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)

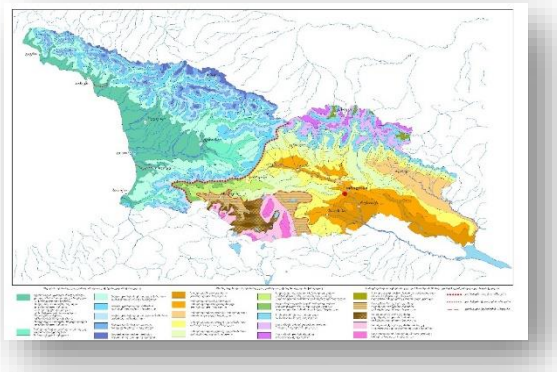
National Environment Agency of Georgia
Hydrometeorology Department

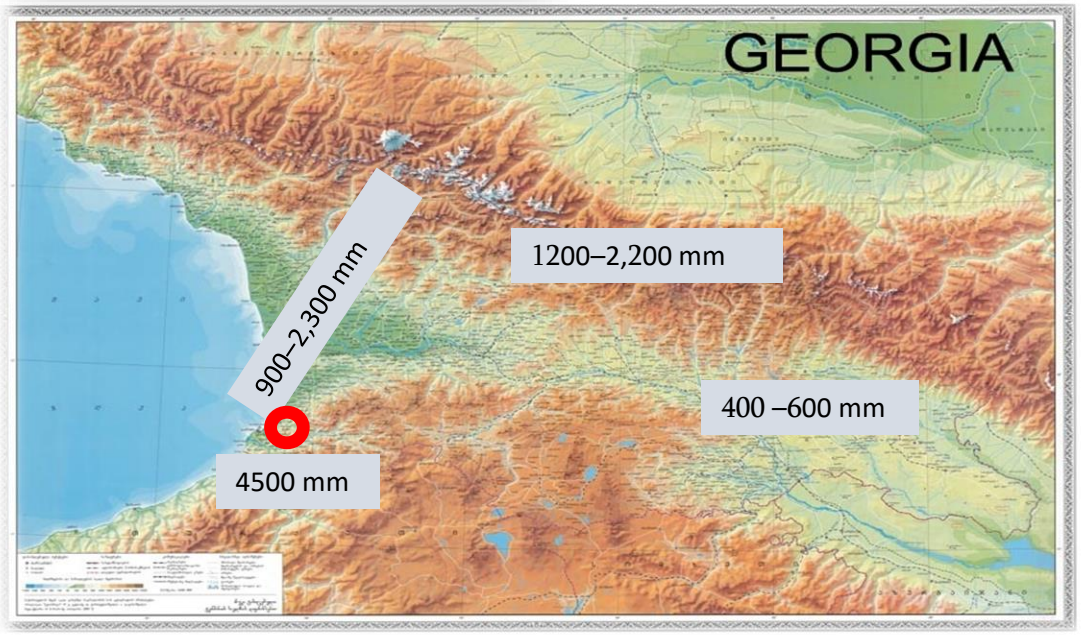
Ioseb Kinkladze

8 July 2025

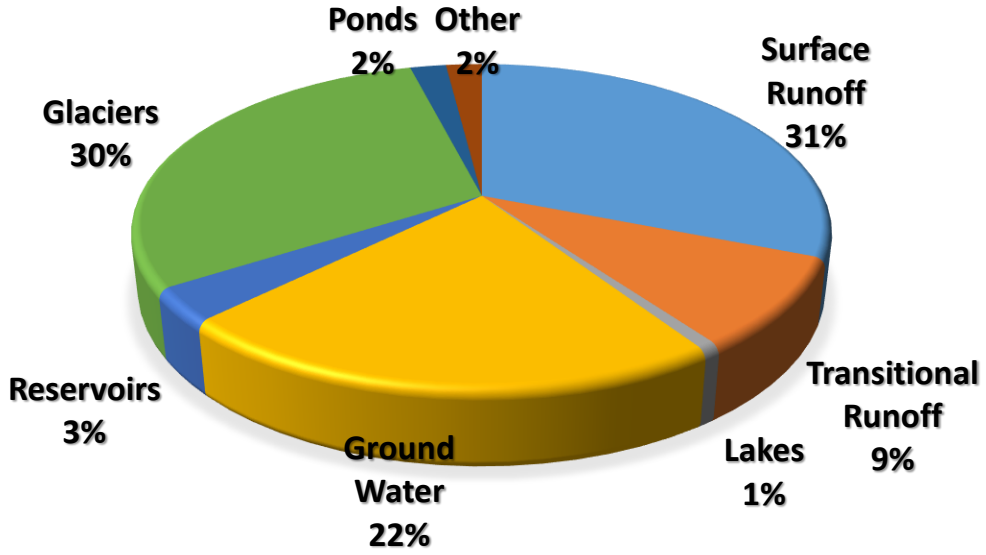
About the Country

- Population - 3.9 million
- Area - 69.700 km^2
- 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).

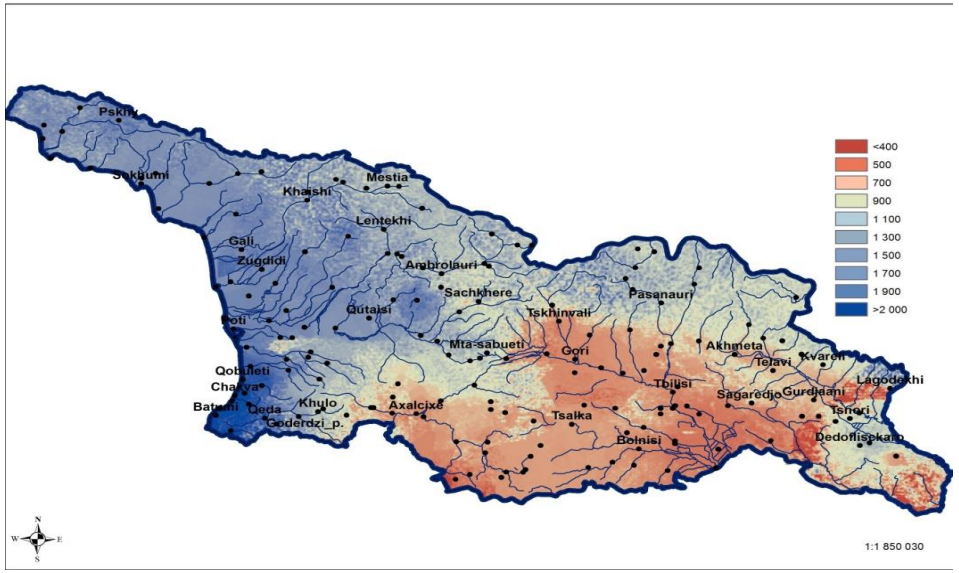




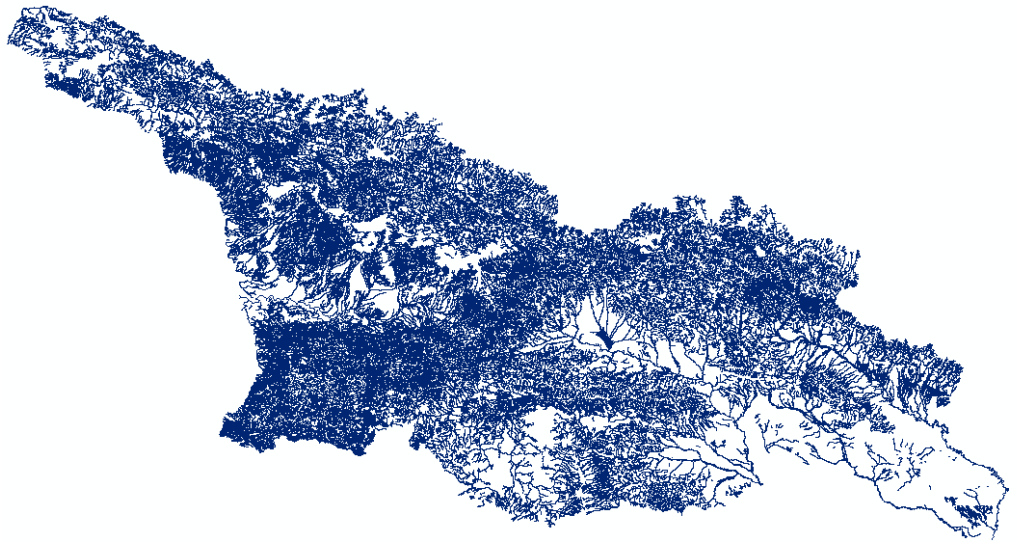
Water Resources in Georgia



Precipitation Annual Sums (1961-1900)



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

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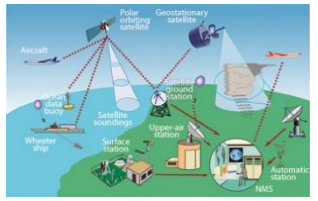
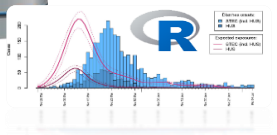
Meteorological and Hydrological Observation

Data collection and dissemination at national and international level

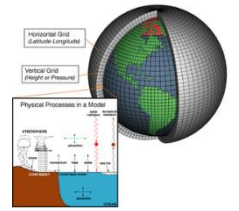


Hist



Separate agencies for Aviation and Marine Services

Hazard Assessment and Mapping



Weather and hydrological short, medium and long term forecasting

Forecasting and warning dissemination

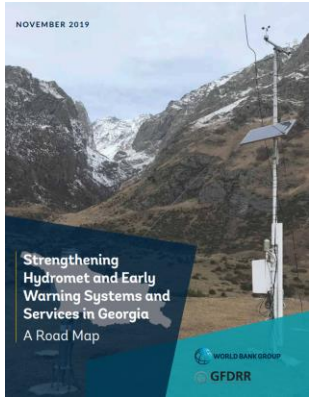
International Cooperation

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

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1832 – fragmented observation started;

1844 – established Tbilisi magnetic-meteorological (geophisical) observatory

1850 –Glaciological expeditions;

1883 – Agrometeorological observation;

1904 – actinometric observation;

1905 – hydrological observation;

