to disaster risk reduction efforts, including disaster preparedness; and for the international community to contribute to enhance the use of space-based technologies and related services to support national measures related to disaster risk reduction. The project is also framed to serve as a contribution in the context of Paris climate change agreement, which was launched at the 21st Conference of Parties, held in Paris, France in December 2015. The Paris climate change agreement calls for the strengthening of scientific knowledge, including research, systematic observation of the climate system and early warning systems, in a manner that informs climate services and supports decision-making. The project will also contribute to efforts conducted as a way to achieve at least two of the 17 Sustainable Development Goals (SDGs) that were launched in 2015. In particular Goal 1 that calls for efforts to build the resilience of the poor and those in vulnerable situations; and Goal 2 that calls for efforts to ensure sustainable food production systems and implement resilient agricultural practices.

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[2] Dominican Republic (2010), El Salvador (2014), Guatemala (2010), Haiti (2010), Honduras (2015), and Jamaica (2009).

II. Strengthening Early Warning Systems for Drought in Central America and the Dominican Republic

9. The Dry Corridor of Central America, the Dominican Republic and several Caribbean islands have been experiencing more intense and more frequent droughts for the past decades. The rural communities' high vulnerability in this area, particularly of those that depend on subsistence agriculture; the high poverty and extreme poverty indexes that characterize many of the rural areas in this region; and the national economies' dependency on agriculture are forcing national and local governments to implement a series of measures in order to respond to the impacts caused by such hydrometeorological events.

10. As a way to increase their resilience to natural hazards, Central American and the Caribbean countries have taken major steps related to the incorporation of risk reduction management into their policies, and sectoral and inter-sectoral regional strategies. Risk reduction management is addressed in the region in three ways:

(a) Central American governments decreed the Central American Policy for Integral Disaster Risk Management (PCGIR in its Spanish acronym);

(b) In Central America, sectoral policies and strategies have been established directly incorporating the topic at different hierarchic levels. In the context of the agricultural and livestock sector, disaster risk reduction management is reflected in the Central American Agricultural Policy (PACA in its Spanish acronym), in the Regional Agro-environmental and Health Strategy (ERAS in its Spanish acronym), shared between the environmental and healthcare sectors, in the Central American Strategy for Territorial Rural Development (ECADERT in its Spanish acronym), and the Regional Policy for Horticulture Development (POR-FRUTAS in its Spanish acronym); and

(c) Trans-sectoral strategies and policies on interlinked topics have been established, such as the Regional Strategy for Climate Change (ERCC in its Spanish acronym), the Central American Strategy for the Integral Management of Hydrological Resources (ECAGIRH in its Spanish acronym) and the Food Security and Nutrition Policy of Central America and the Dominican Republic (POLSAN in its Spanish acronym).

11. Traditional Early Warning Systems for Droughts (EWS-D) in these regions rely on the measurement of rainfall data anomalies and on the observations gathered at specific places by the employees of ministries of agriculture and local authorities. As a way to institutionalize and improve such EWS-D, more efforts should be made to stimulate the participation of a greater number of ministries, institutions and organizations in such systems; to promote the implementation of national, risk-based, drought policies; and to make use of information regarding the status of the vegetation that is generated through the use of satellite images and composite products.

12. The SEWS-D pilot project, which is conducted by UN-SPIDER and a network of national, regional, and international partners, aims to strengthen such DEWS through the strengthening of national policies and the incorporation of the routine use of the information generated through the Agricultural Stress Index System (ASIS) which has been developed by the Food and Agriculture Organization of the

United Nations (FAO), information generated by the International Centre for the Research of El Niño Phenomenon (CIIFEN in its Spanish acronym), and the use of additional space-based information. In particular through the incorporation of the use of indexes based on satellite products such as the Normalized Differential Vegetation Index (NDVI), the Enhanced Vegetation Index (EVI), the Vegetation Condition Index (VCI), the Vegetation Health Index (VHI) and the Vegetation Anomaly Index (VAI), as well as soil-moisture. The reasons that justify the use of such indexes include:

(a) These indexes address vegetation as a vulnerable element, thus complementing the observations on rainfall deficit that are related to the drought hazard;

(b) Several of these indexes are calculated from satellite composite products that are available free of charge and using either open-source or commercial software;

(c) These products cover the whole country and possess an appropriate resolution for the needs of ministries and food security and nutrition commissions or committees;

(d) The VCI and the SVI allow for the comparison of the effect of a current drought with the effects of historic droughts in the last 15 years. In the case of ASIS of FAO, the comparison spans a period of 30 years, but with a slightly more coarse spatial resolution.

