



The Development of Nationwide Flood Forecasting and Early Warning Systems in Georgia

FPCUP Copernicus transfer of knowledge and expertise activities on natural disasters (Floods and Fires)

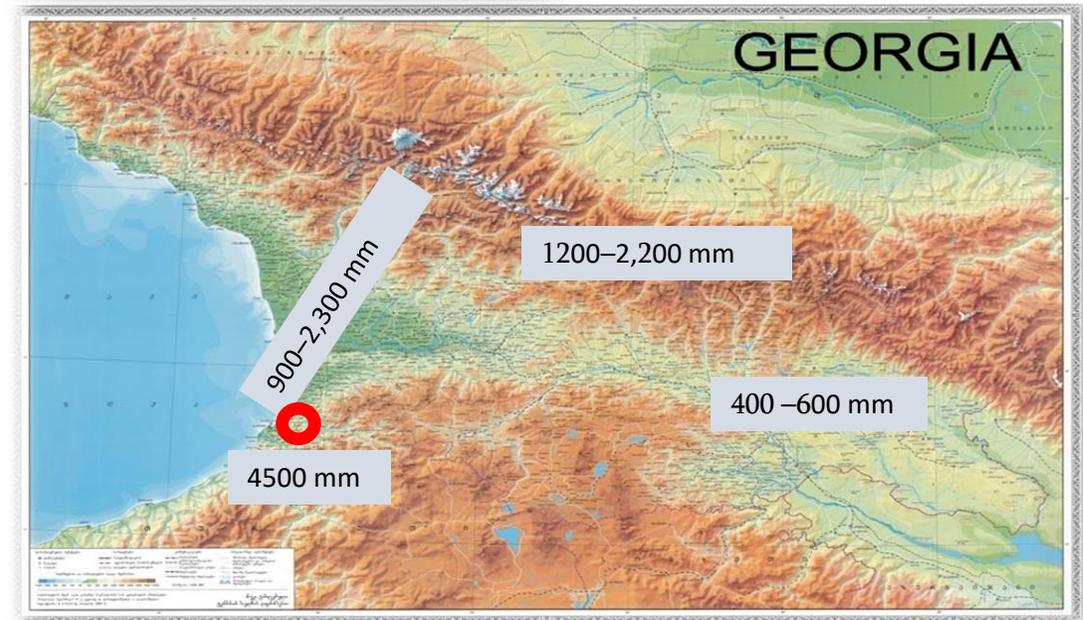
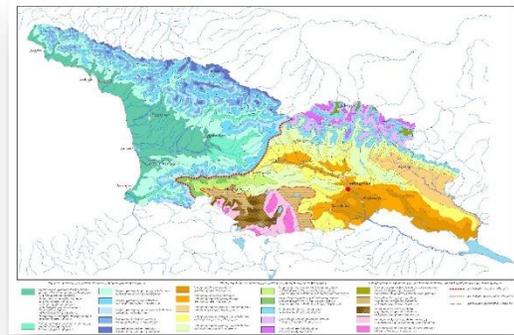
*National Environment Agency of Georgia
Hydrometeorology Department*

Ioseb Kinkladze

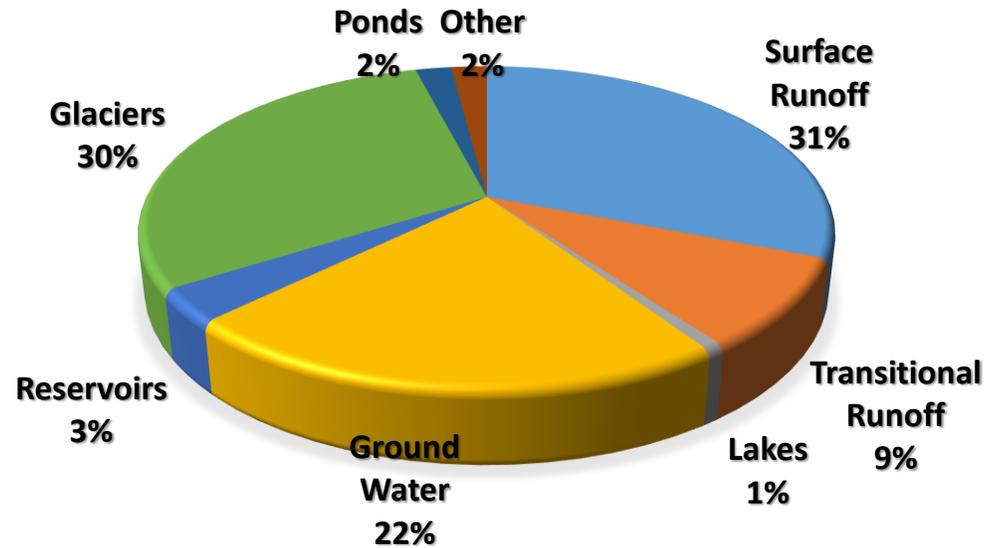
8 July 2025

About the Country

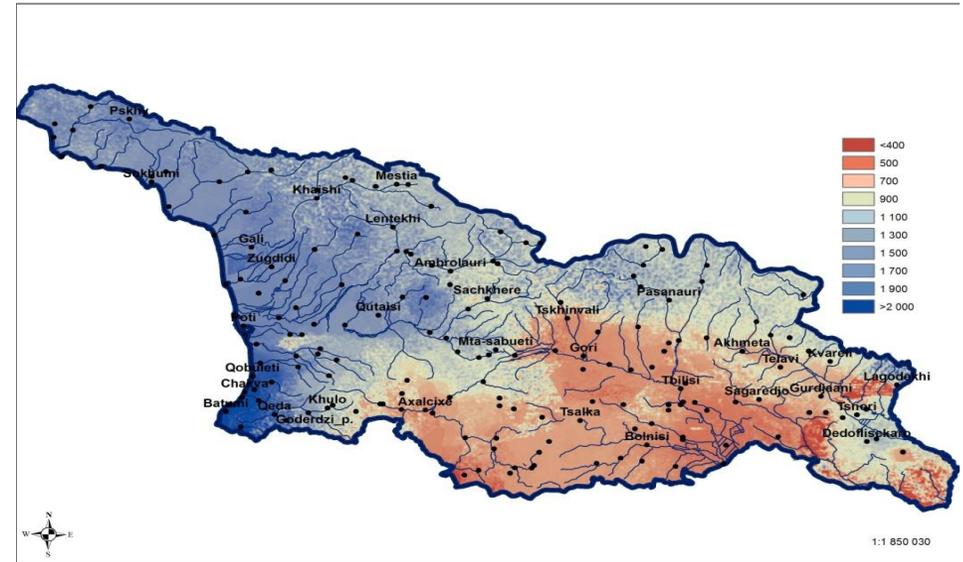
- Population - 3.9 million
- Area - 69.700 km²
- Approximately two-thirds of the country is mountainous, with 20% of the land situated at elevations of 2,000 meters or higher above sea level.
- Annual precipitation varies between 400 and 4,500 mm.
- Average temperatures in Georgia vary seasonally, ranging from sub-zero levels in winter (December to February) to a relatively warm average in the summer (around 18°C in July and August).



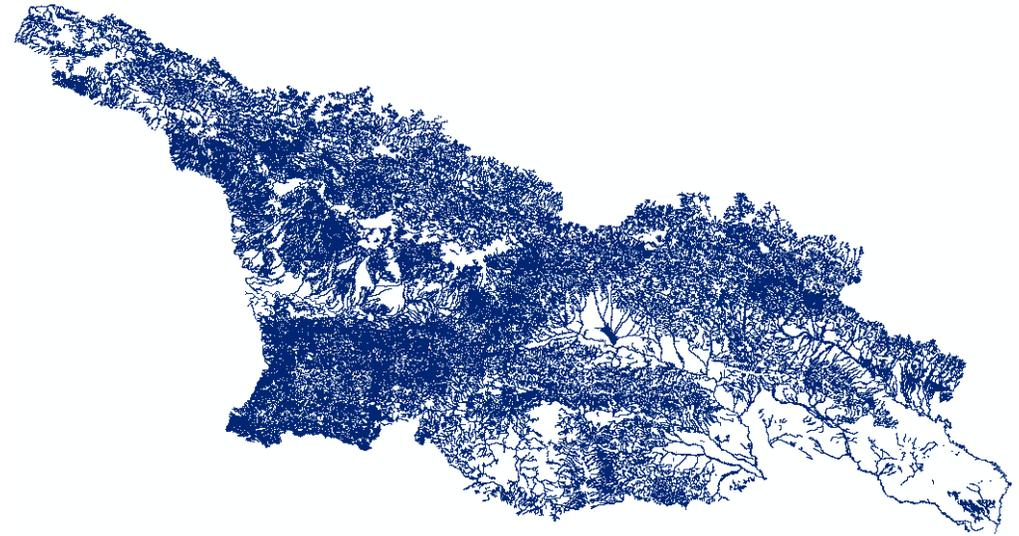
Water Resources in Georgia



Precipitation Annual Sums (1961-1900)



- Georgia is well endowed with water resources, 3,144 m³ per capita per year
- 42.6 billion m³, 75% of renewable surface waters belong to Black Sea Basin
- 14.4, 25% billion m³ in Caspian Sea



Major Natural Hazards

Flash Floods/Surface/Urban Floods



Snow Avalanches



Drought



Riverine Floods



Landslides & Debris flow/Mudflow



National Environment Agency (NEA)

The agency is legal successor of the national meteorological and hydrological service of Georgia which was founded in 1884



NEA was established as legal entity of public law in 2008



NEA Departments

Department of Hydrometeorology (Floods, Snow Avalanches, Heatwaves, Hailstorm etc.)

Department of Geology (Landslides, Debris flows, Rockfall etc.)