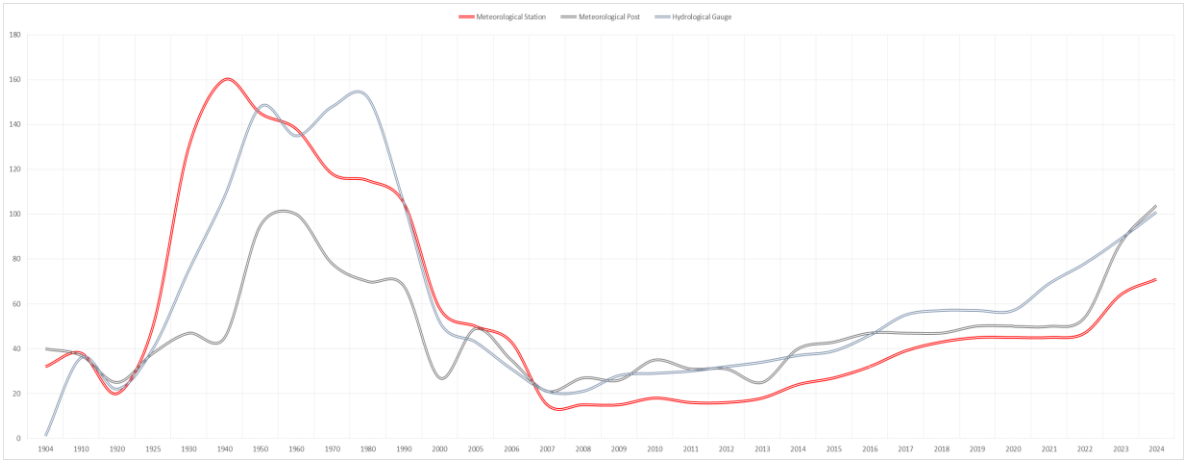
1932 – Snow depth observation by field expeditions;

1937 – air soundings;

1964 – Black Sea water level and meteorological observations;

1967 – Cloud seeding;

1988 – Snow avalanche artificial triggering



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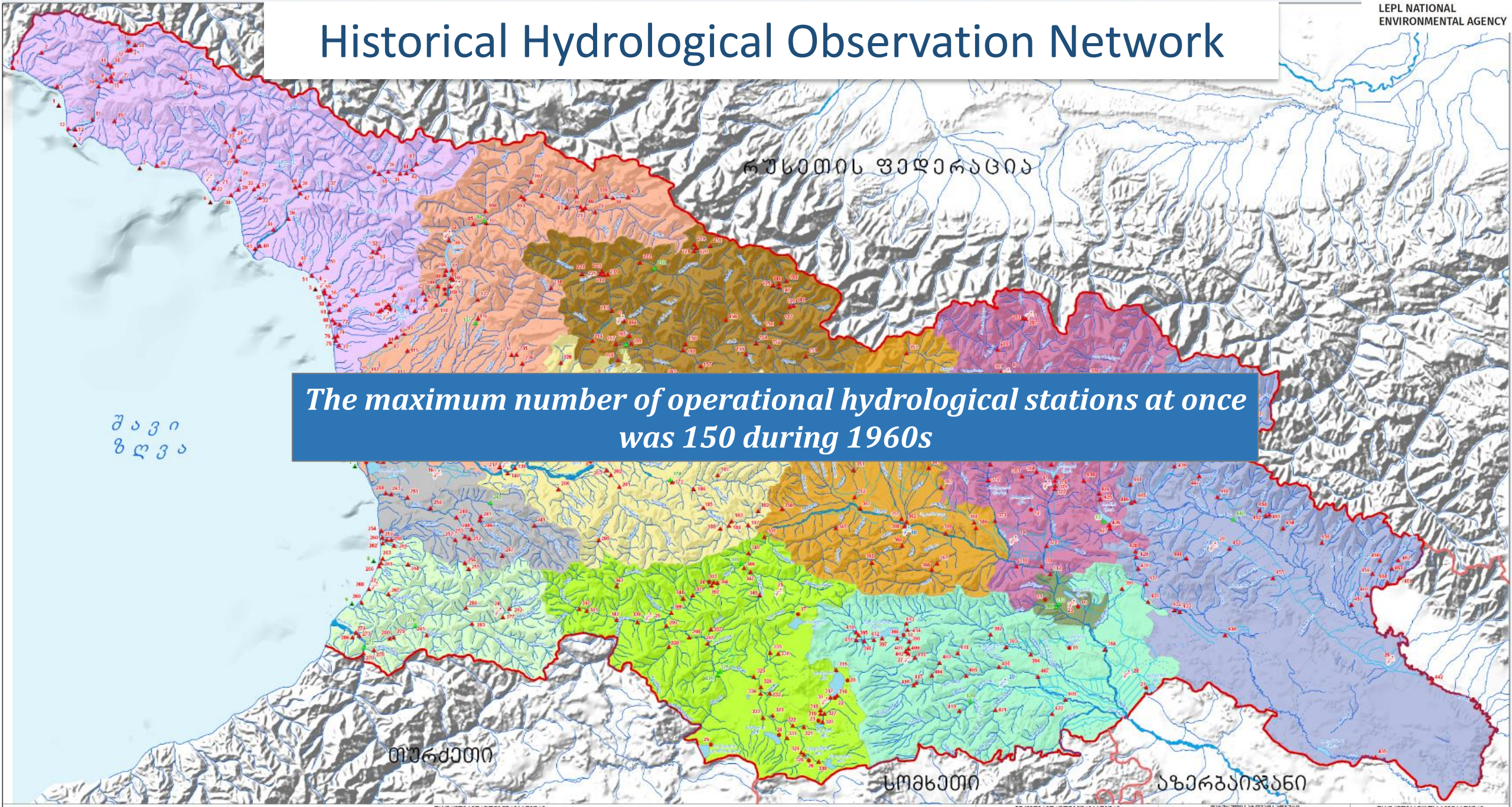
Historical Hydrological Observation Network



The maximum number of operational hydrological stations at once was 150 during 1960s

Current Observing Systems

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Meteorological Stations – 145

Hydrological Gauges – 78

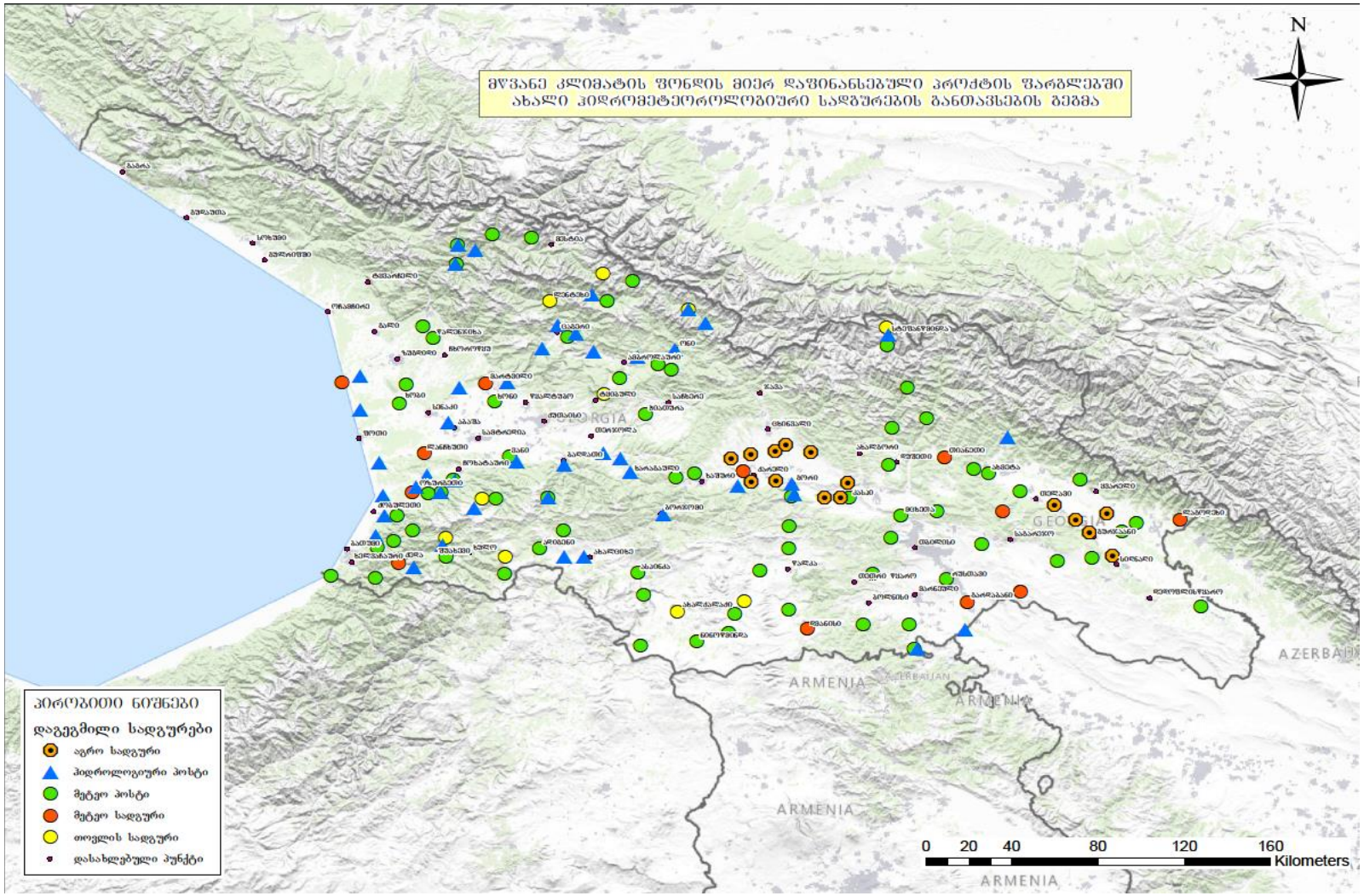
Weather Radars - 2

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

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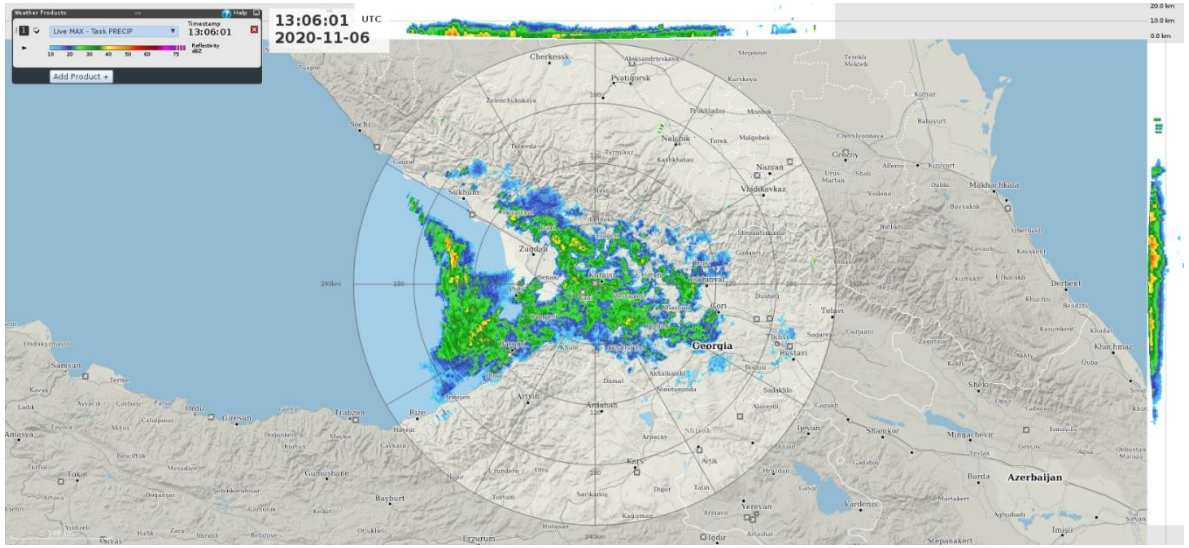