13. Partners in this pilot project include the UN-SPIDER programme of the United Nations Office for Outer Space Affairs (UNOOSA), FAO's Sub-Regional Office for Mesoamerica, the United Nations Convention to Combat Desertification (UNCCD), CIIFEN, the Regional Centre for Space Science and Technology Education for Latin America and the Caribbean (CRECTEALC in its Spanish acronym), the Central American Agricultural Council (CAC in its Spanish acronym), the Central American Coordination Centre for Natural Disaster Prevention (CEPREDENAC in its Spanish acronym) of the Central American Integration System, the Agustin Codazzi Geographic Institute of Colombia (IGAC in its Spanish acronym) in its role as one of the UN-SPIDER Regional Support Offices, the Mexican Space Agency and the Federal University of Santa Maria in Brazil (UFSM in its Portuguese acronym); as well as government ministries, meteorological departments, and civil protection or disaster management institutions of several countries in Central America and in the Caribbean. The project will target National Food Security and Nutrition Commissions or Committees, Ministries of Agriculture and Environment, as well as national civil protection agencies (more information on the project can be found in the UN-SPIDER Knowledge Portal at: www.un-spider.org/projects%20/%20SEWS-D-project).

14. The project can be linked to the outcomes of the High-level Meeting on National Drought Policies (HMNDP) held in Geneva in March 2013; aiming to support countries regarding the development and implementation of national drought policies. This entails specific policy guidelines on a step-by-step approach to formulate national drought policies based on the philosophy of risk reduction. A particular focus will be mainly on the three key pillars: monitoring and early warning systems; vulnerability and risk assessment as well as risk mitigation measures.

15. The general objective of this project is to contribute to the efforts conducted by regional and international organizations, as well as by governments and stakeholders in Central America and the Dominican Republic, in particular in the area of drought early warning, drought monitoring, vulnerability and risk assessment.

16. The specific objectives of this project are to strengthen national policies based on the principles of integral risk reduction and to enhance the capacity of ministries, civil protection agencies and meteorological observatories to generate and make use of space-based information on a permanent basis as a way to improve the routine operation of early warning systems for these hydrometeorological events. Once such capacities have been increased in countries taking part in this project, those institutions operating these early warning systems will be able to generate policy-relevant information for decision makers incorporating space-based information. It is expected that through this project decision makers will enhance their spatial awareness regarding the extent of current droughts and will have an improved sense regarding current droughts in comparison to historic droughts which may have taken place within the last 15 to 30 years or so.

17. The project comprises four phases and is expected to be completed in a period of approximately three to four years:

(a) The first phase of the project covers the development and testing of the country-based ASIS developed by FAO and other procedures developed by UN-SPIDER, IGAC, UFSM and other partners to generate drought-related indexes such as the NDVI, the EVI, the VCI and the SVI. This phase would pave the way for the subsequent incorporation of the use of ASIS and other indexes into the EWS-D;

(b) In the second phase of the project, those professionals and specialists involved in early warning systems in the pilot Member States will be trained on the procedures to generate relevant information. To the extent possible, a mapping exercise will be carried out focusing on vulnerability and the risk profile of regions and populations will be incorporated;

(c) In the third phase, the use of the maps will be incorporated into the Standard Operating Procedures (SOPs) of the EWS-D; and

(d) During the last phase lessons learnt will be compiled and the methodologies will be revised in order to improve them when it is necessary. Also, the replication of such a project in other regions of the world will be explored.