Fisheries, Aquaculture and Water Biodiversity Department

Department of Environment Pollution Monitoring

Department of Environmental Damage Remedial Measures

Department of Licenses

Department of Environmental Assessment

Department of Hydrometeorology (NMHS)

Meteorological and Hydrological Observation

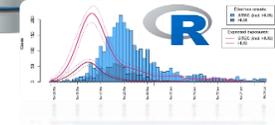


Data collection and dissemination at national and international level

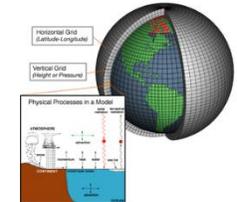


Historical

Separate agencies for Aviation and Marine Services



Hazard Assessment and Mapping



Weather and hydrological short, medium and long term forecasting



Forecasting and warning dissemination



International Cooperation



European Flood Awareness System
(EFAS)



1994

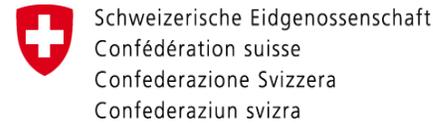
2018

2021

2025

International Projects

➤ Reducing the risk of climate-driven disasters



➤ Horizon 2020 - MedEWSa



➤ Technical Assistance by Hydromet team of the World Bank



History of hydrometeorological observation

1832 – fragmented observation started;

1844 – established Tbilisi magnetic-meteorological (geophysical) observatory

1850 – Glaciological expeditions;

1883 – Agrometeorological observation;

1904 – actinometric observation;

1905 – hydrological observation;

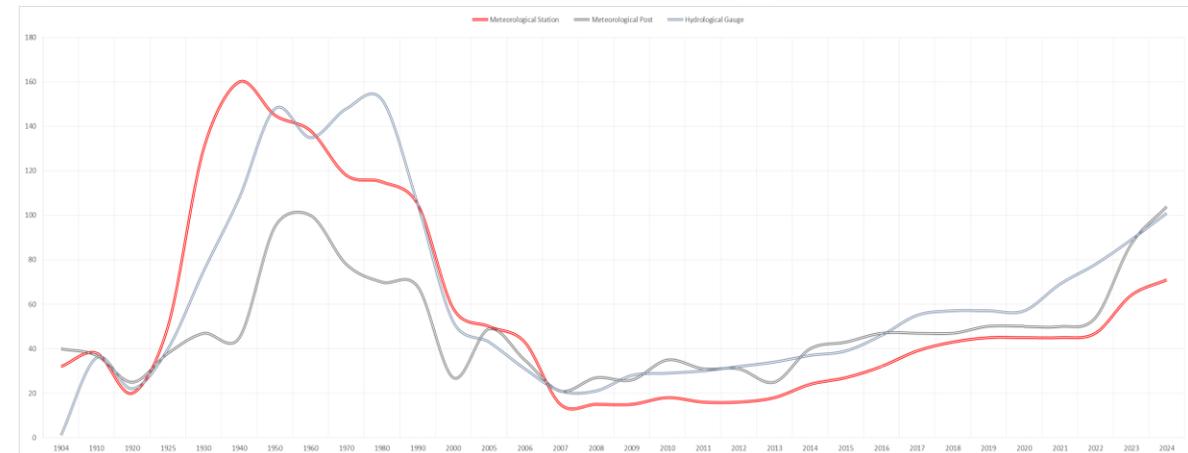
1932 – Snow depth observation by field expeditions;

1937 – air soundings;

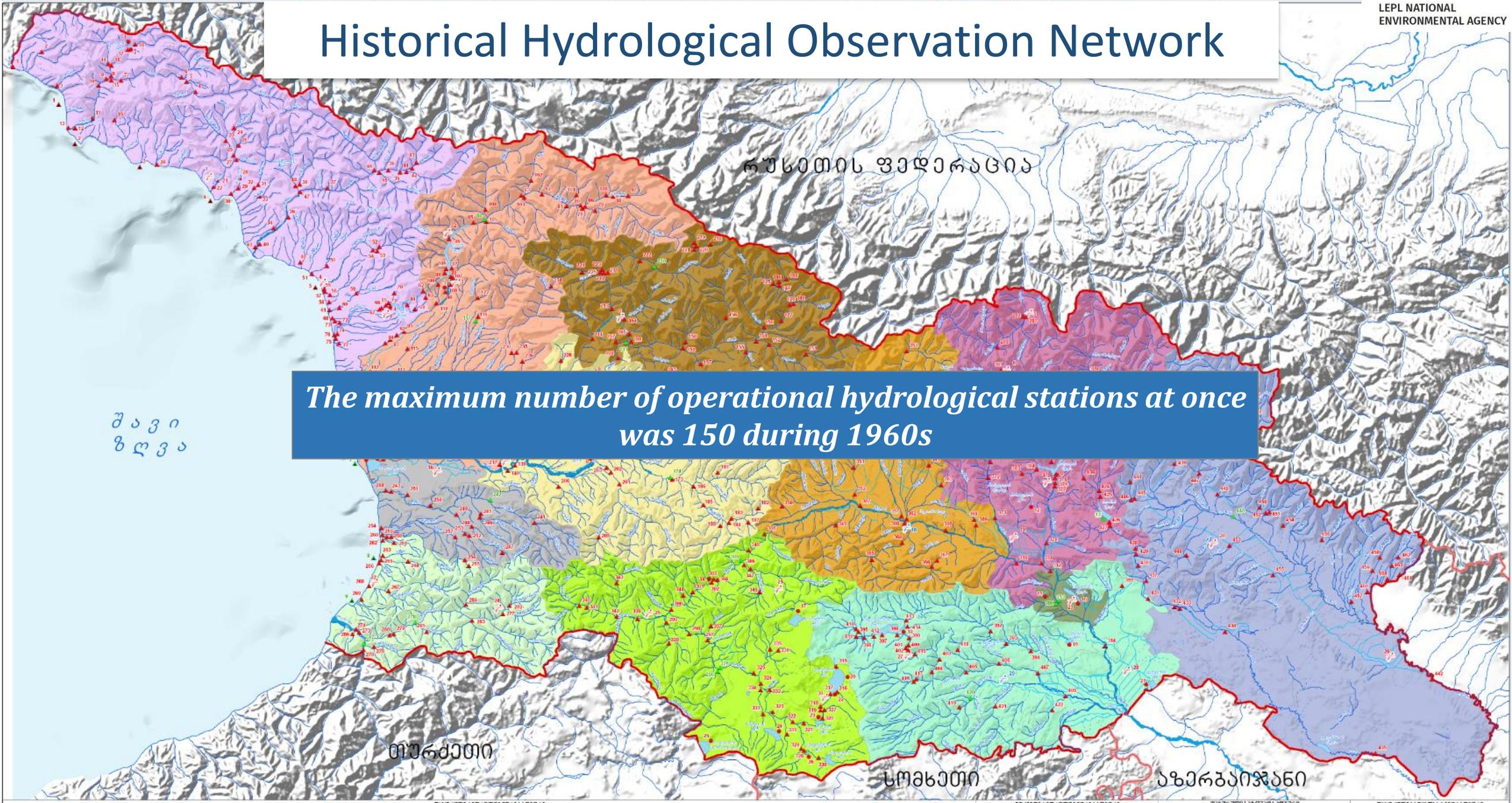
1964 – Black Sea water level and meteorological observations;

1967 – Cloud seeding;