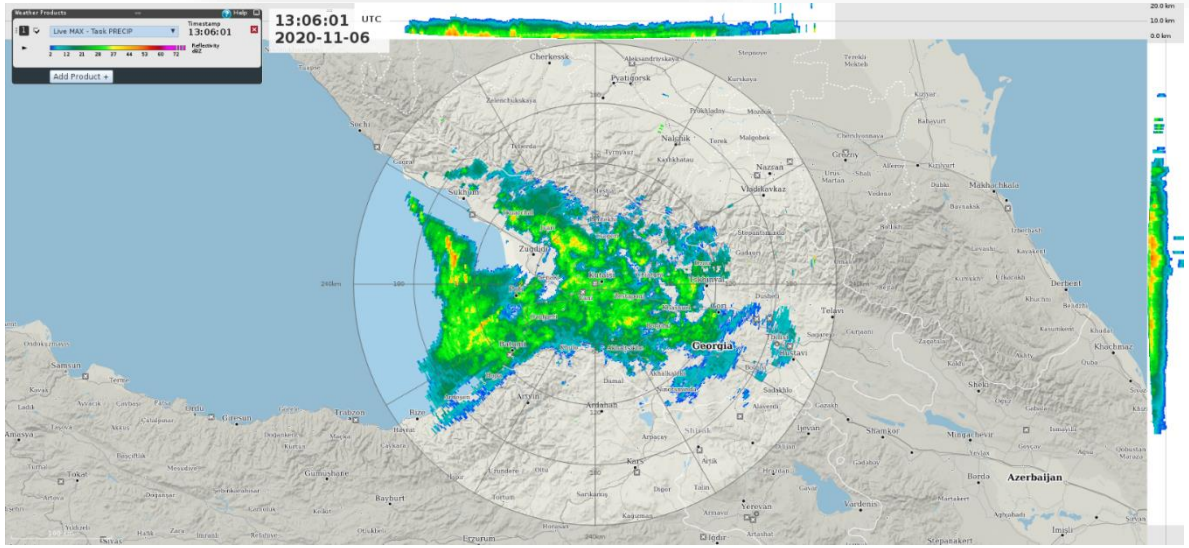

Hydrological Database System

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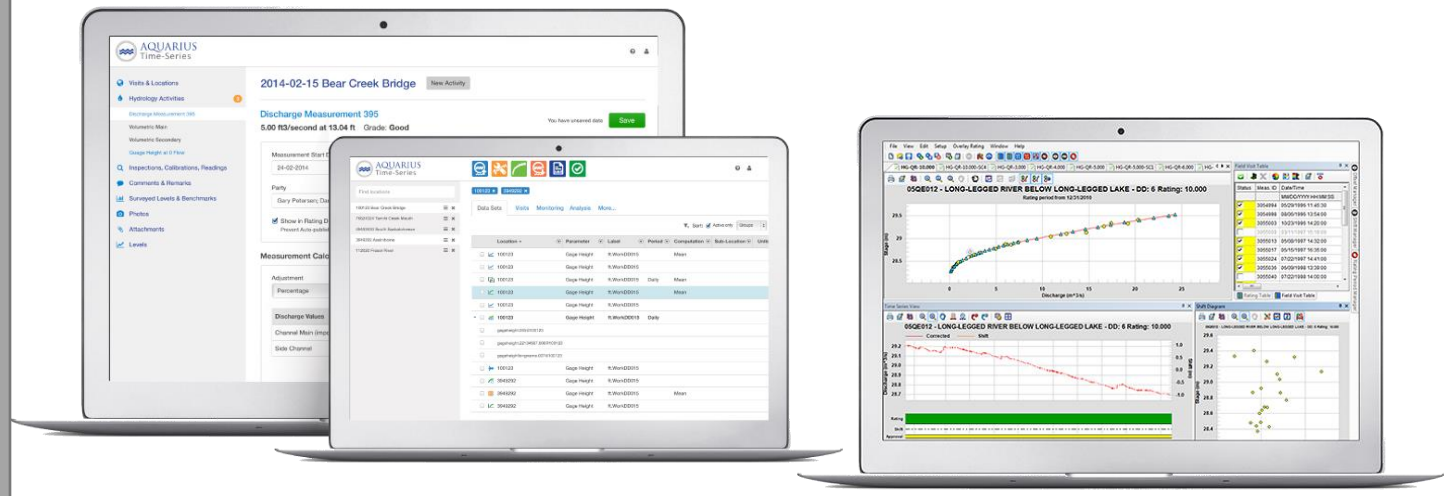
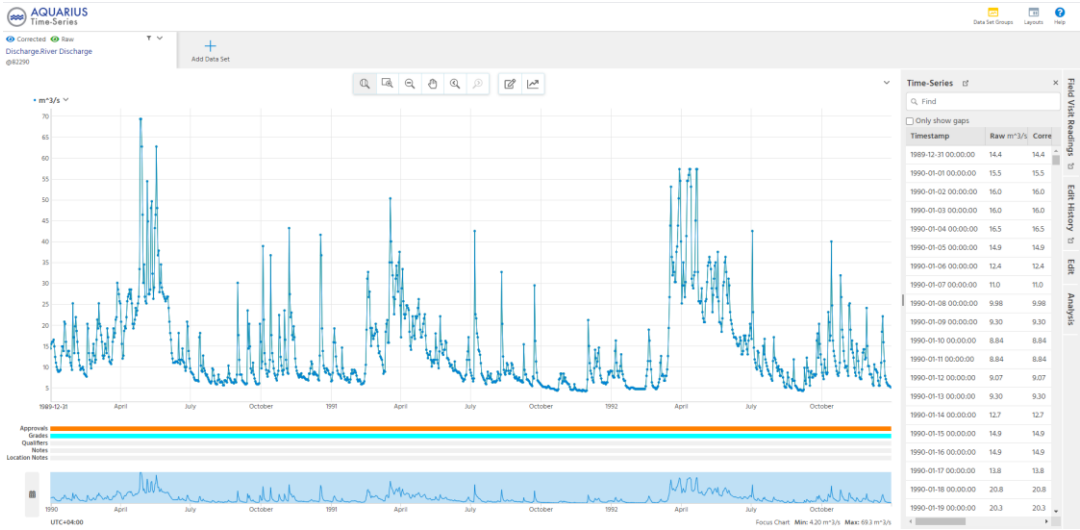
Hydrological Database System

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

GREEN CLIMATE FUND

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

შვედეთი
Sverige

UNDP

Reducing the risk of climate-driven disasters

7 Hazards

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

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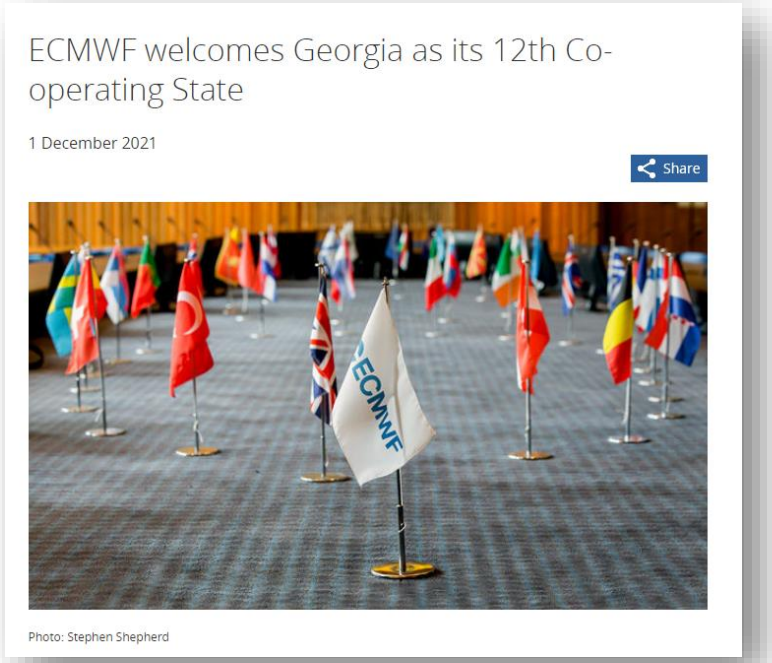
Key Activities

- 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)



Flood Hazard/Risk Mapping

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FLOOD HAZARD

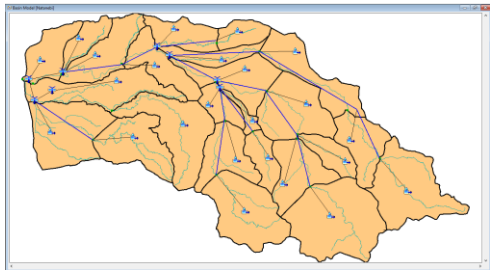
Methodologies and procedures for hydrological analysis for the purpose of flood hazard mapping data analysis for Georgia

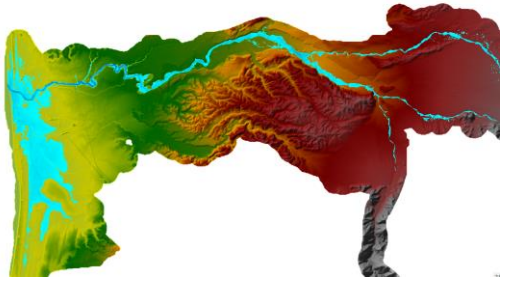
Methodology for

Flood Hazard

modelling and mapping for georgia (hydraulic modelling)