18. The main outcomes of the project include an enhanced spatial awareness regarding the extent of droughts and the visualization of the changes in their extent from month to month using products derived from satellite imagery such as the NDVI and/or the EVI; a comparative view of an on-going event with respect to historic events manifested in the last 15 to 30 years through the use of ASIS and the VCI and VAI; and a more holistic approach to the monitoring of such events through an integrated system that allows operators and decision makers to view parameters related to rainfall, vegetation, soil, and social parameters such as population, poverty and income in a simultaneous fashion. Another major outcome is the implementation of national drought policy in accordance with the international drought policy guidelines.

Efforts conducted in 2015

19. Throughout 2015, UN-SPIDER embarked on discussions with regional and international partners as a way to develop the concept note for the pilot project. In a similar fashion, UN-SPIDER and several partners conducted missions to El Salvador, Guatemala and Honduras as a way to engage national government agencies in the project. In the case of El Salvador the Environmental Observatory of the Ministry of Environment and Natural Resources and the National Civil Protection Directorate of the Ministry of Governance and Territorial Development were engaged in the project. In the case of Guatemala the Ministry of Agriculture, the National Institute for Seismology, Vulcanology, Hydrology and Meteorology and the National Coordinating Agency for Disaster Reduction have been engaged. In the case of Honduras it has been the Inter-Agency Drought Panel and the Permanent Commission for Contingencies have been engaged. In the case of the Dominican Republic, the local partner is the Inter-Institutional Earth Observation Team that has been established by the National Emergency Commission at the recommendation of UN-SPIDER.

20. Taking note of the advancements on behalf of FAO regarding the development of the ASIS and taking note of the usefulness of the use of ASIS at a national scale; FAO's Sub-Regional Office for Mesoamerica is now developing an ASIS-Country version and has developed a guideline regarding its calibration at the national level as a way to incorporate its use. FAO's Sub-Regional Office for Mesoamerica conducted a mission to Honduras to promote the use of the ASIS-Country version and will carry out subsequent missions to other Members States supported by this project in 2016.

21. By February 2015 UN-SPIDER developed a version of the UN-SPIDER Recommended Practice on Droughts using the R-Studio open software (available in the UN-SPIDER Knowledge Portal at: www.un-spider.org/advisory-support/recommended-practices/recommended-practice-agricultural-drought-monitoring). Using this version, between February and June 2015 nearly 350 maps were elaborated for each the following countries: El Salvador, Guatemala and Honduras. These maps were distributed to national government agencies in these countries.

22. The Federal University of Santa Maria in Brazil (UFSM) developed a Recommended Practice to generate the SVI by the summer of 2015, and developed maps of the SVI for Central America and the Dominican Republic. In addition, it developed nearly 350 VCI maps for the Dominican Republic.

23. Experts from UFSM, CRECTEALC, and AEM took part in the Technical Advisory Mission to Honduras in July 2015 and used the opportunity to provide the VCI maps to the members of the Inter-Agency Panel on Drought and conducted a training session on the use of the VCI procedure developed by UN-SPIDER in R-Studio.

24. During 2015, IGAC of Colombia developed a Recommended Practice on the generation of maps to assess the expansion or the contraction of water bodies due to El Niño events (available in the UN-SPIDER Knowledge Portal at: www.un-spider.org/advisory-support/recommended-practices/pr%C3%A1ctica-recomendada-la-generaci%C3%B3n-de-mapas-de-expansi%C3%B3n-y).

25. From 12 to 14 August 2015, UN-SPIDER and IGAC conducted the Regional Expert Meeting in Bogota Colombia, The Regional Expert Meeting on the use of Space-based Information in Flood and Drought Disaster Risk Management. The Regional Expert Meeting brought together experts from CIIFEN, CRECTEALC, UFSM, IGAC, and staff from government agencies from El Salvador, Dominican Republic, Guatemala, Honduras, Colombia and Bolivia. The Expert Meeting was used to conduct training sessions on the IGAC and the UN-SPIDER Recommended Practices.