1988 – Snow avalanche artificial triggering



Historical Hydrological Observation Network



Current Observing Systems



Meteorological
Stations – 145
Hydrological Gauges
– 78



Weather Radars -
2



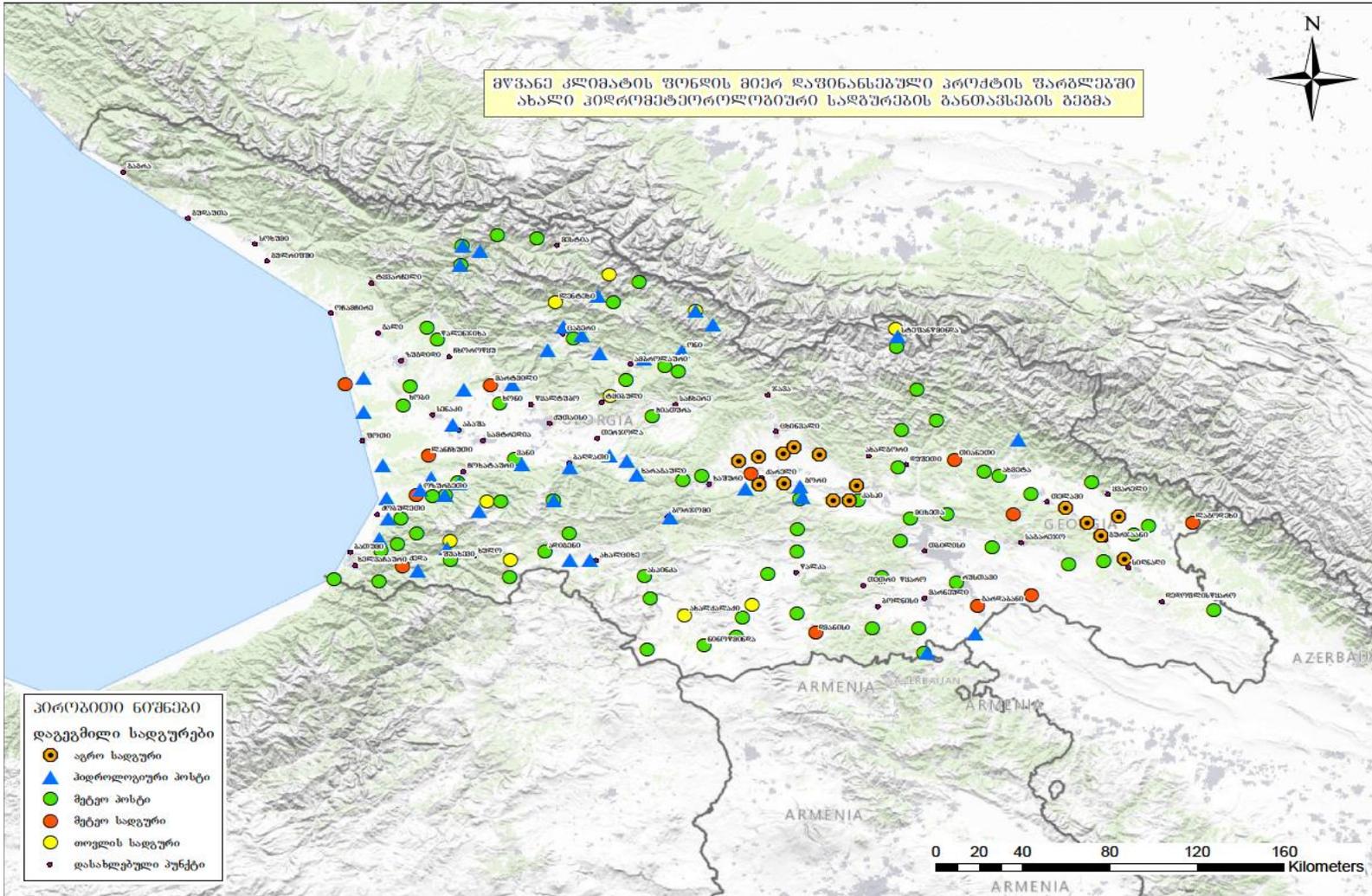
Air-Sounding
System - 1



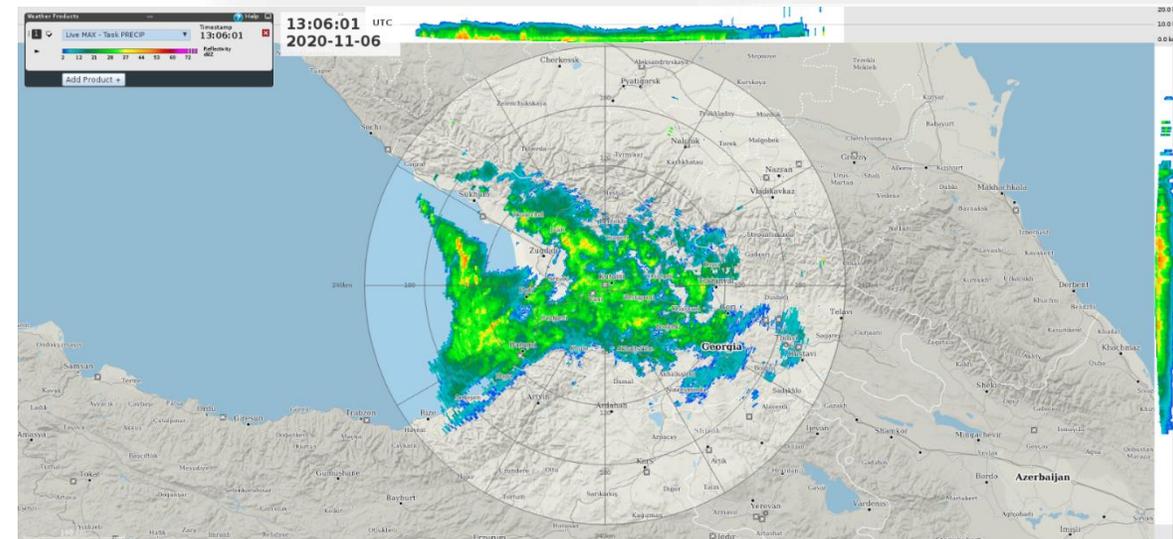
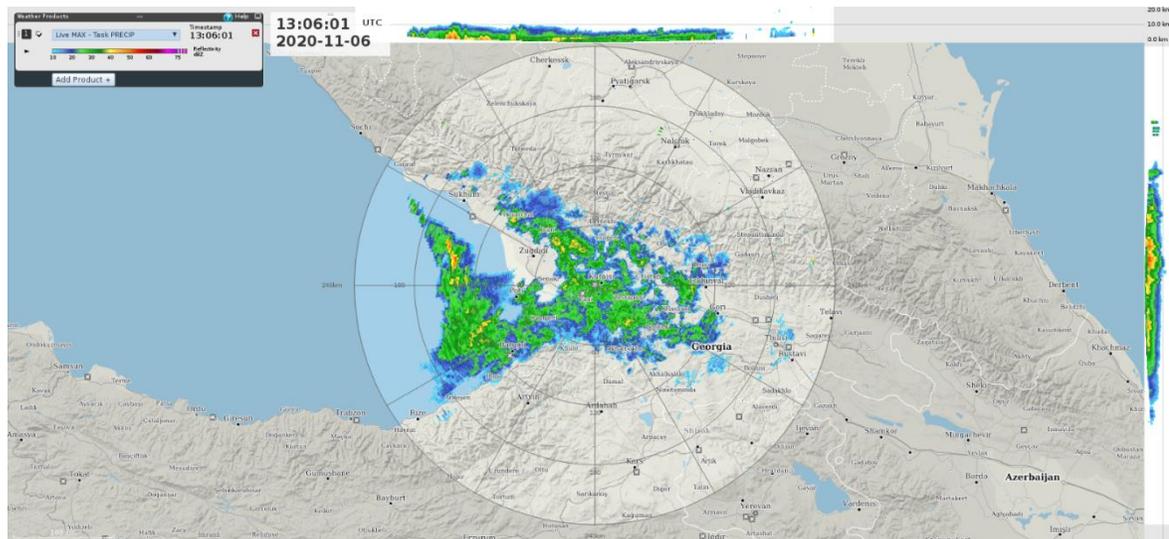
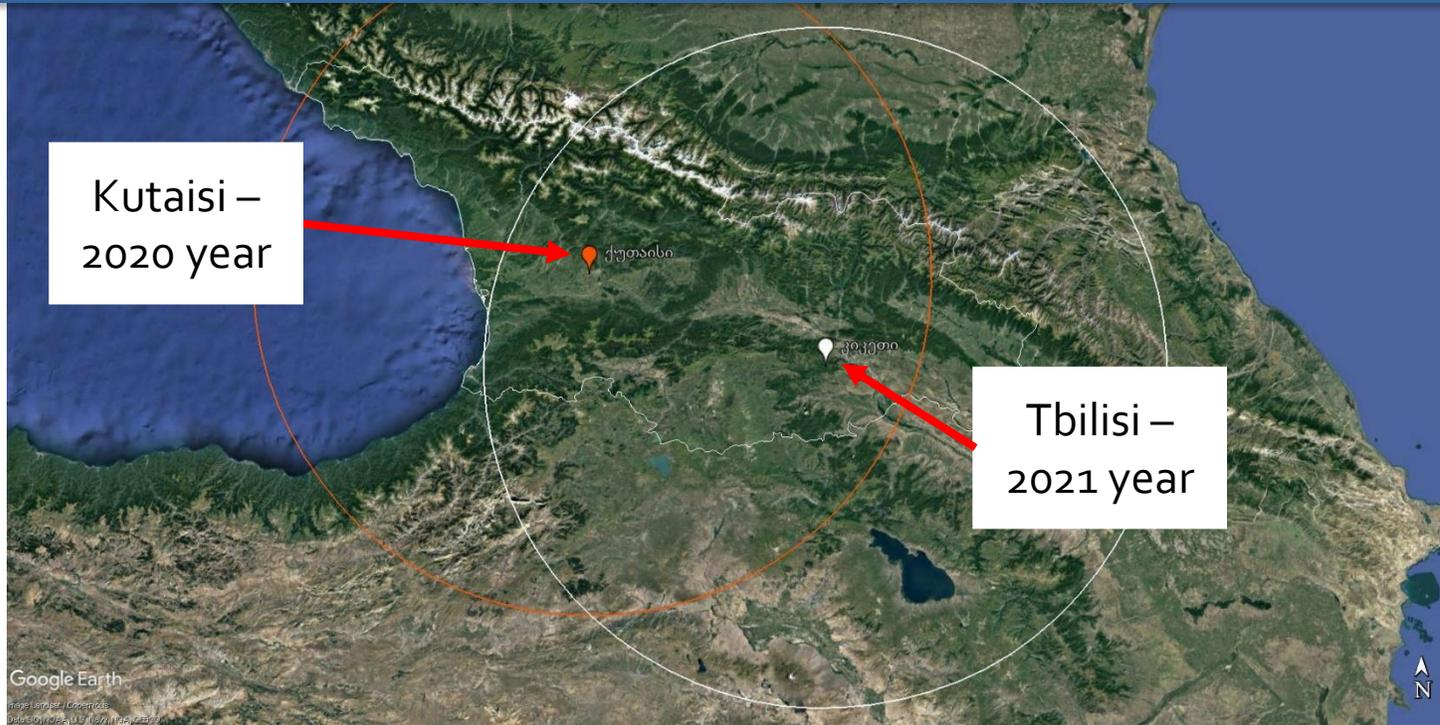
Satellite
Observations

Upgrade of Hydrometeorological Network

Category	Amount
snow station	10
meteo station	12
meteo post (prpc, tmp, humid.)	73
hydro post	44
agromet station	15
Total	154

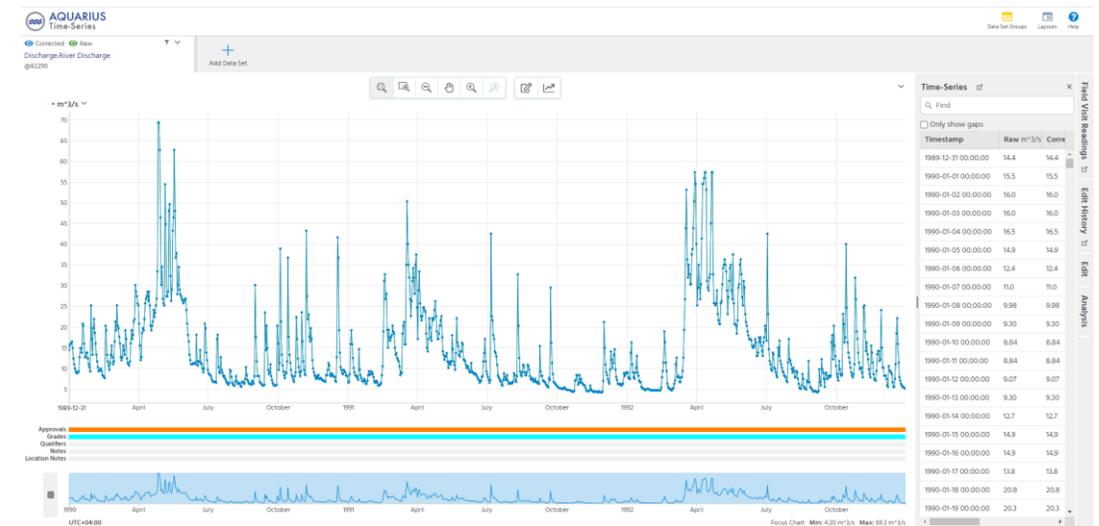
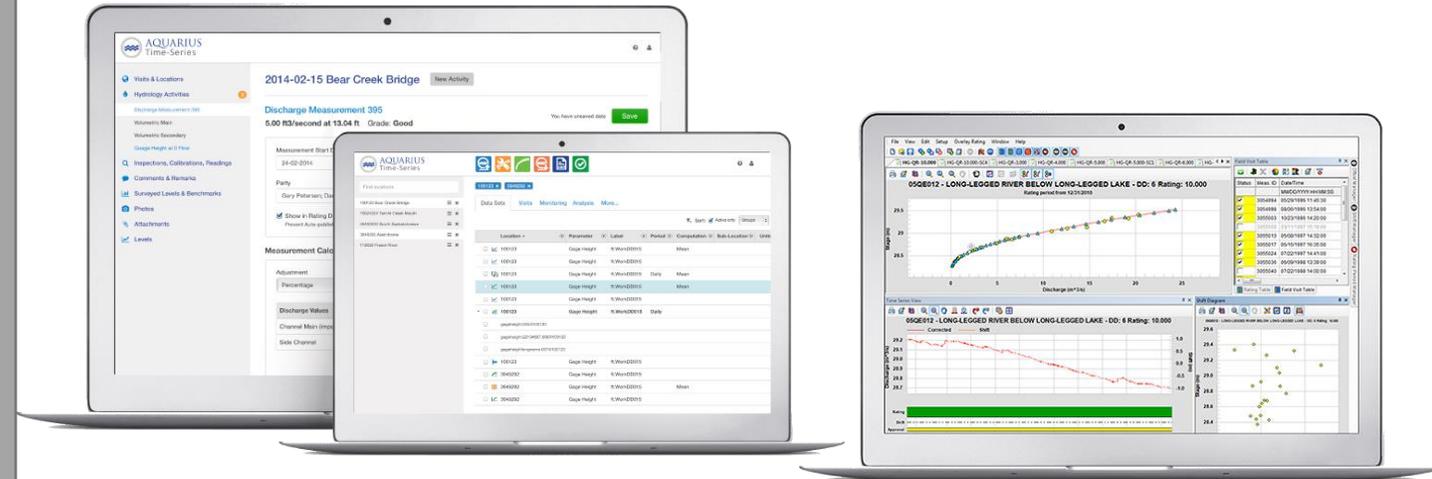