2022





Hydrological Modelling
HEC-HMS

Hydraulic Modelling

HEC-RAS 2D

GIS Mapping

Bathymetric Survey

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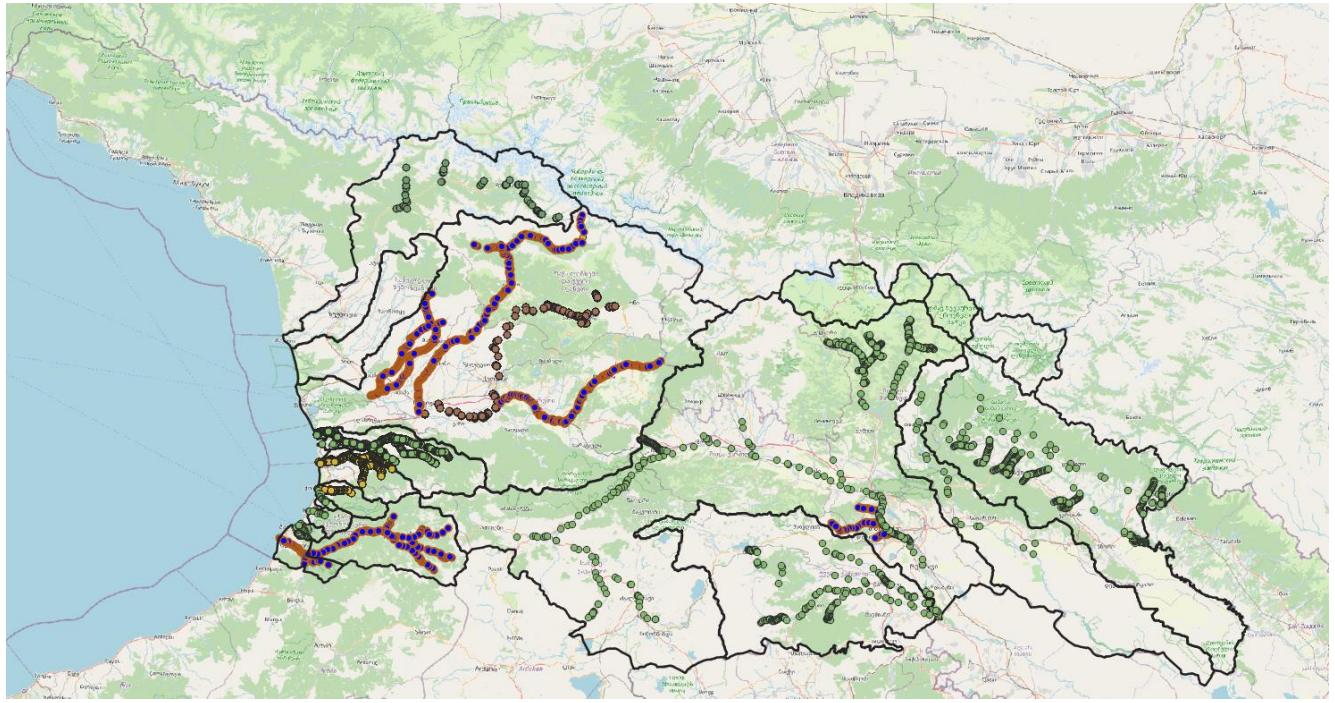
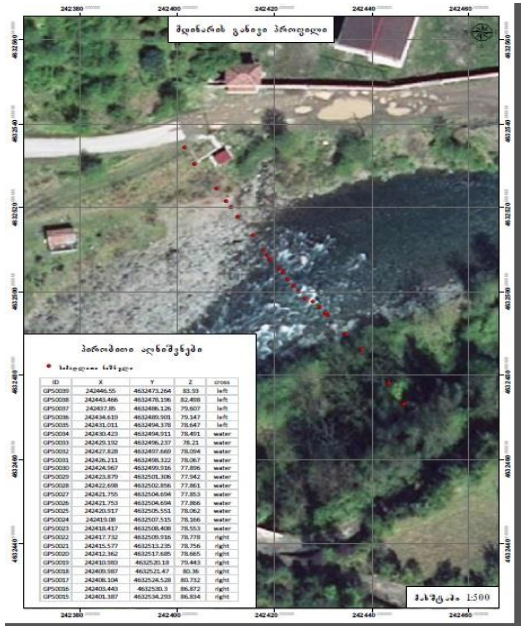
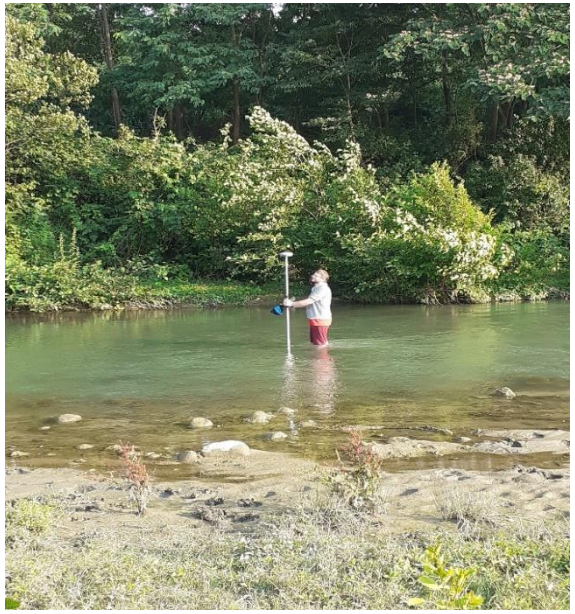
- Bathymetric survey has been conducted for the entire country







LiDAR Data Collection

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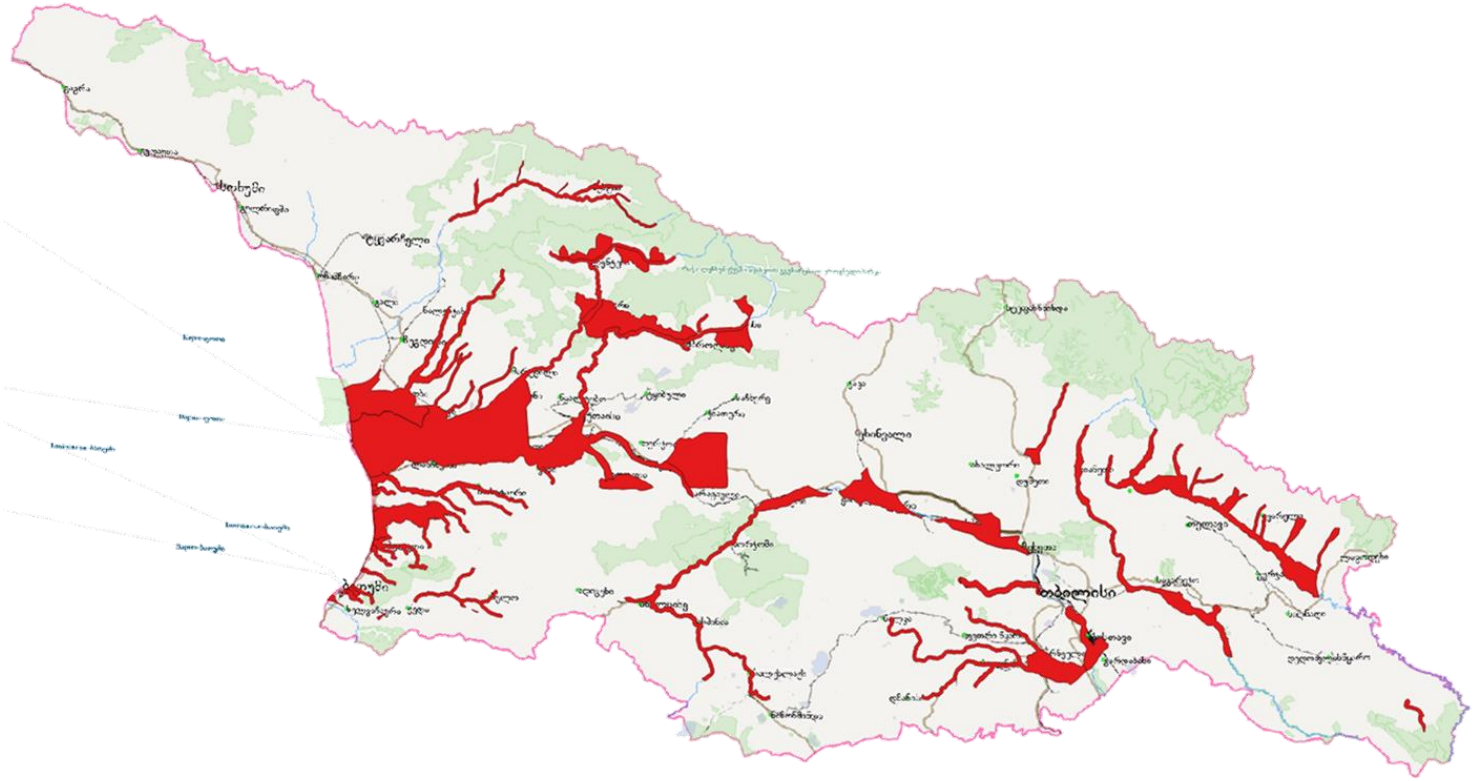
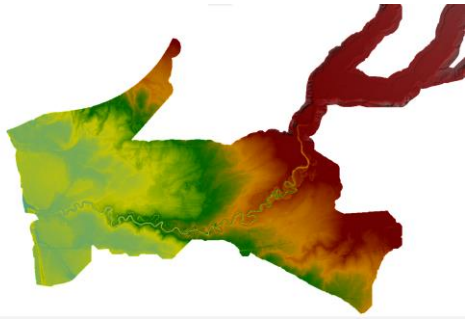


- Survey period: 2020-2021
- Coverage: 6400 km²
- Point cloud : 12 points per 1m²
- DEM Resolution: - 1m



Flood Hazard/Risk Mapping

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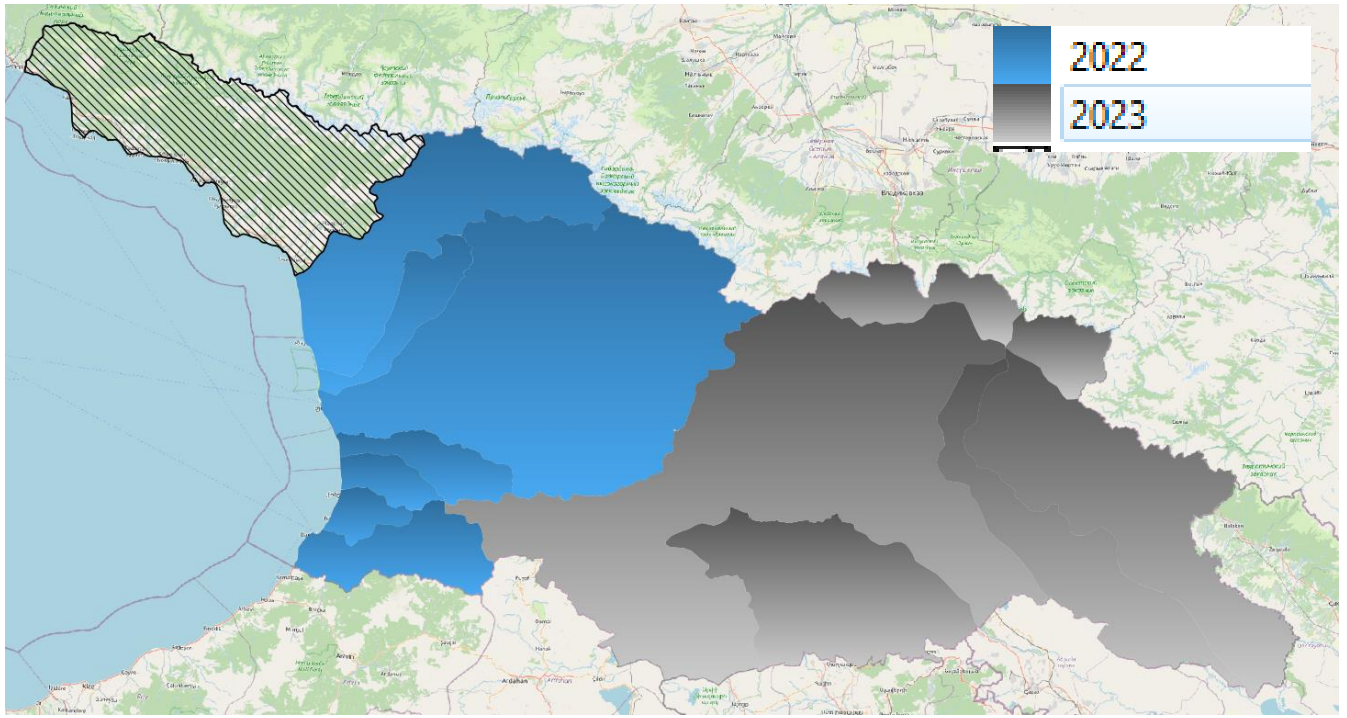
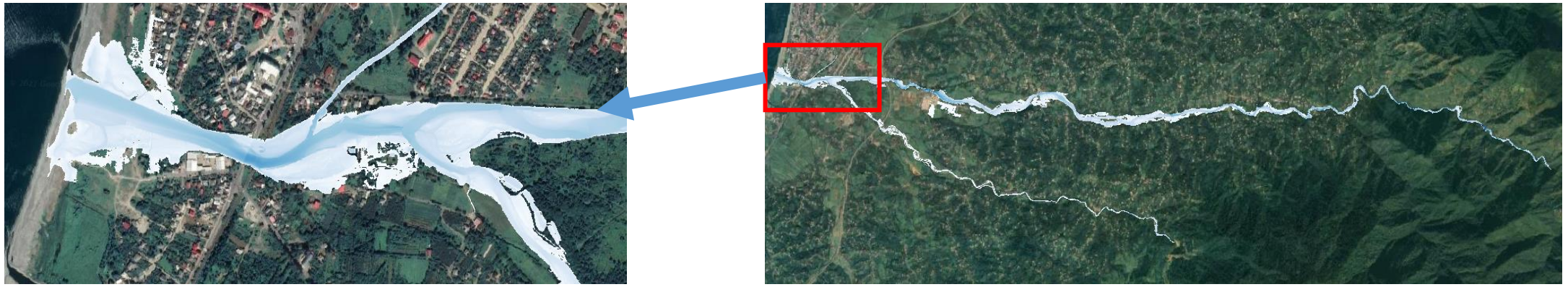
- Return periods
  2, 5, 25, 50, 100, 500 years

