FLOOD HAZARD ASSESSMENT AND MAPPING

TECHNOLOGY DESCRIPTION

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Climate change is manifested in a significant change in the hydrological regime of water bodies now and in future. The most dangerous manifestations of the change in the hydrological regime are catastrophic floods and flash floods. The territory of the Ukrainian Carpathians (Tisza, Dniester and Prut basins) is one of the most flood-prone regions in Europe. Flood hazard assessment and mapping technology is used to identify areas at risk of flooding, and consequently to improve flood risk management and disaster preparedness. Flood hazard assessments can be further expanded to assess specific risks, which take into consideration the socioeconomic characteristics (e.g. industrial activities, population density, land use) of the exposed areas. Technology helps to increase readiness to floods, reduces vulnerability of climate during timely preparation of adaptation measures and the mitigation of possible impact, has a potential of decreasing losses and damage caused by flood, helps to increase preparedness to floods, decreasing costs needed for dealing with their consequences, creates preconditions for development of insurance business. Increased preparedness to floods leads to smaller negative environmental impact, which is especially important in case of availability of landfills, nuclear power plants etc. Protection of population and companies via improved planning and increased preparedness. Creation of visual product that helps to understand one of the displays of climate change.
Flood hazard assessment and mapping technology consist of 5 stages:
1. The collection of information about areas at risk of flooding;
2. The preparation of information, tools and data preprocessing;
3. Flood modelling and scenario design;
4. Flood Hazard Assessment/Risk Mapping.
5. Transfer of the technology products to the Risk Management Authorities.

In the first stage of the technology, all kinds of the information required for flood's risk assessment must be collected. Observational data sources used in flood hazard assessments are either station data (e.g., meteorological stations, discharge gauging stations) or gridded data (e.g., reanalysis data, satellite data). Next steps in this technology stage for flood's hazard assessment are: 1. a preparation of detailed topographical and specialized maps and digital elevation models of the river basin district at the appropriate scale including the borders of the river basins; 2. a description of the floods which have occurred in the past and which had significant adverse impacts on human health, the environment, cultural heritage and economic activity; 3. a description of the significant floods which have occurred in the past, where significant adverse consequences of similar future events might be envisaged.

In the second stage of the technology, there must be the preparation of information, chose of hydrological models, mapping tools and data pre-processing. The most common hydrological models are MIKE FLOOD, MIKE 11, MIKE 21, InfoWorks RS, LISFLOOD-FP. MIKE FLOOD is highly efficient and flexible for riverine flood modelling. Flood mapping, risk and hazard analysis of flood incidents from extreme upstream inflows as well as local high intensity rainfall in surrounding catchments are perfectly modelled with MIKE FLOOD. InfoWorks RS is a river modelling software for open channels, floodplains, embankments and hydraulic structures. InfoWorks RS can be used for accurate and timely flood forecasts and risk assessments. LISFLOOD-FP can simulate the dynamic propagation of flood waves over fluvial, coastal and estuarine floodplains.

In the third stage, there must be scenario design and flood modelling. DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks foresees the following scenarios: (a) floods with a low probability, or extreme event scenarios; (b) floods with a medium probability (likely return period ≥ 100 years); (c) floods with a high probability, where appropriate according to the following scenarios: (a) floods with a low probability, or extreme event scenarios; (b) floods with a medium probability (likely return period ≥ 100 years); (c) floods with a high probability, in case it is appropriate.

In the fourth stage the assessment shall include at least the potential adverse consequences of future flood for human health, the environment, cultural heritage and economic activity, taking into account as far as possible issues such as the topography, the position of watercourses and their general hydrological and geomorphological characteristics, including floodplains as natural retention areas, the effectiveness of defense infrastructures for existing man-made

flood, the position of populated areas, areas of economic activity and long-term developments including impacts of climate change on the occurrence of flood. For flood hazard visualization, we must use the creation of flood hazard maps, which shall cover the geographical areas which could be flooded according to the following scenarios, which have been chosen in the third stage of technology. Flood hazard mapping is a basic component in flood risk analysis studies of the flood phenomenon. Hazard can be mapped in three zones (high, medium, and low) for which boundaries and usage restrictions must be established.

In the fifth stage, there is a transfer of results and products of technology 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 flood regions, NGOs and media.

CLIMATE RATIONALE OF THE TECHNOLOGY

Climate change impacts, driven by temperature rises and shifts in precipitation patterns, could lead to changes in flood frequency, seasonality of water discharge. Such changes may have adverse effects on agricultural, energy, transport, and social sectors, dependent on water resources. Adaptation strategies have to be developed in regional water resource management in order to avoid the risks and damages associated with such impacts, so that the readiness of the water-dependent sectors could be ensured to meet the future challenges. Climate change is manifested in a significant change in the hydrological regime of water bodies. The most dangerous manifestations of the change in the hydrological regime are catastrophic floods and flash floods. The regional manifestation of these phenomena is wide enough in Ukraine. The impact of the harmful effects of flooding is observed in Ukraine on an area of 165,000 km^2, which reaches 27% of the territory of Ukraine. This is primarily the Carpathian region Transcarpathia (Transcarpathian region), Prykarpattya (Lviv, Ivano-Frankivsk and Chernivtsi regions) and the catchment of the Pripyat river in the northwest of the country.Within the last 20 years, in Ukraine, significant flood that has led to emergencies have been observed in 1995, 1998, 2001, 2008, 2010. Annual average flood loss in 1995-1998 amounted to more than UAH 900 million, in 1999-2007 more than UAH 1.5 billion, in 2008-2010 - about UAH 6 billion.