Weather Radar Network



Hydrological Database System

AQUARIUS Time-Series



Strengthening the capacity in streamflow measurement and O&M of Observing Network

➤ Strengthening the capacity in regional observatories (Tbilisi, Kutaisi, Akhaltsikhe, Batumi)

- SUV Cars
- ADCP
- Current Meter
- Sonar (sound navigation and ranging)
- Field Laptops
- GPS





Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



Reducing the risk of climate-driven disasters

7 Hazards

Flood, Snow Avalanche, Drought, Windstorm, Hailstorm, Landslide, Debris Flow/Mudflow

Key Activities

- Development of Hazard&Risk Maps
- ~ 150 Hydrometeorological Stations (2021-2023)
- High Performance Computing System (2021)
- Financial support to become a co-operating state ECMWF (2021)
- Upgrade of ICT systems (2024-2026)
- 2 Air Sounding Systems (2023-2024)

ECMWF welcomes Georgia as its 12th Co-operating State

1 December 2021

Share



Photo: Stephen Shepherd



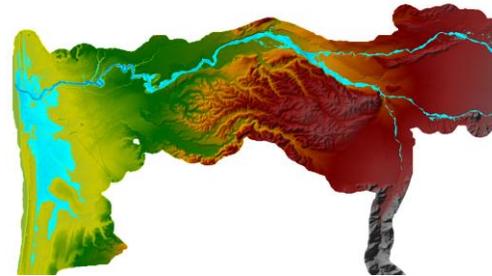
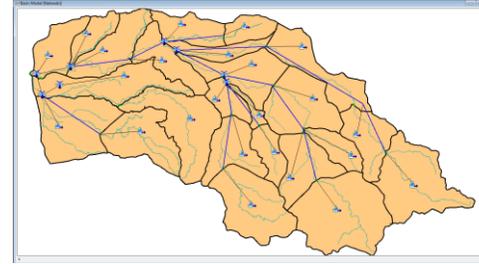
FLOOD HAZARD



Methodology for
Flood Hazard
modelling and mapping
for Georgia
(hydraulic modelling)

Methodologies and procedures for
hydrological analysis for the purpose of
flood hazard mapping data analysis for
Georgia

2022



Hydrological Modelling
HEC-HMS

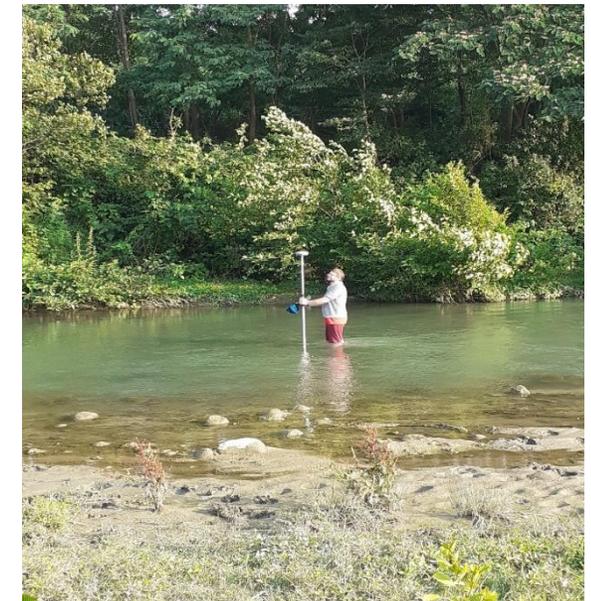
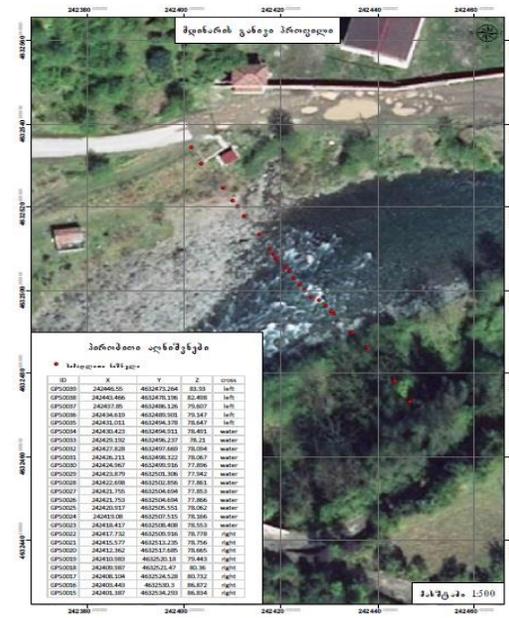


Hydraulic Modelling
HEC-RAS 2D

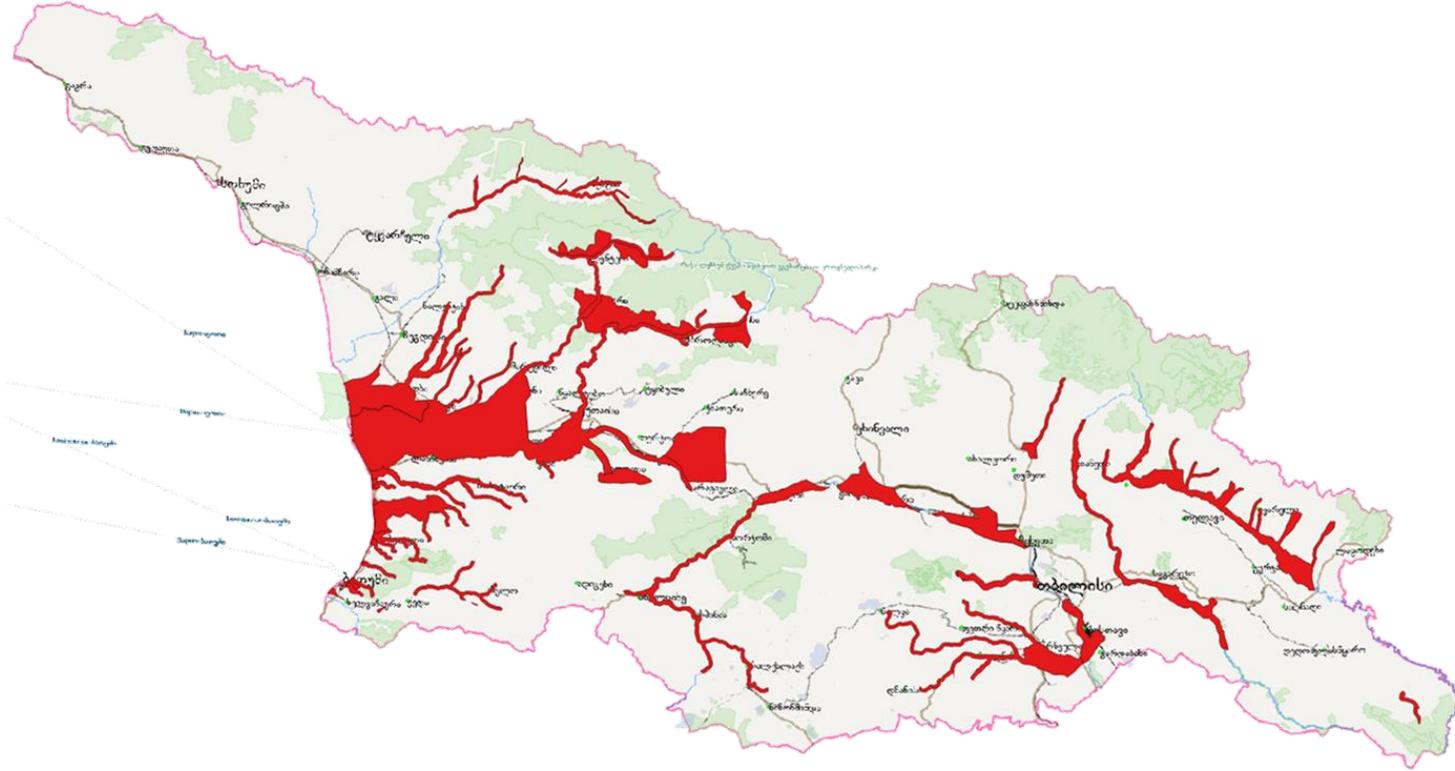


GIS Mapping

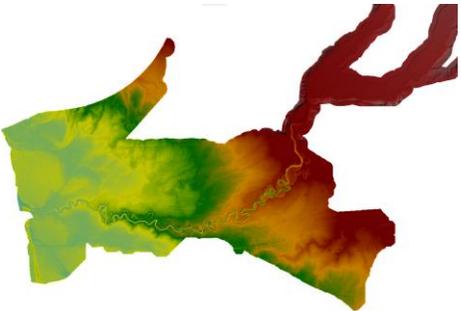
- Bathymetric survey has been conducted for the entire country