- Maps
  - Inundation
  - Depth
  - SWE
  - Velocity
  - Time of arrival
  - Flood Duration





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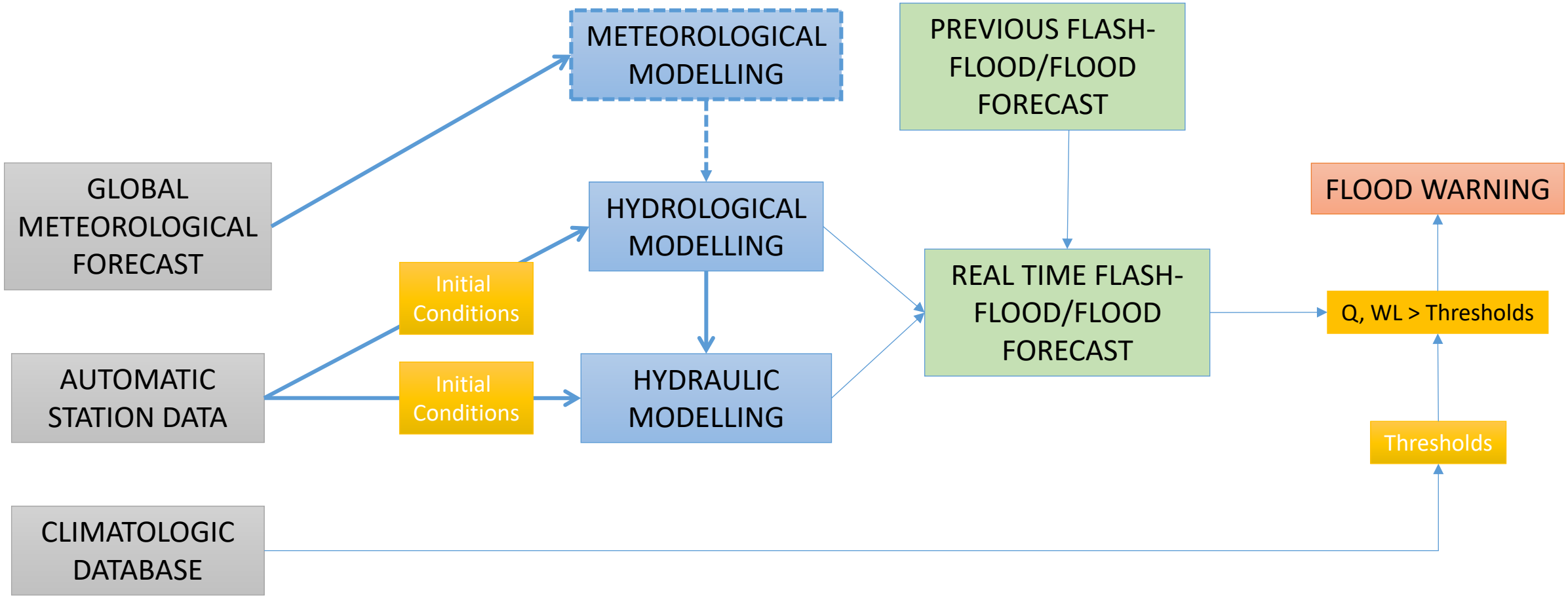
Flood Forecasting - FFEWS approach



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Flood Forecasting and EWS - DELFT-FEWS

v2022.02 (Stand alone)

NWP Models

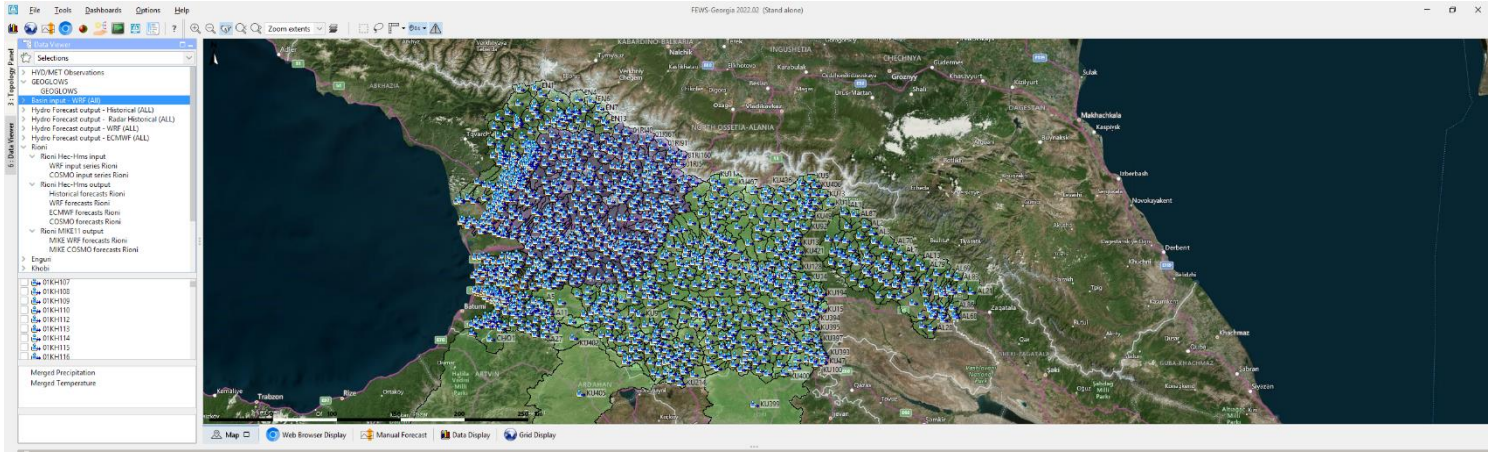
- ECMWF (EPS)
- WRF (1.5 km)

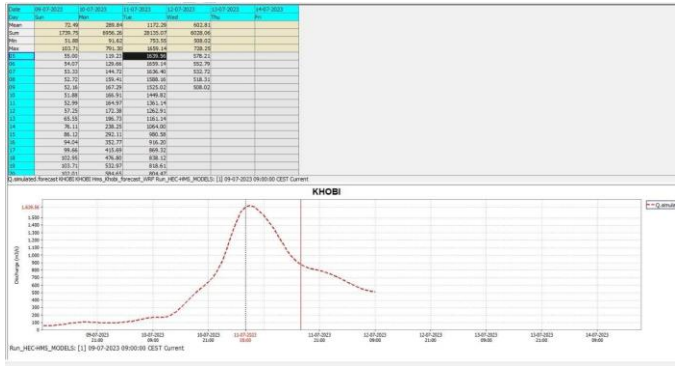
Hydrological Model

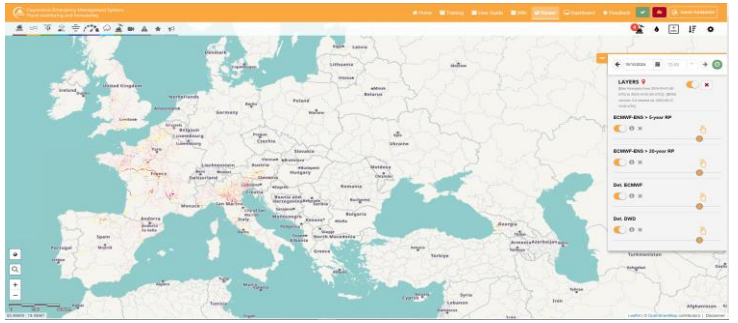
- HEC-HMS (Deficit and Constant)

