DROUGHT RISK ASSESSMENT AND MAPPING

TECHNICAL DESCRIPTION

Drought's risk assessment and mapping are a very important technology for Ukraine, because the climate of its territory is under the influence of atmospheric large-scale circulatory systems, which lead to long periods with shortage in precipitation, resulting in drought. The increased air temperature and uneven distribution of rainfall, which do not provide an effective accumulation of moisture in the soil caused the increased incidence and intensity of drought. Many researchers have noted that since 2000, there has been a tendency to increase the frequency, intensity and prevalence of seasonal drought. Although drought studies are conducted in Ukraine, they are non-systematic in nature, do not have a clear and functional technological basis and do not prevent the risks and loss of drought in the water and agriculture sectors.

The description of Drought risk assessment and mapping is a key element of drought management, as it helps to identify most of areas at the risk of drought, allowing communities to plan, as well as to prepare for and mitigate possible impacts. Drought's risk is calculated as the probability of negative impact caused by interactions between hazard (the probability of future drought events occurring on the basis of past, current and projected drought conditions), exposure (scale of assets and population in the area) and vulnerability (the probability of assets and population being affected by drought in the area). Drought assessment and mapping technology consist of 6 stages:

1. Collection of observational data for drought assessment;
2. Data preprocessing;
3. Formulation of methodology for drought assessment;
4. Assessment of drought;
5. Mapping;
6. Transfer of technology products to Risk Management Authority and other stakeholders

In the first stage of the technology, all kinds of the information required for drought assessment must be collected. Data for drought risks assessments include that derived from remote sensing, as well as field measurements. For the calculation of typical drought, indexes SPI or SPEI is needed data of field measurement: daily and monthly values of temperature and precipitation, soil moisture. Remote drought monitoring is carried out on the basis of the use of the Normalized Vegetation Index (NDVI), or the normalized NWI water index, calculated by satellite data TERRA / MODIS and other satellites. **In the second stage** of the technology all data, including basic quality control, generation of meteorological, hydrological or satellite parameters required for drought indexes (DI) calculation, verification and validation must be processed. **In the third stage**, there must be the formulation of the technology for drought assessment and should be selected of type of DI (on the basis of meteorological, hydrological, or satellite observational data). Standardized Precipitation Index (SPI) is the most-used standardized meteorological drought index. WMO has recommended the use of SPI by all national meteorological and hydrological services (NMHSs) worldwide to characterize meteorological drought.Advantages of SPI are that its calculation results in normalized values and that it can be computed for different time scales (e.g., 1, 3, 6, 12 months, or more).

When satellite data are used for identifying and monitoring drought, index NDVI is recommended. Radiance values measured in both the visible and near-infrared channels are used to calculate NDVI. It measures greenness and vigor of vegetation over a seven-day period as a way of reducing cloud contamination and can identify drought-related stress to vegetation. Input parameters: NOAA satellite data.

In the fourth stage, drought must be assessed, including daily data transformation into DI, DI database creation, DI ranging (5 classes of DI) /classification. Spatial data from the paper maps, remote sensors and records are required to be transformed into a digital format and create a spatial database of DI. Geographic references (longitude or latitude/columns and rows – spatial data) identify the spatial location of information collection.

In the fifth stage, there must be the mapping of drought. This final stage of technology seeks next technical procedure with DI spatial database like spatial DI interpolation, visualizing resulting DI maps, publicly available DI maps publication. The creation of risk maps requires Geographical Information Systems (GIS) software. To carry out it, the spatial data analysis can be used for next GIS software: MapInfo, ERDAS, Intergraph, IDRISI, GRAM, ArcInfo, GRASS, AutoCAD maps etc. **In the sixth stage**, there is a transfer of results and products of technology (drought risk maps, drought forecast,

relevant drought information) to the Risk Management Authorities and other stakeholders. Risk Management Authorities in Ukraine are State Emergency Service (Risk Management Department), River Basin Authorities, Ministry of Agrarian Policy and Food, State Water Agency. Among other stakeholders, there can be insurance companies, state and private agrarian farms, municipalities in drought regions, NGOs and media.