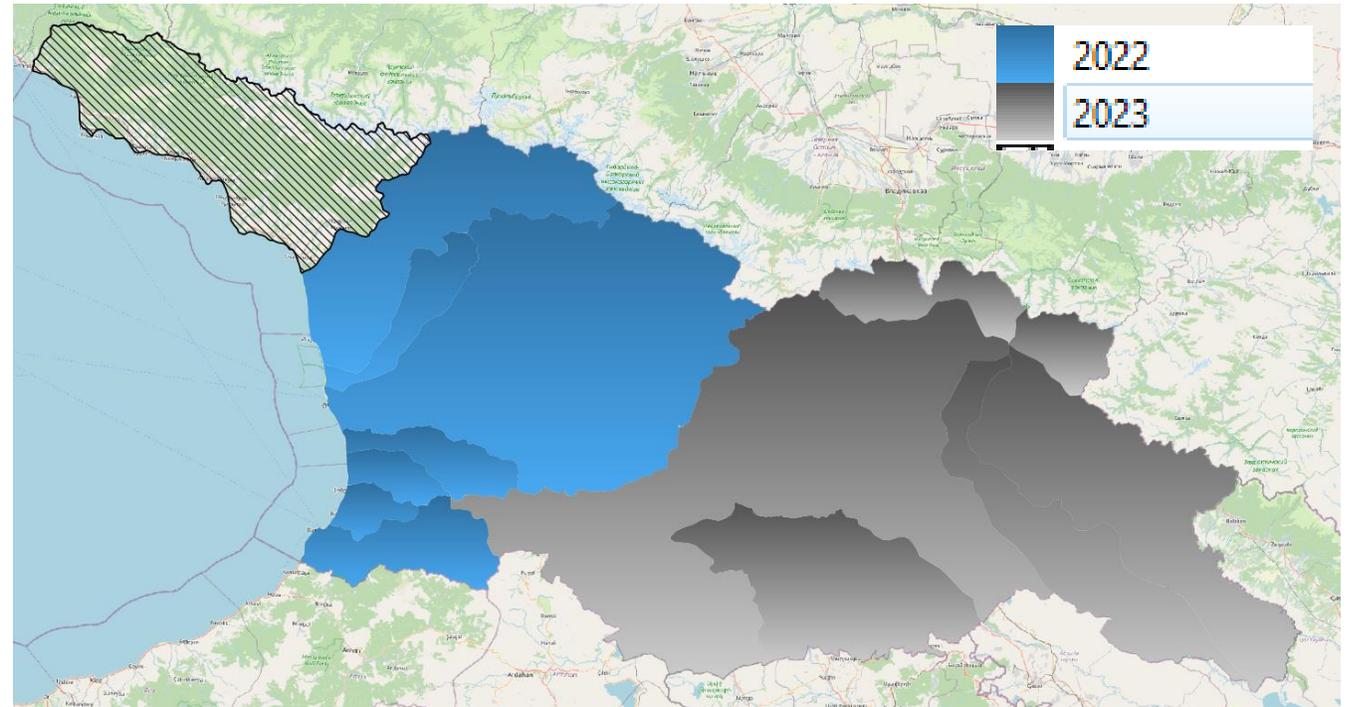
LiDAR Data Collection



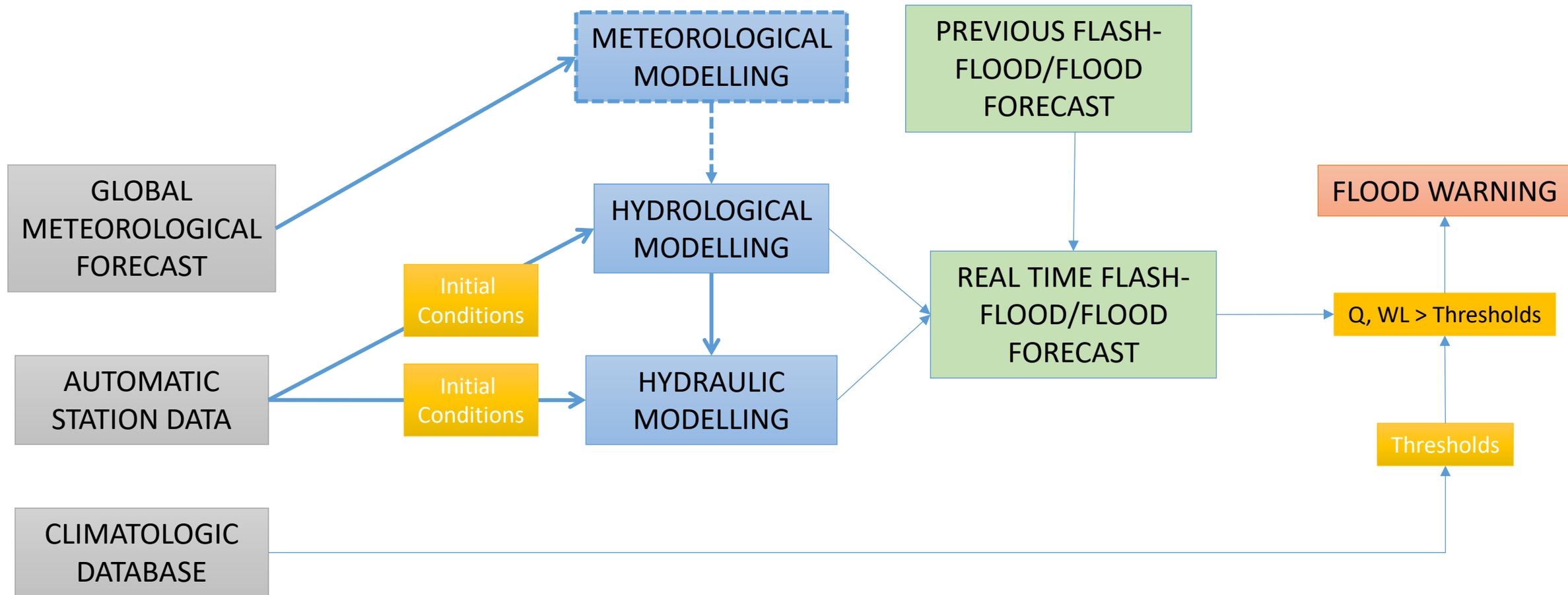
- Survey period: 2020-2021
- Coverage: 6400 km²
- Point cloud : 12 points per 1m²
- DEM Resolution: - 1m



- Return periods
2, 5, 25, 50, 100, 500 years
- Maps
 - Inundation
 - Depth
 - SWE
 - Velocity
 - Time of arrival
 - Flood Duration



Flood Forecasting - FFEWS approach



Flood Forecasting and EWS - DELFT-FEWS

v2022.02 (Stand alone)

NWP Models

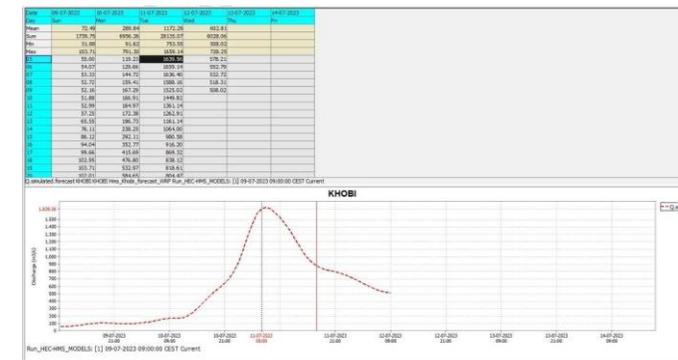
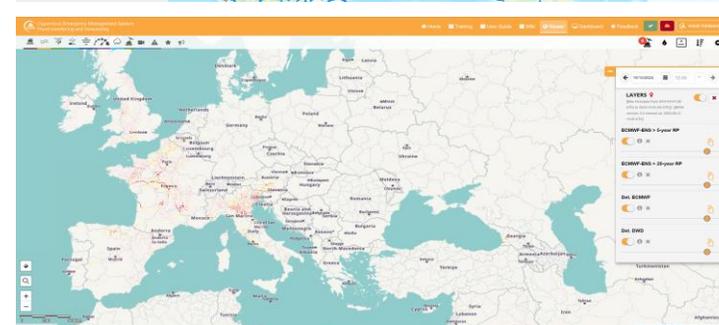
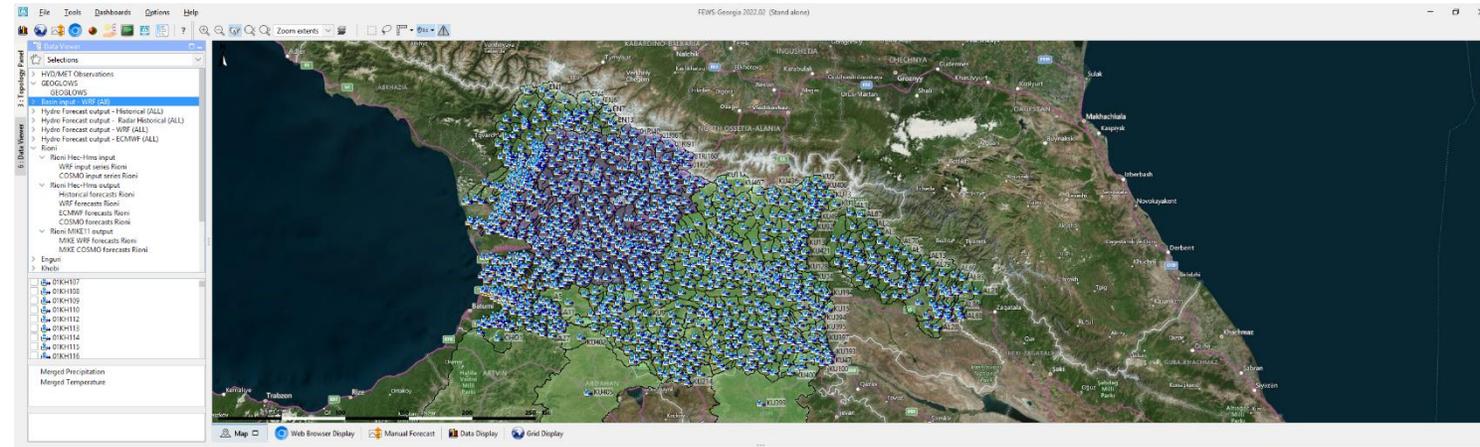
- ECMWF (EPS)
- WRF (1.5 km)

Hydrological Model

- HEC-HMS (Deficit and Constant)