Hydraulic Models

- HEC-RAS
- MIKE 11







Numerical Weather Prediction Models in FEWS

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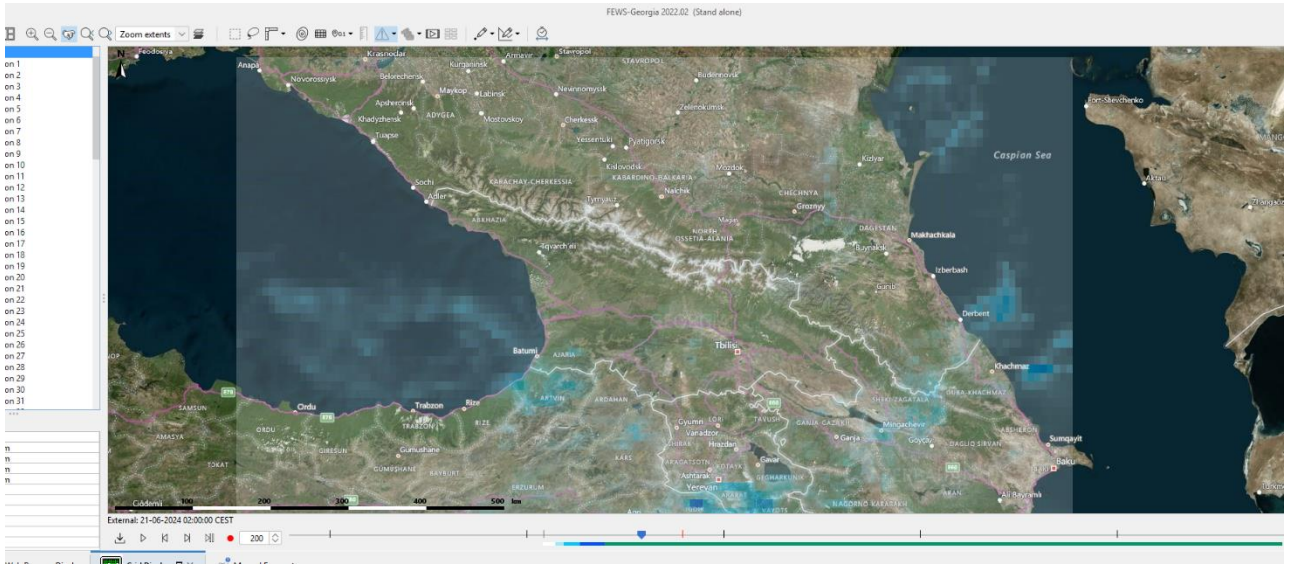
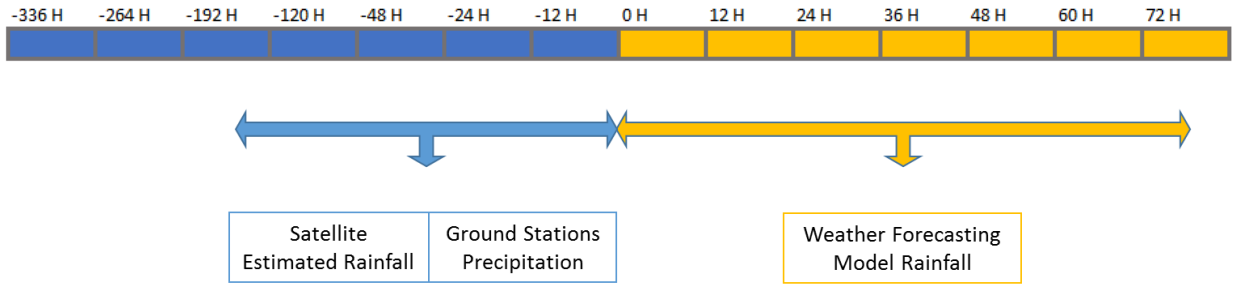
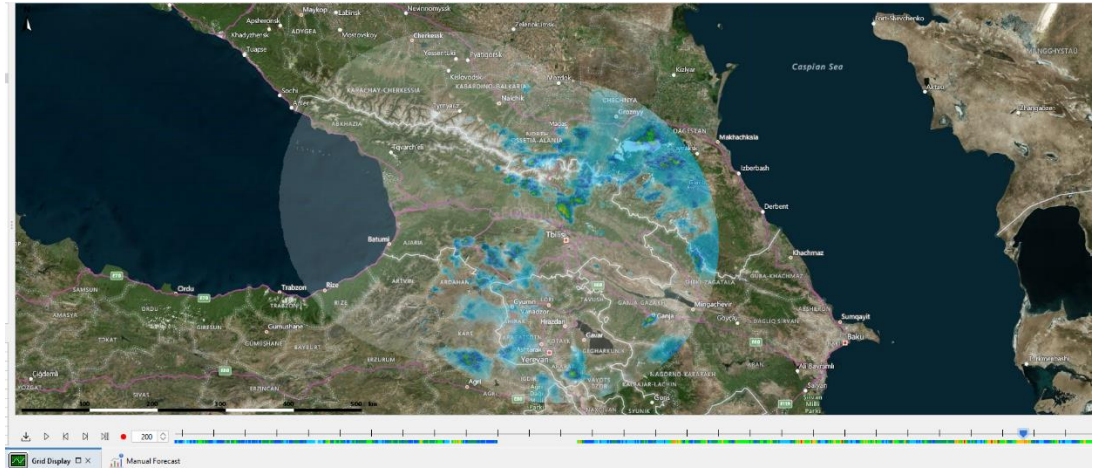
Limited Area Model	Horizontal Resolution (km)	Global NWP/Boundary Conditions	Forecasting lead time	Runs per day
WRF	~1.5	ECMWF	90 hours	2
	~7	ECWMF (EPS) members		