CLIMATE RATIONALE OF THE TECHNOLOGY

Climate warming, which is manifested in rising maximum temperatures and the number of hot days, increases the risks in those sectors of the economy that are most dependent on the effects of the weather. The most vulnerable sector of Ukraine's economy is agriculture. The main agricultural capacity of the country is placed in two agroclimatic zones (Steppe and Forest-Steppe) with a level of significant risk due to the fast-changing climate conditions. On average, 70 percent of the country's arable land belongs to these zones. This fact is evidence of significant dependence on the future of agricultural production and national food security from the character of climate changes. According to experts, annual crop loss can be from 10 to 70% due to adverse weather conditions in Ukraine and the main cause of this loss is drought. More than 30% of the areas of the best land has a constant shortage of moisture. In the years of severe drought, the negative deviation of the crop's yield from the trend line is up to 500 kg / ha in Ukraine as a whole, in the steppe regions - up to 1000-1500 kg / ha, there are cases of complete loss of the crop.

In combination with other adaptation technologies, such as climate-smart irrigation (CSI), this could have a significant economic effect not only in agriculture but also in other sectors of Ukraine's economy.

AMBITION OF THE TECHNOLOGY

SCALE FOR IMPLEMENTATION AND TIME-LINE

Studies conducted for the territory of Ukraine about arid phenomena shows that the maximum number of droughts has been observed in the southern and southwestern regions of Ukraine and a tendency has been observed to increase the recurrence, intensity and prevalence of seasonal drought after 2000. Some of severe droughts have been observed in the last decade (2007, 2010, 2015, 2020) and affected 50–80 % of the country territory (TNA Ukraine, 2019). On the basis of this, we propose in the first stage of technology's implementation to focus efforts in the southern region of Ukraine - the Steppe zone (40% of the county territory or 241,5 thousand square kilometers), then spread it to the forest-steppe (33% of the country territory or 199,1 thousand square kilometers) and the third stage to the whole country. The time-line of technology implementation: first stage - 40% of the county territory, steppe zone by 2027; second stage - 33% of the country territory, forest-steppe zone by 2030; whole country by 2033.

EXPECTED IMPACTS OF THE TECHNOLOGY

Drought risk assessment and mapping technology has a potential of decreasing losses caused by drought, contributes to decrease of desertification and land degradation, improves the efficiency of water use and related expenses, creates preconditions for development of insurance business, protects of vulnerable groups of population and of water-dependent sectors of economy (eg., in agriculture), promotes water saving measures amongst all water users.

The application of drought's risk assessment and mapping technology on the basis of modernized monitoring system would reduce crop losses in droughts annually by $ 950 million to $ 1400 million. This means that every year Ukraine will additionally benefit from the implementation of this technology in the agricultural sector at 2.1 -3.1% of GDP.

The modernization of monitoring and use of modern technologies for drought and flood risk assessment and mapping will allow to get considerable economic effect in different sectors of the economy, which depend on the weather.

The index of effectiveness of the investments needed for the technical modernization and development of the National Hydrometeorological Service of Ukraine ranges from 1: 4.1 to 1: 10.8: each dollar that will be invested in monitoring upgrades can benefit from $ 4 to $ 11 at the expense of the warning losses from natural meteorological phenomena.

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EXISTING POLICIES IN RELATION TO THE TECHNOLOGY

The development of the drought risk assessment and mapping technology has coincided with increasing national interest in sectoral adaptation to climate change and desires to increase climate resilience. For the last year, the adaptation actions have been recognized as a key pillar of green sectoral growth for Ukraine. Moreover, recently, the adaptation policy has been recognized as a matter of national environmental security by its acceptance in the President Decree for the Implementation of the Decision of National Security and Defense Council of Ukraine on Environmental Security. Since the beginning of the year, the Ministry of Environmental Protection and National Resources, supported by the UNDP under the EU4Climate initiative, has developed the Draft Strategy of Environmental Security and Climate Change Adaptation by 2030, which is expected to be accepted soon. The next step is being developed as a sectoral adaptation plan.