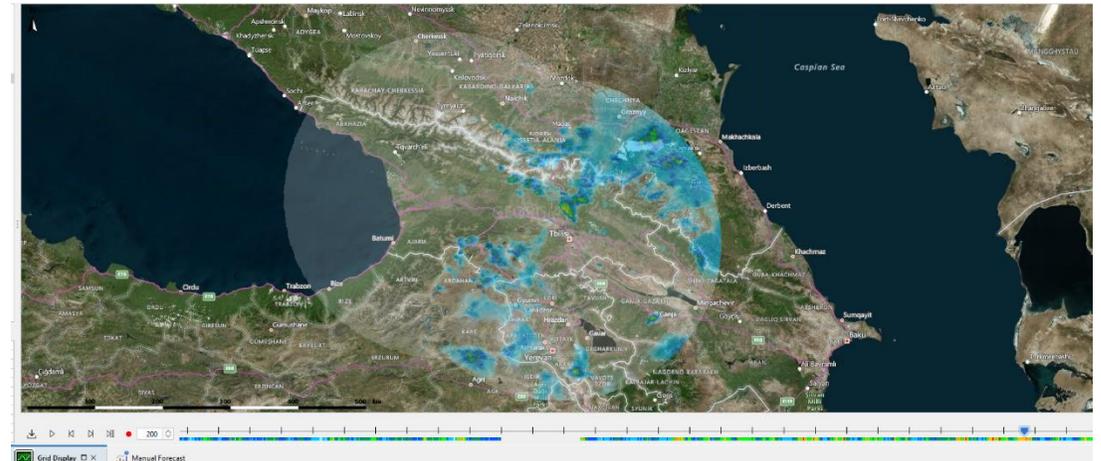
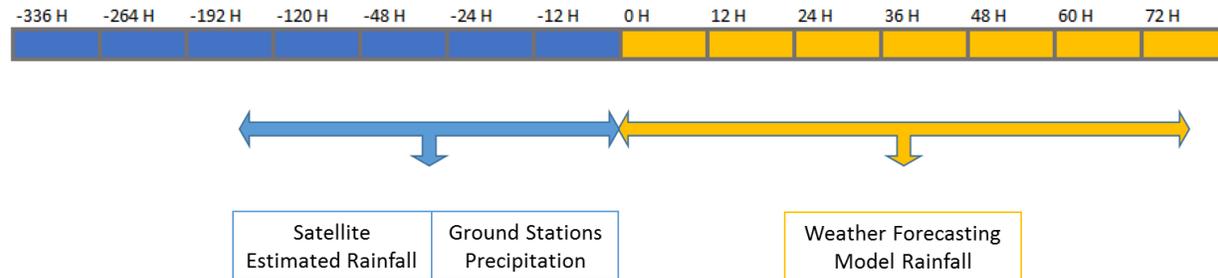
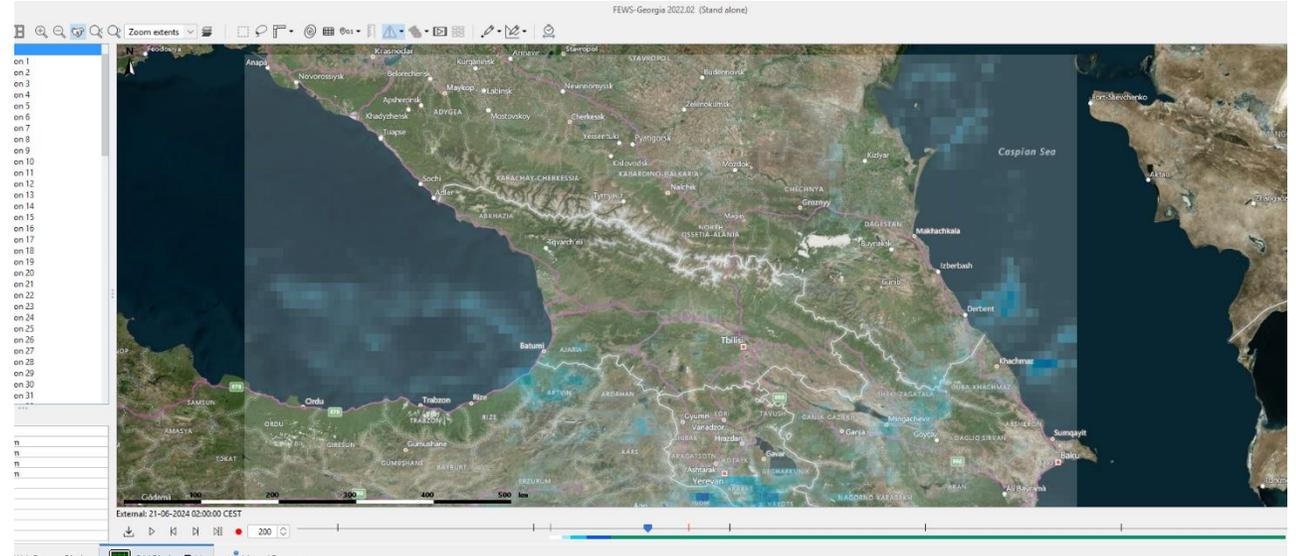
Hydraulic Models

- HEC-RAS
- MIKE 11



Numerical Weather Prediction Models in FEWS

Limited Area Model	Horizontal Resolution (km)	Global NWP/Boundary Conditions	Forecasting lead time	Runs per day
WRF	~1.5	ECMWF	90 hours	2
	~7	ECWMF (EPS) members		



HEC-HMS Model - Rioni River Basin

Simulation period: 1985-1988

Data used in HEC-HMS

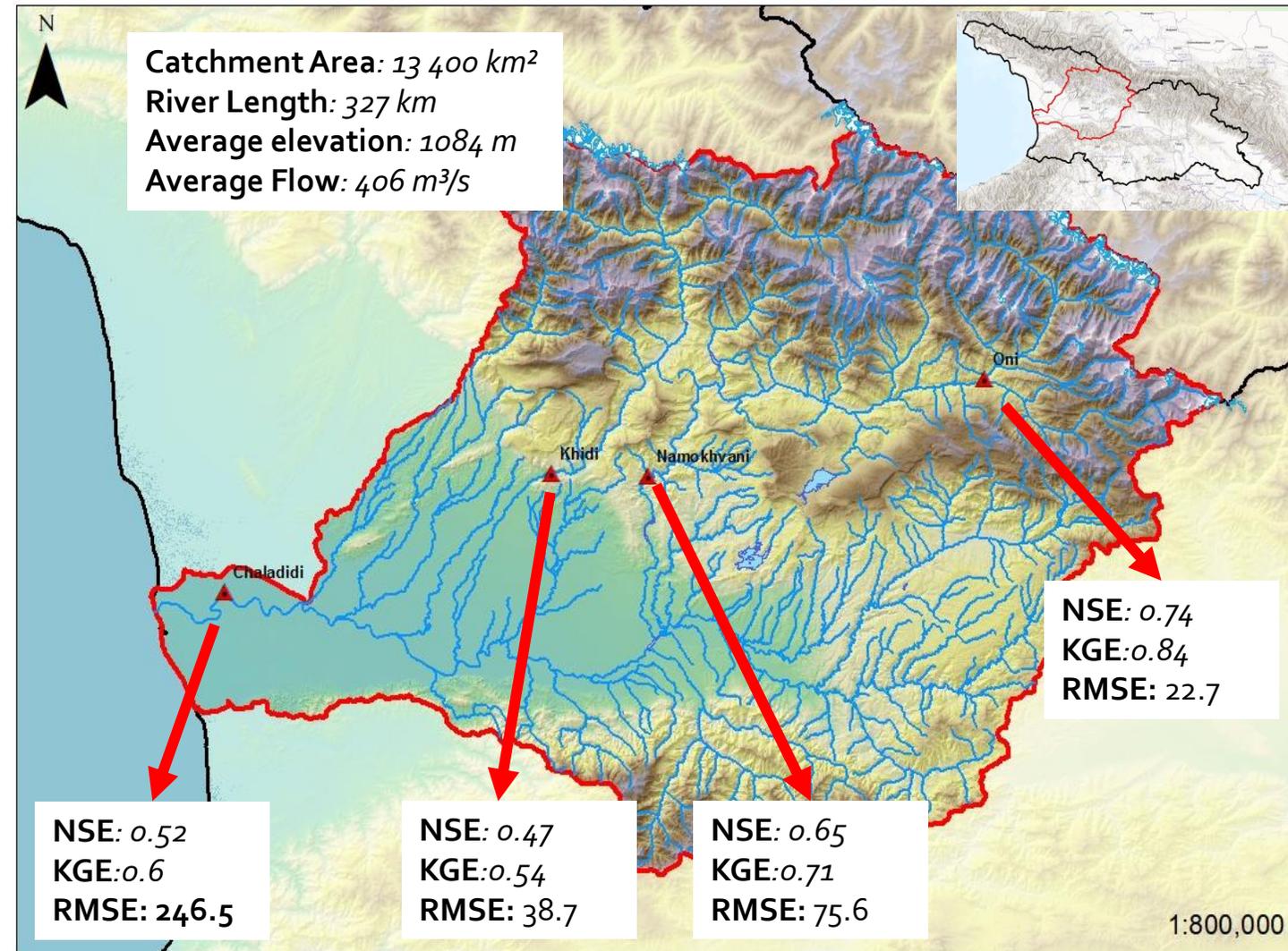
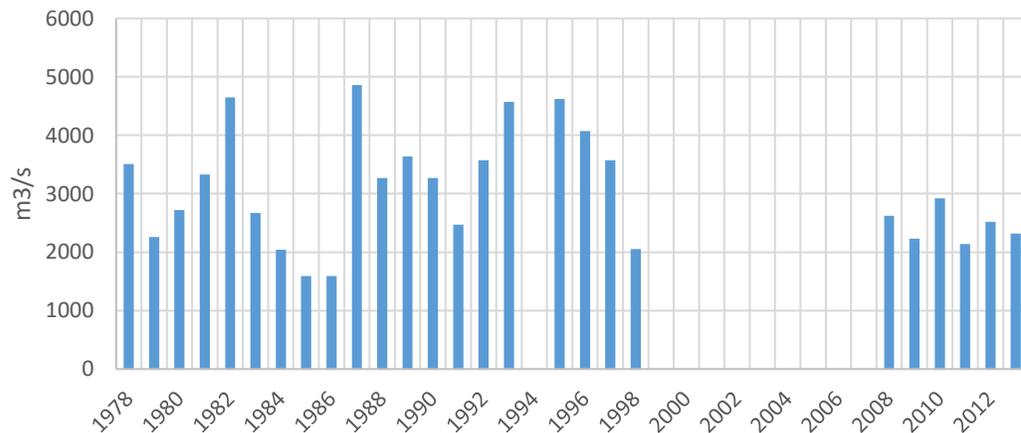
Precipitation & Temperature:

ERA5 hourly gridded data

Discharge:

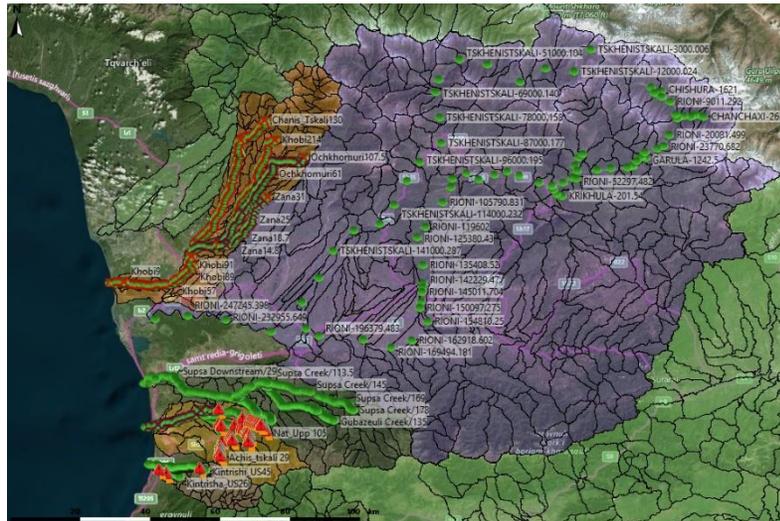
Observations daily flow

Annual Peak Flows - 1978-2013

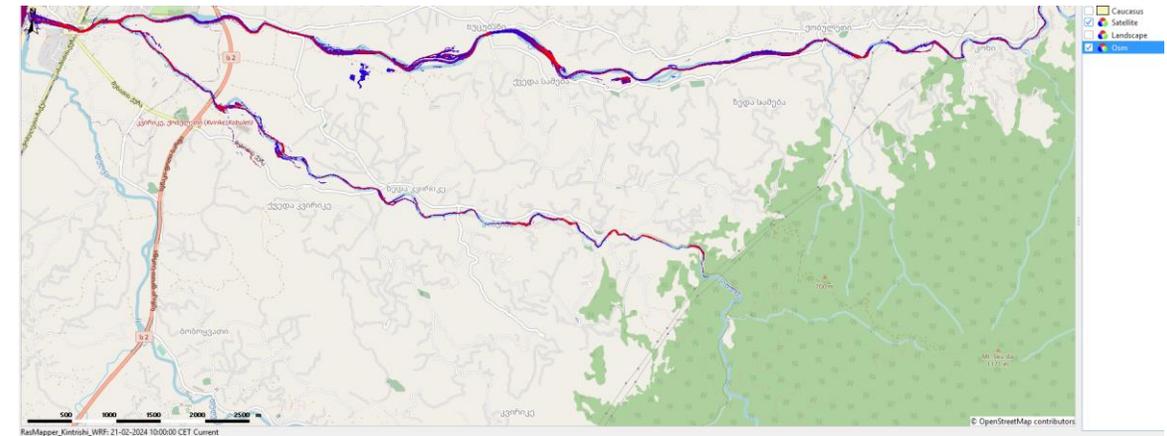


HEC-RAS Models

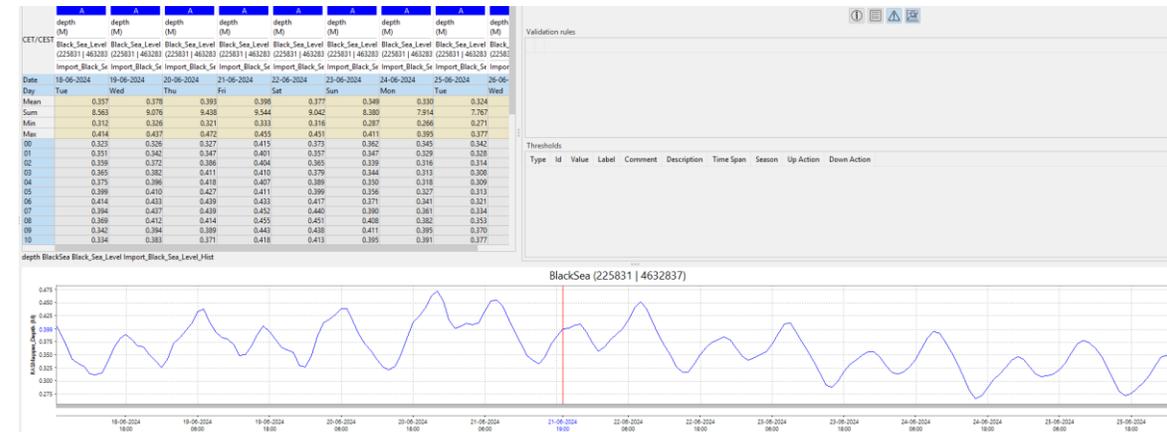
- Currently 7 river basins are included into Delft-FEWS



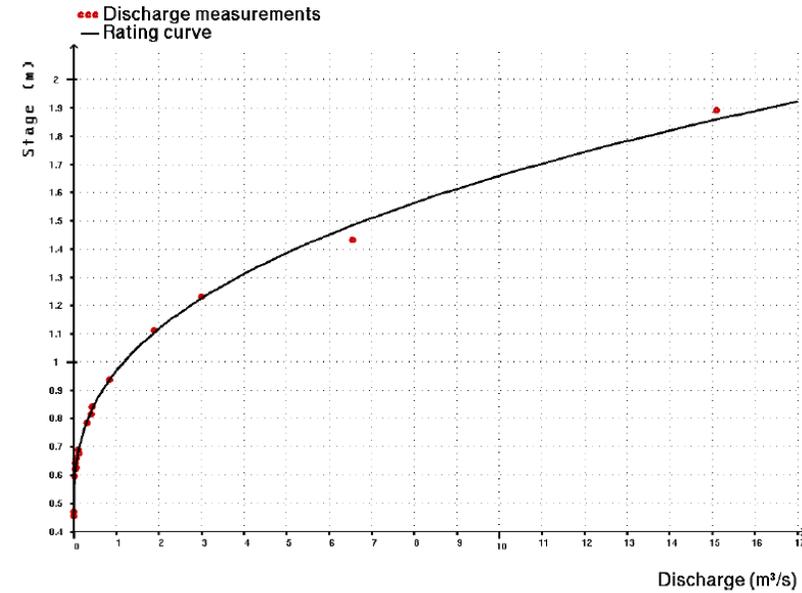
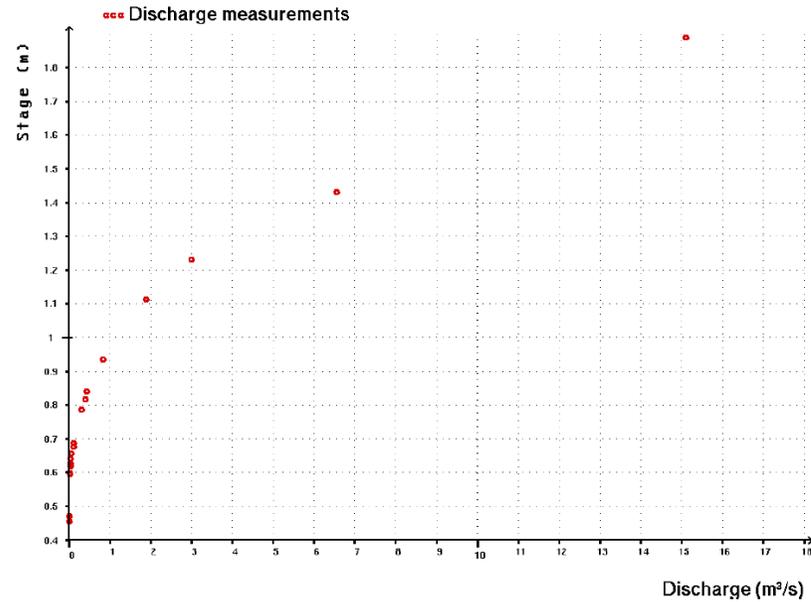
Flood Inundation in RAS Mapper - FEWS



The Black Sea BC – Copernicus MyOcean2



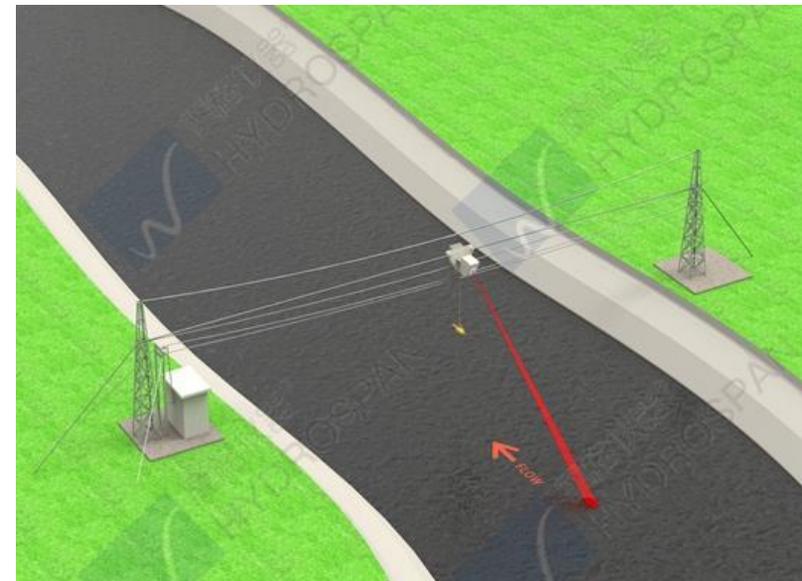
Challenge – Reliable Rating Curves



To establish reliable stage-discharge relationship curves, approximately 25-30 measurements are required annually

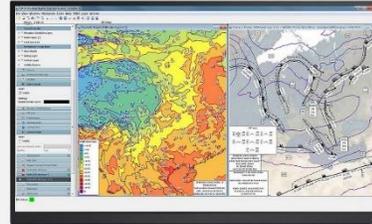


Challenge – Stationary Hydrometric Stations



ICT Systems Upgrade (Completion by 2025)