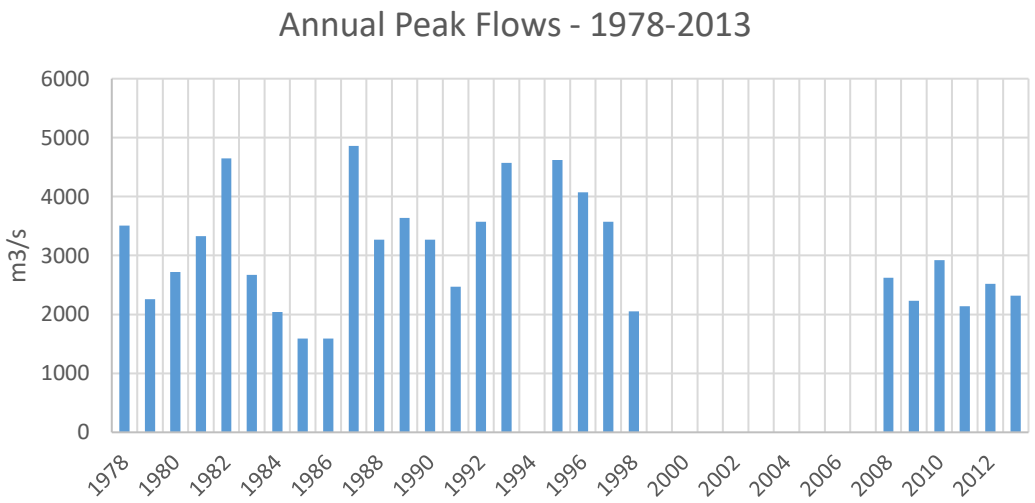


HEC-HMS Model - Rioni River Basin

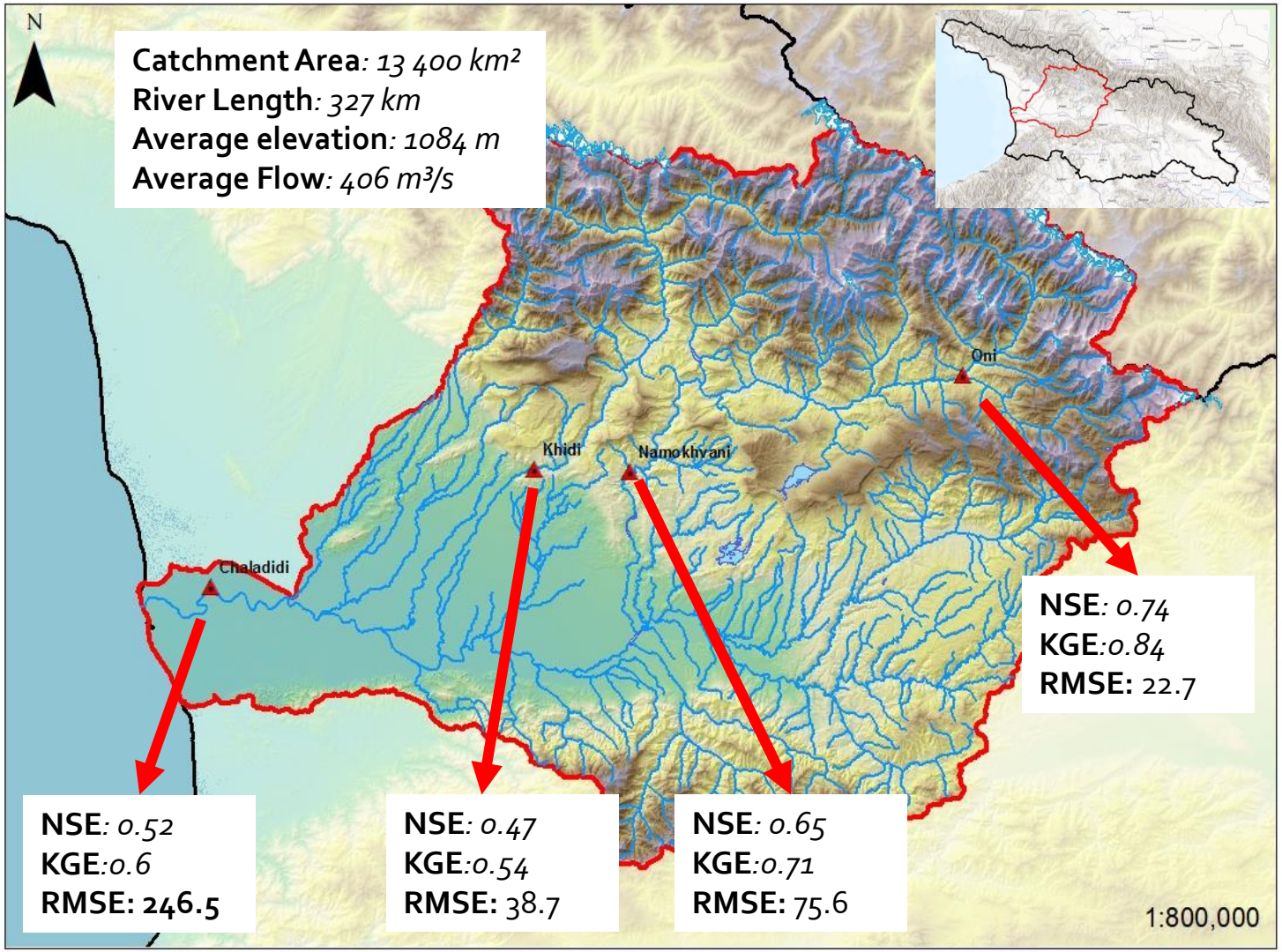
Data used in HEC-HMS

Precipitation & Temperature:
ERA5 hourly gridded data

Discharge:
Observations daily flow



Simulation period: 1985-1988



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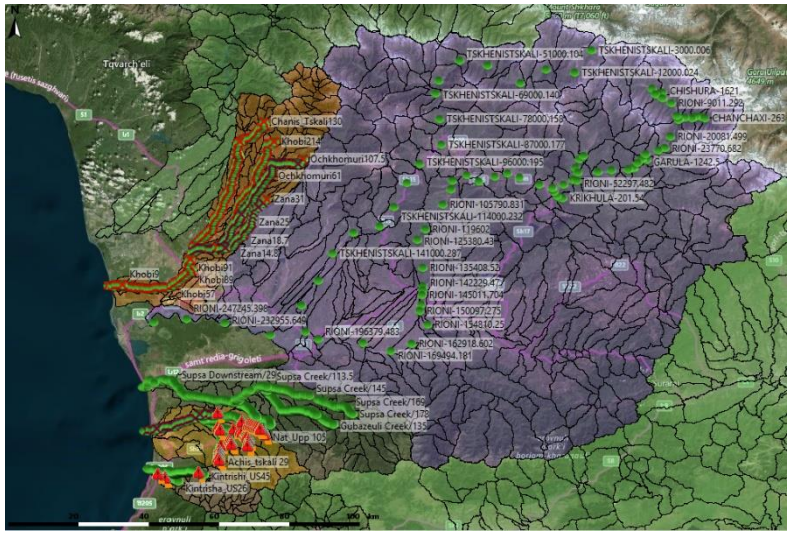
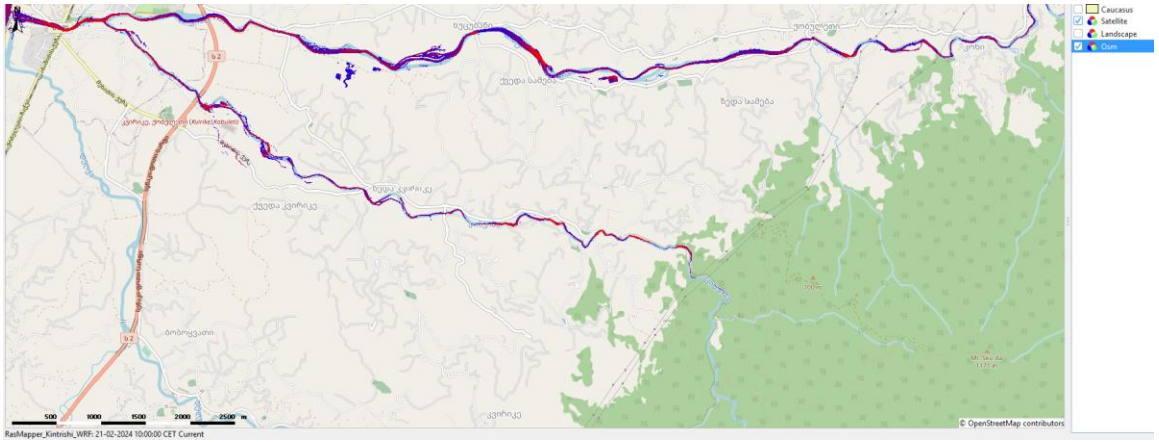
HEC-RAS Models

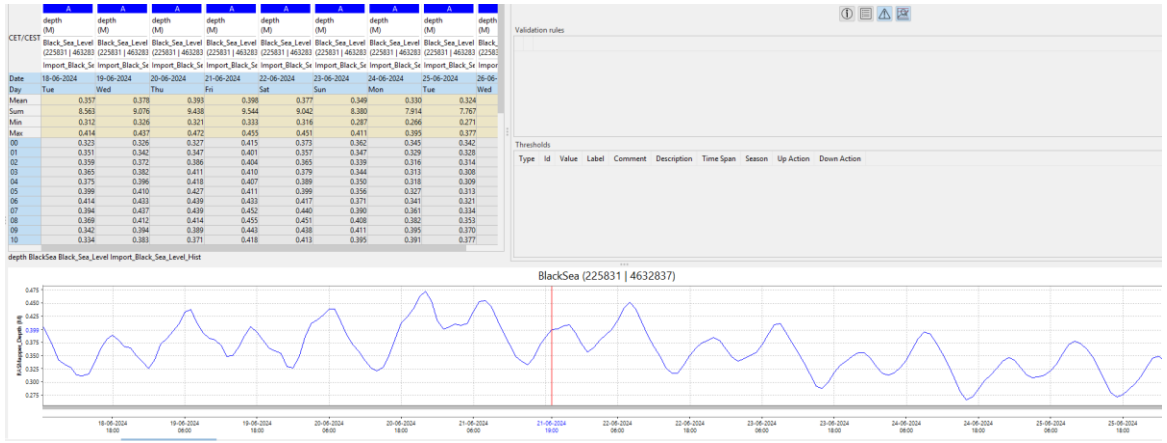
- Currently 7 river basins are included into Delft-FEWS



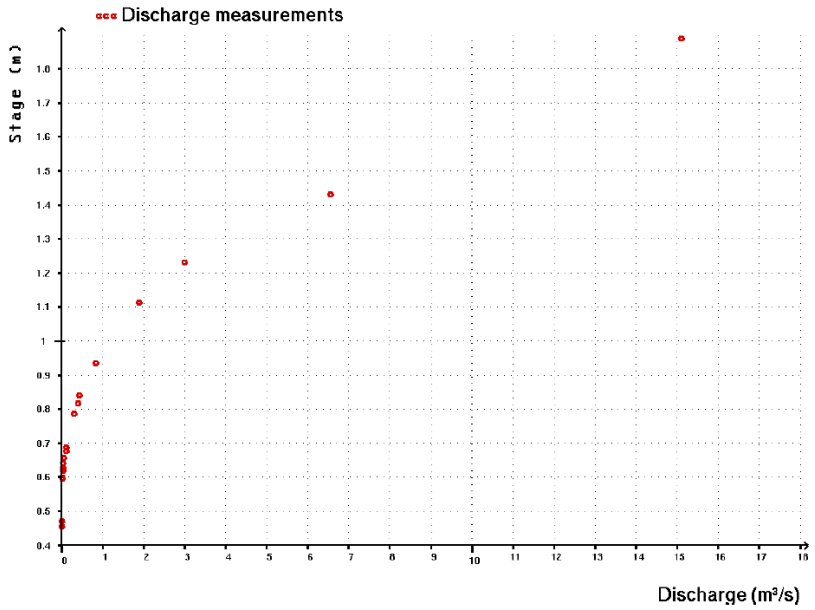
Flood Inundation in RAS Mapper - FEWS

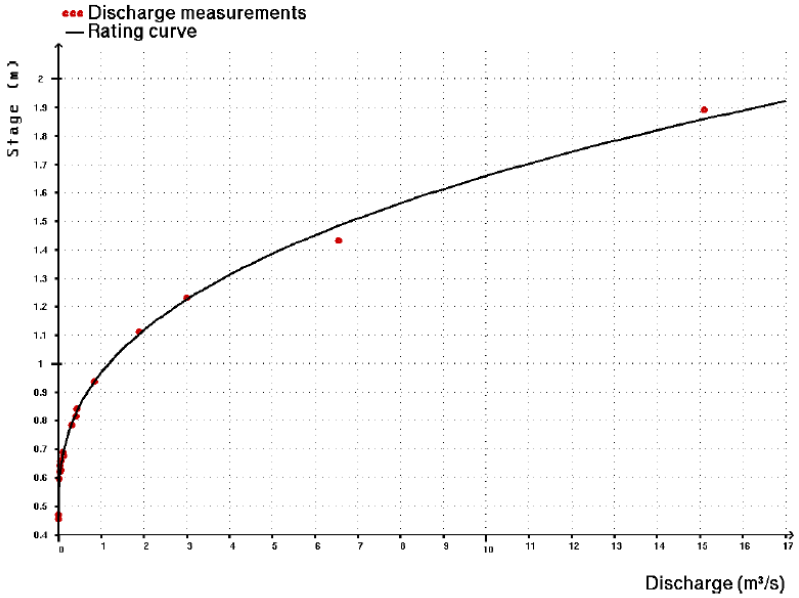


The Black Sea BC – Copernicus **MyOcean2**



Challenge – Reliable Rating Curves





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

Challenge – Stationary Hydrometric Stations

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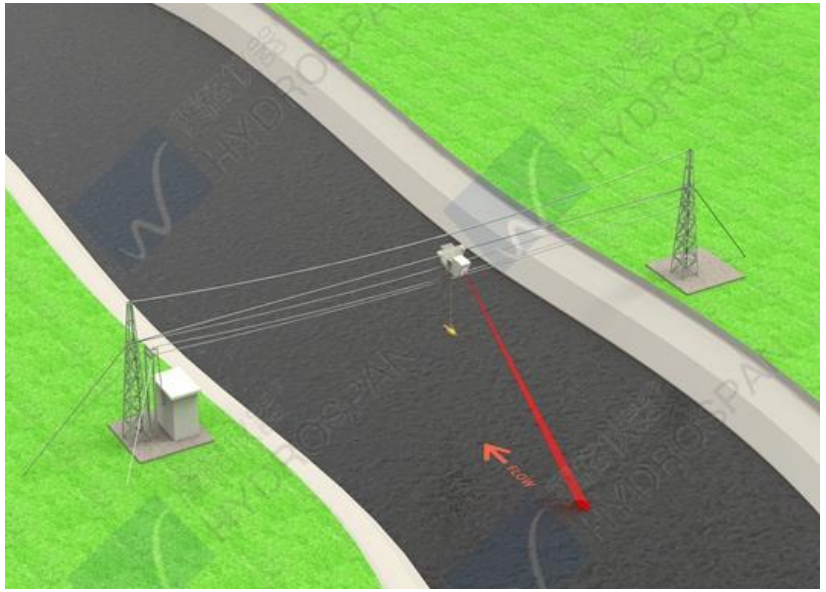
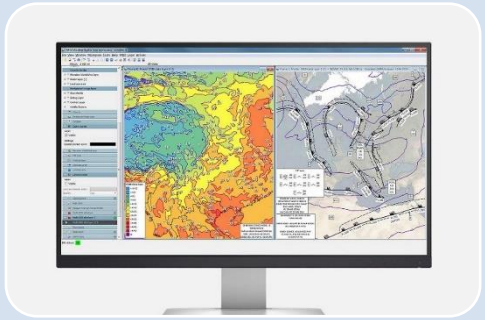


ICT Systems Upgrade (Completion by 2025)



Data Collection System

Weather Forecasting and Production System

SmartMet

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ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Commong Alering Protocol