26. Government agencies in Dominican Republic, El Salvador, Guatemala and Honduras are beginning to examine the maps provided by UN-SPIDER and UFSM as a way to determine their usefulness in contributing to characterize the geographical extension of droughts between the years 2000 and 2015. Two sets of maps have been provided to each country: maps depicting the VCI and maps depicting the SVI. Furthermore, two types of maps have been provided for the VCI and for the SVI, based on the input composite products used (NDVI and EVI). Initial results of this analysis are to be expected by the summer of 2016.

The way forward

27. In the first months of 2016, regional and international partners will approach national partners in the four countries to become aware of existing national drought policies and on-going efforts related to the implementation of such policies.

28. By the end of March 2016 UN-SPIDER expects to upload the Recommended Practice on the SVI that has been developed by UFSM in the UN-SPIDER Knowledge Portal.

29. In the first half of 2016 UN-SPIDER and several regional partners will continue to support national government agencies in their efforts related to the analysis of the applicability of VCI and SVI maps as part of the EWS-D. Based on the feedback from national government agencies, UN-SPIDER, IGAC, CRECTEALC, UFSM and AEM will proceed to modify the step-by-step procedures in the Recommended Practices as a way to increase their usefulness in EWS-D.

30. The Sub-Regional Office of FAO for Mesoamerica will launch the ASIS-Country version in May of 2016 and will conduct missions to other countries where the project is implemented to promote its use as part of this SEWS-D project.

31. In the summer of 2016, UN-SPIDER and the partners will carry out a Regional Expert Meeting in the Dominican Republic as a way to exchange lessons learned on the analysis of the applicability of the VCI and SVI maps in the EWS-D. The Regional Expert Meeting will also be used to explore ways to visualize a variety of data and information that should be incorporated in the monitoring component of the EWS-D (weather forecasts, daily accumulated rainfall, rainfall anomaly, standard precipitation index, EVI, NDVI, VCI, SVI, El Niño or la Niña forecasts, temperature conditions in the Pacific Ocean and the Caribbean sea, land-use and types of crops in different geographic areas, soil classification, poverty and demographic data, as well as any other relevant data or information).

32. Throughout 2016 and 2017 CRECTEALC, UFSM and IGAC will conduct research as a way to develop procedures to elaborate a forecast for the VCI and the

SVI based on extrapolations of the historic VCI and SVI maps. Additional efforts will be conducted on the combined use of MODIS composite products and Landsat imagery to assess the effects of droughts on vegetation and crops.

33. UN-SPIDER will invite regional and international partners and experts from other organizations to conduct a technical advisory mission to another Central American Member State as a way to engage this Member State in the project.

34. As an initiative of the United Nations Office for Outer Space Affairs, the Office will draw attention to this project in the framework of the Global Earth Observation Partnership that was launched by the Office and 17 partners during the Third World Conference on Disaster Risk Reduction in Sendai and will make the United Nations Office for Disaster Risk Reduction (UNISDR) aware of the efforts conducted in this project.

35. The project is currently implemented with minimal internal resources but additional resources would allow UN-SPIDER and the partners to carry out a series of training workshops in every Member State that is targeted with this project, to continue developing and improving the Recommended Practices that have been developed, to facilitate the development of an application that facilitates the visualization of all the data and information that is needed in the context of early warning systems for drought, to develop a procedure that allows for the elaboration of forecasts for the drought indicators as requested by the Central American Agricultural Council, to contribute to the calibration of the ASIS-Country application in all Members States targeted by this project, to support the implementation of national drought policies, and to support government agencies in these Member States to acquire the necessary IT infrastructure to be used to monitor potential and on-going drought conditions. Broadening the partnership to more contributors would thus increase strategically the impacts of the project.

36. As stated earlier, through this pilot project conducted by UN-SPIDER, the Office for Outer Space Affairs aims to contribute to the fulfilment of its mandate, and it aims to contribute to the implementation of the Sendai framework, the Paris climate change agreement and the SDGs that constitute the main global agendas for the period 2015-2030.