Data Collection and Analysis



Weather Warnings

Data Collection
System

Weather Forecasting
and Production System
SmartMet



LEPL NATIONAL
ENVIRONMENTAL AGENCY



ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Common Alerting Protocol

CAP Message

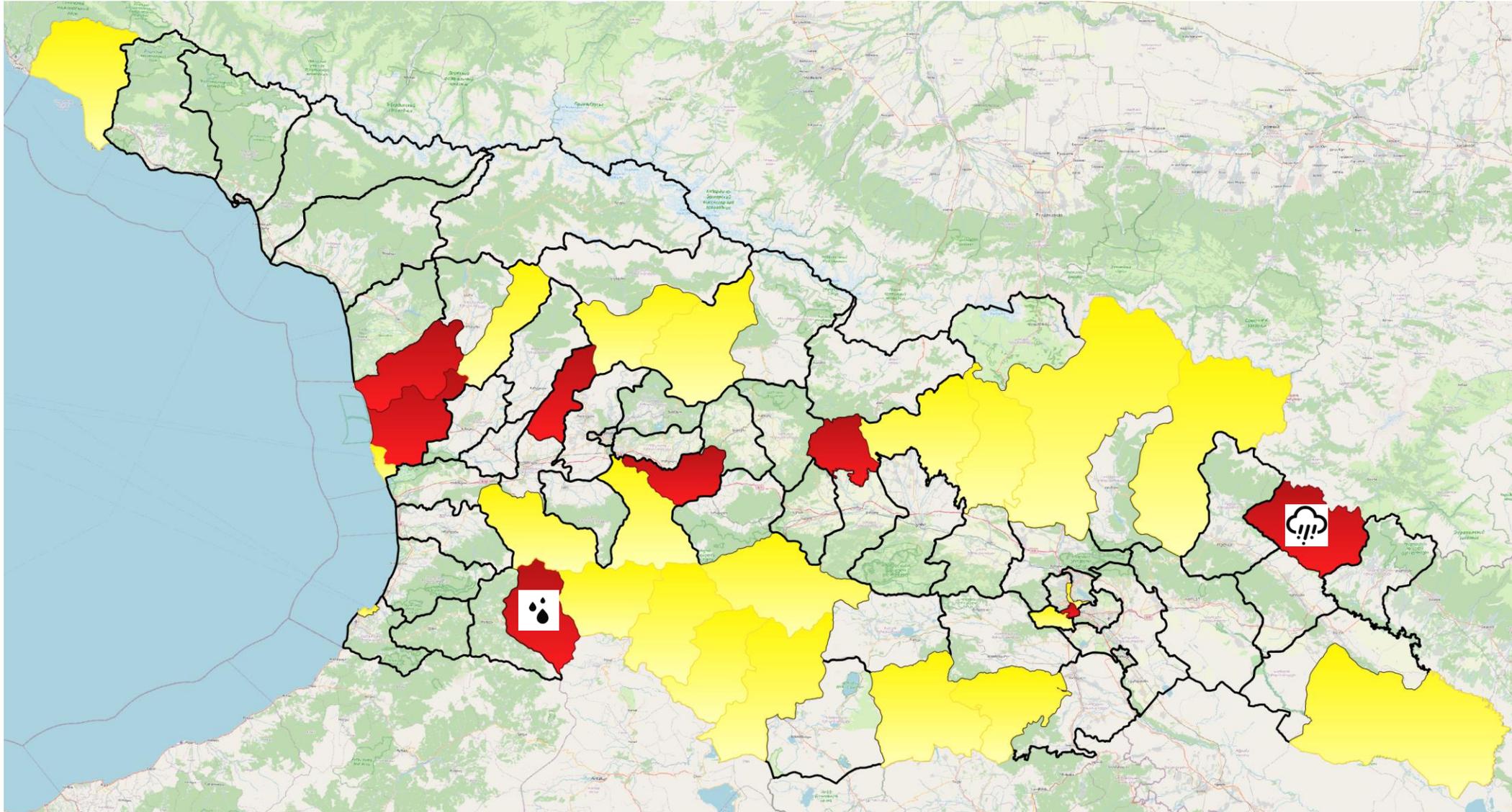


A.2. Severe Thunderstorm Warning

The following is a speculative example in the form of a CAP XML message.

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<?xml version = "1.0" encoding = "UTF-8"?>
<alert xmlns = "urn:oasis:names:tc:emergency:cap:1.1">
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  <sender>KSTO@NWS.NOAA.GOV</sender>
  <sent>2003-06-17T14:57:00-07:00</sent>
  <status>Actual</status>
  <msgType>Alert</msgType>
  <scope>Public</scope>
  <info>
    <category>Met</category>
    <event>SEVERE THUNDERSTORM</event>
    <responseType>Shelter</responseType>
    <urgency>Immediate</urgency>
    <severity>Severe</severity>
    <certainty>Observed</certainty>
    <eventCode>
      <valueName>same</valueName>
      <value>SVR</value>
    </eventCode>
    <expires>2003-06-17T16:00:00-07:00</expires>
    <senderName>NATIONAL WEATHER SERVICE SACRAMENTO CA</senderName>
    <headline>SEVERE THUNDERSTORM WARNING</headline>
    <description> AT 254 PM PDT.. NATIONAL WEATHER SERVICE DOPPLER RADAR INDICATED A SEVERE THUNDERSTORM OVER SOUTH CENTRAL ALPINE COUNTY...OR ABOUT 18 MILES SOUTHEAST OF KIRKWOOD...MOVING SOUTHWEST AT 5 MPH. HAIL...INTENSE RAIN AND STRONG DAMAGING WINDS ARE LIKELY WITH THIS STORM.</description>
    <instruction>TAKE COVER IN A SUBSTANTIAL SHELTER UNTIL THE STORM PASSES.</instruction>
    <contact>BARUFFALDI/JUSKIE</contact>
    <area>
      <areaDesc>EXTREME NORTH CENTRAL TUOLUMNE COUNTY IN CALIFORNIA, EXTREME NORTHEASTERN CALAVERAS COUNTY IN CALIFORNIA, SOUTHWESTERN ALPINE COUNTY IN CALIFORNIA</areaDesc>
      <polygon>38.47, -120.14 38.34, -119.95 38.52, -119.74 38.62, -119.89 38.47, -120.14</polygon>
      <geocode>
        <valueName>FIPS6</valueName>
        <value>006109</value>
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</alert>
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Warning Dissemination at the National Level



Warning Dissemination at the International Level

Severe Weather Information Centre (WMO)

Severe Weather Information Centre 3.0
A Core Component of the WMO Global Multi-hazard Alert System (GMAS) Framework Supporting UN Early Warnings for All Initiative

Home (Map) | Table View | Sources of Data | Links | About | Notes to User | Timezone UTC+0

Severe Weather Information Centre, enhancing the availability of authoritative warnings and information related to extreme and/or potentially high-impact weather, water, and climate events from WMO Members, is one of the core components of WMO GMAS Framework in support of the Early Warnings for All Initiative.

Display all CAP alerts (UTC+0) | 24 Mar (Mon) | 25 Mar (Tue) and onwards

2034 alerts
Updated on: 2025-03-24 12:06 UTC
Sorted by the latest warning

Regions: Global | WMO Members: Please select

Extreme (12) | Severe (154) | Moderate (953) | Minor (882) | Unknown (33)

- India 20
Region II | National Disaster Management Authority
- China 795
Region II | China Meteorological Administration
- Canada 12
Region IV | Meteorological Service of Canada
- Australia 39
Region V | Bureau of Meteorology
- United States of America 250
Region IV | National Weather Service
- Kazakhstan 260
Region II | Ministry of Energy of the Republic of Kazakhstan

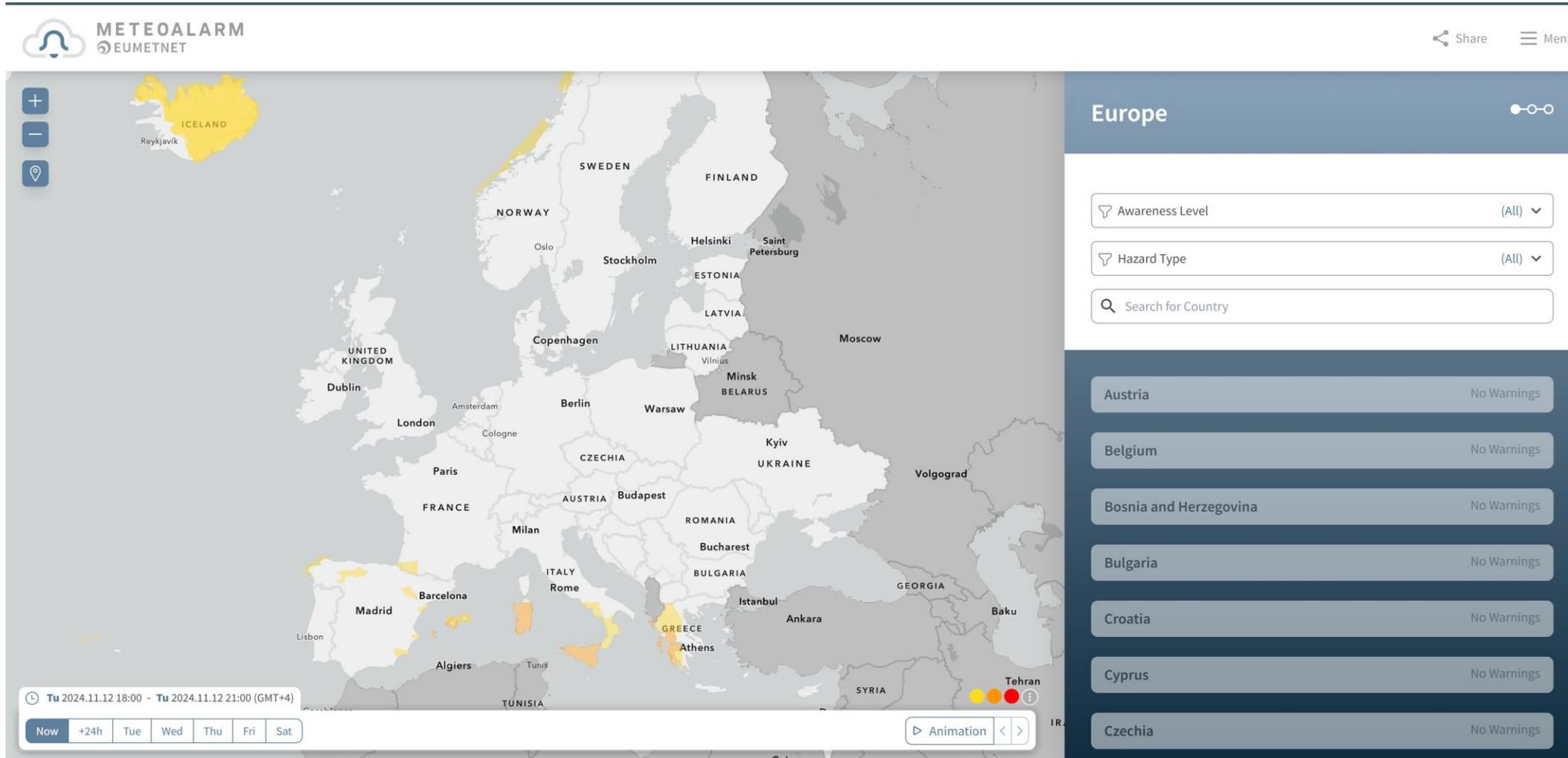
CAP Severity: Extreme | Severe | Moderate | Minor | Unknown

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Warning Dissemination at the International Level

Meteoalarm



The screenshot displays the Meteoalarm website interface. At the top left, the logo for METEOALARM and EUMETNET is visible. To the right, there are links for 'Share' and 'Menu'. The main content area is divided into two sections. On the left is a map of Europe with various countries highlighted in yellow and orange, indicating warning levels. On the right is a sidebar with a title 'Europe' and a search bar. Below the search bar are two dropdown menus for 'Awareness Level' and 'Hazard Type', both set to '(All)'. Below these are several rows, each representing a country and its current warning status. The countries listed are Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, and Czechia, all of which currently show 'No Warnings'. At the bottom of the map, there is a time range selector showing 'Tu 2024.11.12 18:00 - Tu 2024.11.12 21:00 (GMT+4)' and a navigation bar with buttons for 'Now', '+24h', 'Tue', 'Wed', 'Thu', 'Fri', and 'Sat'. There is also an 'Animation' button and a legend with three colored circles (yellow, orange, red) and an information icon.

Country	Warning Status
Austria	No Warnings
Belgium	No Warnings
Bosnia and Herzegovina	No Warnings
Bulgaria	No Warnings
Croatia	No Warnings
Cyprus	No Warnings
Czechia	No Warnings

THANK YOU FOR YOUR ATTENTION!



Ioseb.Kinkladze@nea.gov.ge