CAP Message

A.2. Severe Thunderstorm Warning

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

```
<?xml version = "1.0" encoding = "UTF-8"?>
<alert xmlns = "urn:oasis:names:tc:emergency:cap:1.1">
  <identifier>KSTO1055887203</identifier>
  <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>
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CALAVERAS COUNTY IN CALIFORNIA, SOUTHWESTERN ALPINE COUNTY IN CALIFORNIA</areaDesc>
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        <value>006109</value>
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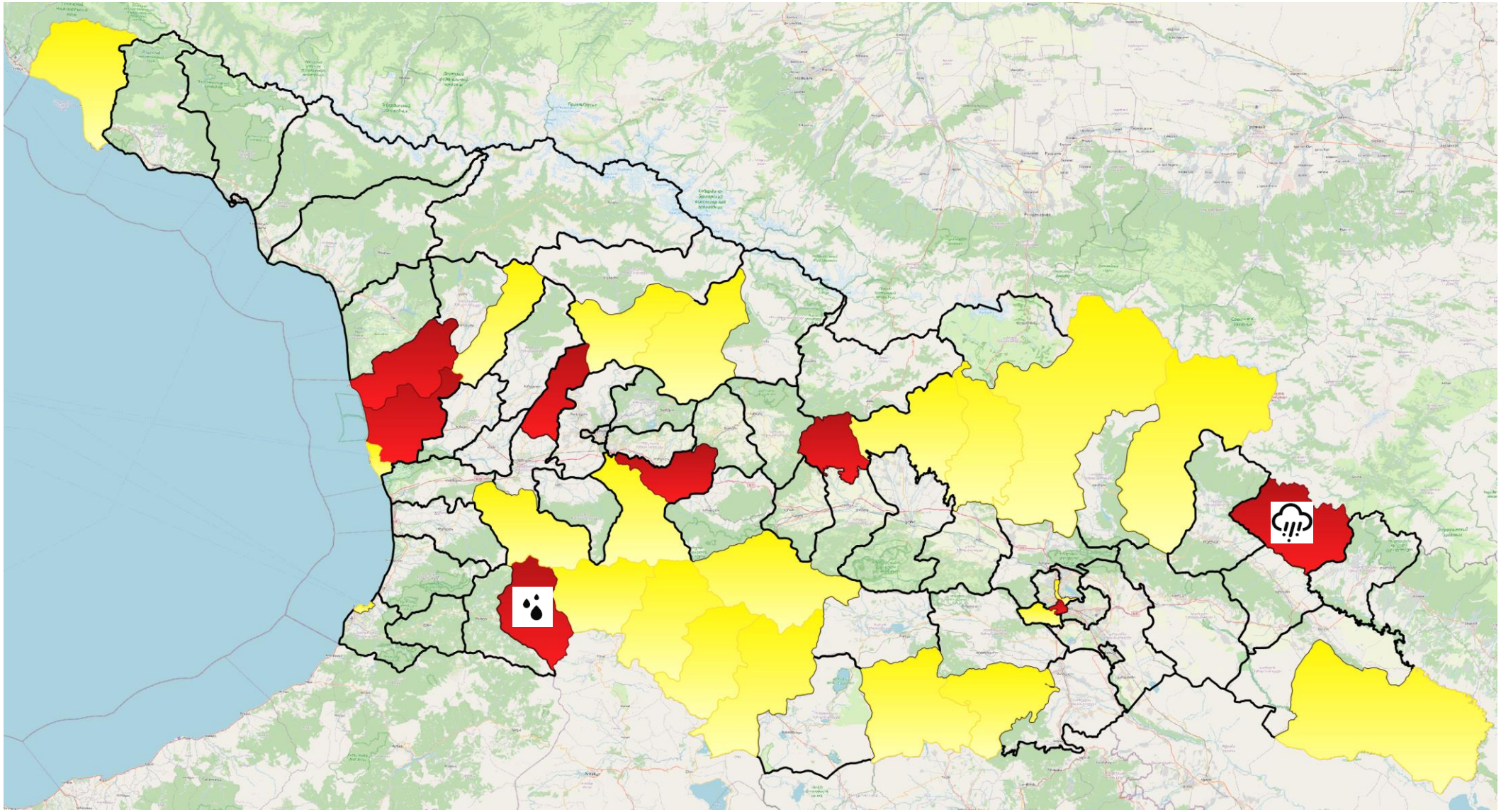
Warning Dissemination at the National Level

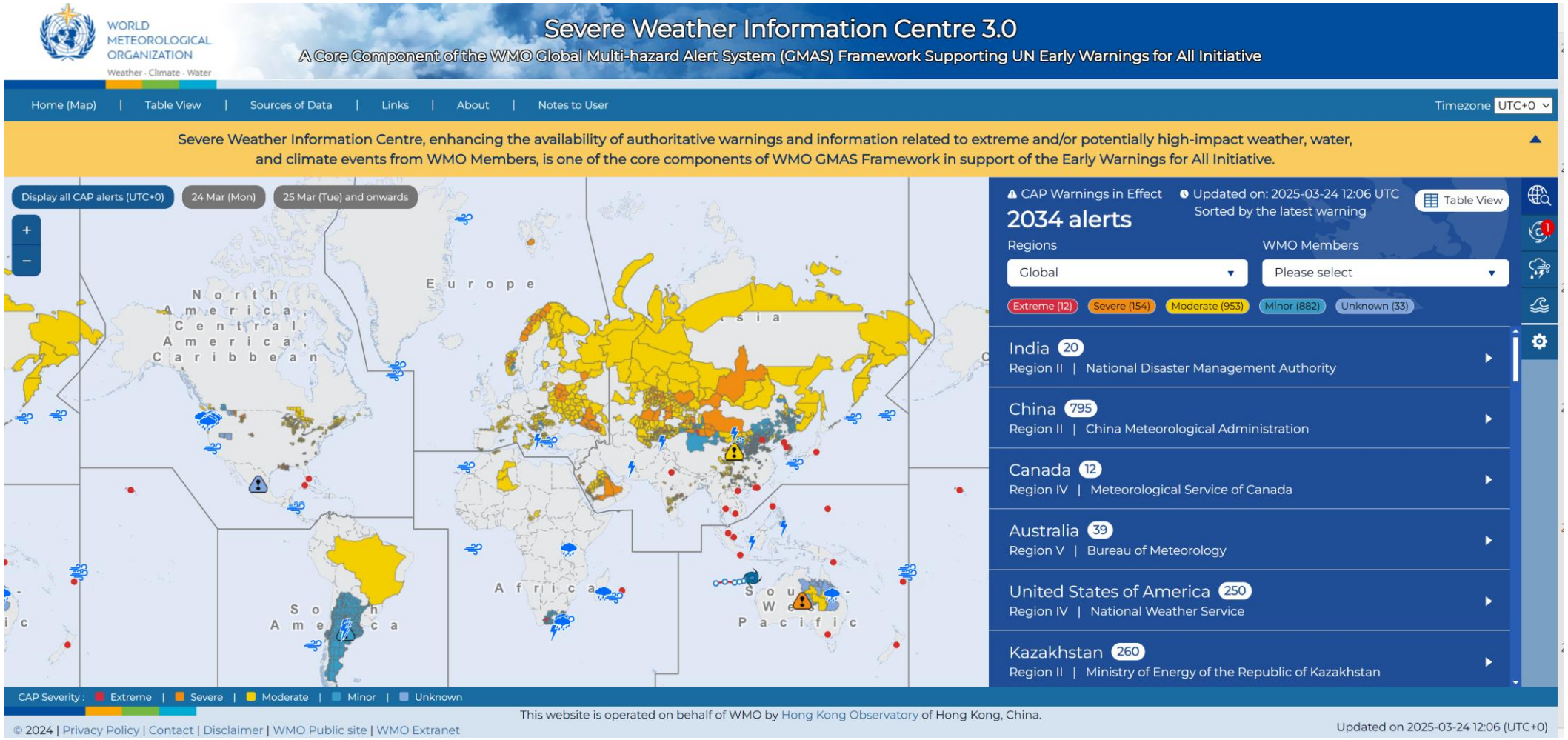
LEPL NATIONAL
ENVIRONMENTAL AGENCY



Warning Dissemination at the International Level

LEPL NATIONAL ENVIRONMENTAL AGENCY

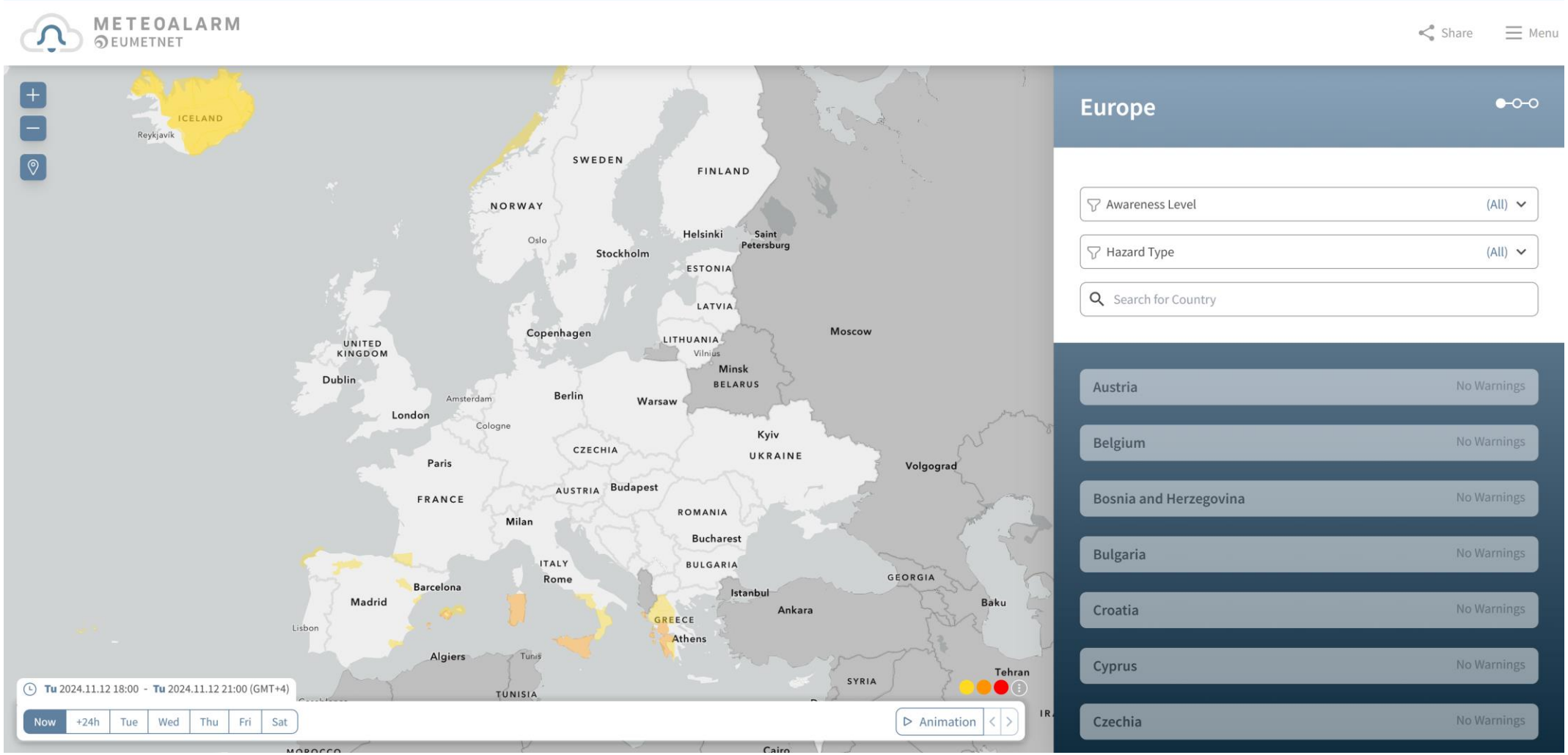
Severe Weather Information Centre (WMO)



Warning Dissemination at the International Level

LEPL NATIONAL ENVIRONMENTAL AGENCY

Meteoalarm



THANK YOU FOR YOUR ATTENTION!

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