AMBITION OF THE TECHNOLOGY

SCALE FOR IMPLEMENTATION AND TIME-LINE

Surface (river) flooding is prevailing type of flooding in Ukraine. Flood-prone regions of Ukraine are located in the catchments of different Carpathian inflows in the Dniester (8.7% of the country territory), in the area of some Danube tributaries (5,3%) as well tributaries of the Prypyat (20%), Desna (15%), catchment of West Bug (2,1%). However, the most dangerous flood regions are the river basins of Transcarpathia (about 32.0 thousand km^2) and Precarpathian (52.5 thousand km^2).

Time-Line for the implementation of technology:

first stage - 5,3% of the county territory (Transcarpathia), rivers of Danube catchment by 2027;

second stage – 8,7% of the country territory (Precarpathian), rivers of Dnister catchment by 2030;

Third stage- whole country by 2033.

EXPECTED IMPACTS OF THE TECHNOLOGY

This technology has sufficient adaptation and economic impact:

- technology provides special tools for assessment and forecasting risk of floods, preventing and managing risks, which is the basis for developing adaptation plans for communities and sectors of the economy; helps to identify response measures for adaptation sectors of economics and communities, including those addressing vulnerable group's needs; increases the adaptive capacity in the social sphere, including that of vulnerable groups; increases the resilience and adaptive capacity of flood related sectors of economics, including communities form remote areas; improvement of land use management plans will be facilitated by agricultural mitigation, with strong empowerment of women; the introduction of zoning will help limit the construction of new buildings in areas prone to flooding and prevent flood risks of exposed communities; development of non-structural measures, such as early warning, dry and wet proofing, and relocation available for all members of society; mitigation in insured and uninsured private households due to changes

of flood insurance, addressing the needs of all users; increase the resilience of communities to climate change, including those of remote areas and low -income households; reducing social vulnerability and promoting inclusive resilience .

The introduction of technology provides vulnerable communities with specific tools for flood hazard's forecast and prevention and risk management. This increases the adaptive capacity in the social sphere and the resilience of communities to climate change, including that of low-income, remote areas, helps to increase of readiness of communities to floods, addressing the needs of both women and men, reduces the vulnerability of climate during the timely preparation of gender – responsive adaptation measures and the mitigation of possible impacts, protects of population and companies through the improved planning and increased preparedness.

Economic and financial impact are following: with the help of the functioning of technology, public and private economic entities can timely and fully consider the risks of drought in all their investments and make their business climate resilient; the creation of potential of decreasing losses and damage caused by flood of flood- prone areas; decreasing costs needed for dealing with their consequences; to create preconditions for the development of insurance business available for all members of society; increased preparedness to floods leads to smaller negative environmental impact, which is especially important in case of availability of landfills, nuclear power plants etc; the resilience of ecosystems is enhanced to promote the sustainable economic growth and peoples' livelihoods; the application of flood risk assessment and mapping technology on the basis of modernized floods monitoring system would reduce losses of agricultural land and limit construction of new buildings in flood-prone areas; hydro-meteorological information and early warning systems can save hundreds of lives of both women and men and large financial resources (from millions to billions of dollars annually).

POLICY ACTIONS FOR TECHNOLOGY IMPLEMENTATION

EXISTING POLICIES IN RELATION TO THE TECHNOLOGY

The development of the flood hazard 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.

To implement the Association Agreement between Ukraine on the one hand and the European Union on the other hand, one of the priorities of the environmental policy of Ukraine is the harmonization of the water legislation of Ukraine with the EU legislation, in particular, with Directive No. 2000/60 / EC "On the establishment of the Community framework for activities in the field of water policy "(Water Framework Directive, WFD) and Directive 2007/60 / EC" On Flood Assessment and Management"(Flood Directive), the main principles of which are the implementation of an integrated basin for water management model and flood management.

Regarding this, implementation of flood hazard 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

For the successful implementation of the technology it is planned to hold such actions as:

- Research on a modern scientific and methodological basis of gender-sensitive vulnerability of the water sector to floods and to perform the ranking of vulnerable areas for the phased implementation of adaptation measures.
- The increasing of the state support of hydrometeorological monitoring, search for investment, financial credits, funding for improving of hydrometeorological service. Reform in the remuneration system of the State Emergency Service of Ukraine (SESU) considering the needs of both women and men.
- The training of high skilled experts for the implementation and functioning of technology based on the recommendations of WMO technical commissions, collaboration with EFAS, Delft (NL) and more.
- The establishment of a joint Flood Monitoring and Forecast Center by the Ministry of Environmental Protection and Natural Resources of Ukraine and State Emergency Service of Ukraine.

- The development of effective insurance legislation in collaboration with the National Association of Insurers of Ukraine.
- To create a legal framework for the use of satellite information for flood monitoring in Ukraine.

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 the 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 Flood Monitoring System and Forecast Center - USD 3,000,000.
-The spread of information about technology – USD 100,000.
Thus, overall cost of technology is USD 32.8 million.
In the case of effective use of the technology, in combination with other flood control measures, flood losses could be reduced by at least 30-50%. And moreover, the efficiency of the technology in 1% could save for the state budget of Ukraine (in case of flood 2020 in the Dniester basin) 1, 4 million US dollars, which is more than enough for the annual maintenance of our proposed Center for Flood Monitoring and Prevention.

USEFUL INFORMATION

CONTACT DETAILS

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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