Regarding this, implementation of drought risk assessment and mapping technology creates the ground for the further steps and practical implementation of adaptation policy in the agriculture and water sectors.

PROPOSED POLICIES TO ENHANCE TECHNOLOGY IMPLEMENTATION

Before implementing the technology, it is necessary to conduct climate impact assessment in the water sector of Ukraine on a modern scientific and methodological basis. This will give the impact with climatic risks, vulnerabilities and identification of adaptation options.

A shortage of qualified personnel for the implementation of technology can be corrected by training employees in the middle system of vocational education and higher education is observed. The provision of experts in the field should be made by the higher school, retraining and the advanced training of specialized organization or investors. The training of such specialists can be organized in Ukrainian universities on the basis of recommendations of the WMO Technical Commissions with collaboration with EUMETNET, EFAS, Delft company and other.

State Emergency Service of Ukraine needs to reform job payment system (increasing of monthly payment) to involve skilled people to monitoring department.

The development of special funding program to implement the technology, particularly to the establishment of Drought Monitoring and Water Scarcity Center, to conduct Research and Training and to purchase the necessary equipment.

Such a Centre can be established jointly by the Ministry of Environmental Protection and Natural Resources of Ukraine (MEPNR) and the State Emergency Service of Ukraine (SESU) with the partial involvement of the state budget and international environmental investments.

Objectives of the center establishment: combining advanced technologies and highly qualified and well-motivated specialists with IT and GIS technology skills, big data processing, modeling, forecasting, mapping within the Center. They can ensure the success of technology implementation and operation in Ukraine. The Center may regularly provide public and private stakeholders with different information on the dangers of drought.

The development of effective insurance legislation that would take into account the benefits of using technology. It is possible to use an analogue: the insurance system for drought risk in Austria. It is also necessary to create a legal framework for the use of satellite information for drought monitoring in Ukraine.

Wide awareness campaigns are required to be carried out by authorities, the media and NGOs. Ukrainian stakeholders don't have enough information about the benefits of technology. The lack of information about the benefits of technology among insurance companies is the reason of inefficient insurance system in Ukraine and the ignorance of the benefits of technology. Following the modernization of the hydrometeorological monitoring service and the implementation of the drought's risk assessment and mapping technology, a powerful awareness campaign for stakeholders and insurance companies should be undertaken to clarify the benefits of using the technology and to develop regulatory mechanisms for the use of technology by stakeholders and insurance companies.

COSTS RELATED TO THE IMPLEMENTATION OF POLICIES

The estimated calculations indicate the following costs for the technology implementation:

- Research – USD 200,000;
- The training of high skilled experts for the implementation and functioning of technology - USD 500,000
- The implementation of the technology in arid zone of Ukraine - USD 5,000,000;
- Reform in the remuneration system of the State Emergency Service of Ukraine - USD 2,000,000/year
- The establishment of a Drought Monitoring and Water Scarcity Center - USD 3,000,000;
-The spread of information about technology - USD100,000;

Thus, overall cost of technology is USD 32.8 million.

USEFUL INFORMATION

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LINKS TO TNA REPORTS

Report	Year	Link
TECHNOLOGY ACTION PLAN. ADAPTATION. UKRAINE (in progress)	2021	https://rb.gy/kbli3n
BARRIER ANALYSIS AND ENABLING, FRAMEWORK REPORT. ADAPTATION.UKRAINE	2020	https://rb.gy/atwsg4
TECHNOLOGY NEEDS ASSESSMENT REPORT ADAPTATION. UKRAINE	2019	https://rb.gy/wx7fzsl in