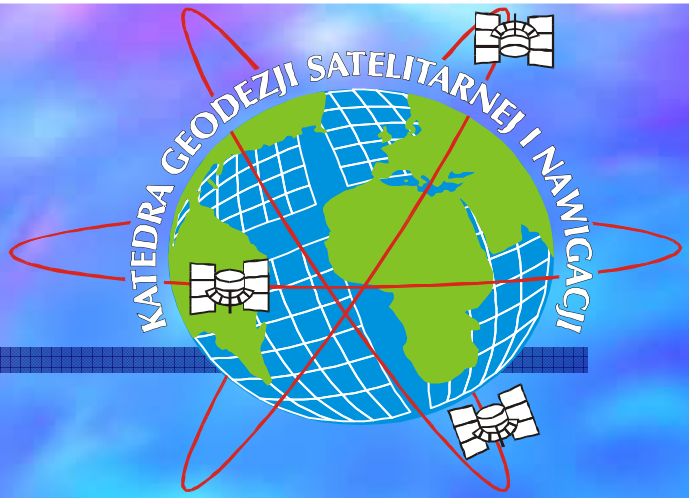

Milka
SW 659



Development of GNSS Applications in Poland

Stanislaw Oszczak, Adam Ciecko

Chair of Satellite Geodesy and Navigation

University of Warmia and Mazury in Olsztyn,Poland

United Nations/Azerbaijan/United States of America/European Space Agency
Workshop on the Applications of Global Navigation Satellite Systems
Baku, Azerbaijan, 11 – 15 May 20

The University of Warmia and Mazury in Olsztyn

The University of Warmia and Mazury was established on September 1st, 1999. The founding of the University in Olsztyn, a city with a 600-year history, was a dream come true for the many generations who had been trying to turn Olsztyn into a strong academic centre. In its activities, the University draws on the heritage of the Albertina of Königsberg, the Hosianum of Braniewo, the Academy of Agriculture and Technology and the Higher School of Pedagogy in Olsztyn. The fact that the University carries the name of Warmia and Mazury is by no means a coincidence. It stems from the great academic and cultural heritage of the region of Warmia and Mazury. The academic community has excellent models to follow: Nicolas Copernicus with his groundbreaking achievements in astronomy and economy, the renowned historian and administrator Martin Kromer, the Enlightenment poet Ignacy Krasicki, the philosophers Johann Herder and Immanuel Kant, the botanist Andrzej Helwing, the mathematician and astronomer Friedrich Bessel and Emil Boehring, a Nobel Prize laureate in medicine.

The greatest challenge for the University is its geographic location. Warmia and Mazury is home to numerous nationalities, religions and cultures; it is a bridge linking the Baltic and East European States with Western Europe. The multicultural nature of Warmia and Mazury is evident in the University's scientific research and studies, while the geographic and environmental conditions suggest directions for academic research and studies, designed to protect the remarkable gift of nature given to this land and its people.

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Faculty of Geodesy and Land Management
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Chair's of Satellite Geodesy and Navigation main activities:

- Extension of the European satellite navigation systems EGNOS and GALILEO to the Central and Eastern Europe Countries.
- Research and development of land, aircraft and marine satellite navigation systems and monitoring of vehicles.
- Application and certification of the GPS receivers in agriculture.
- Precise GPS/RTK surveying.
- Integration of bathymetric survey with GPS/DGPS positioning.
- Establishment of Permamnent Reference Stations for Local Area Augumentation Systems (LAAS)

EUREF-POL Network

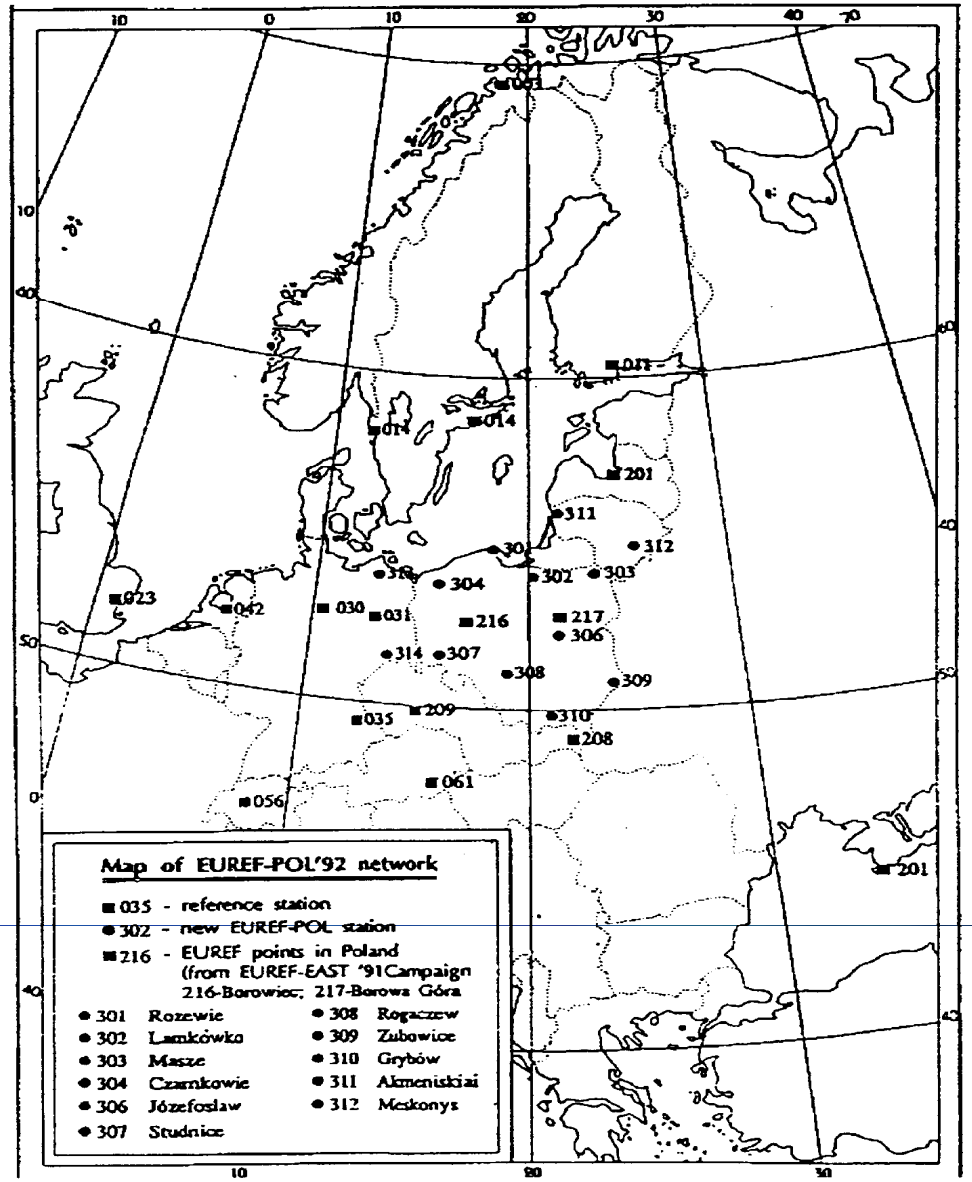
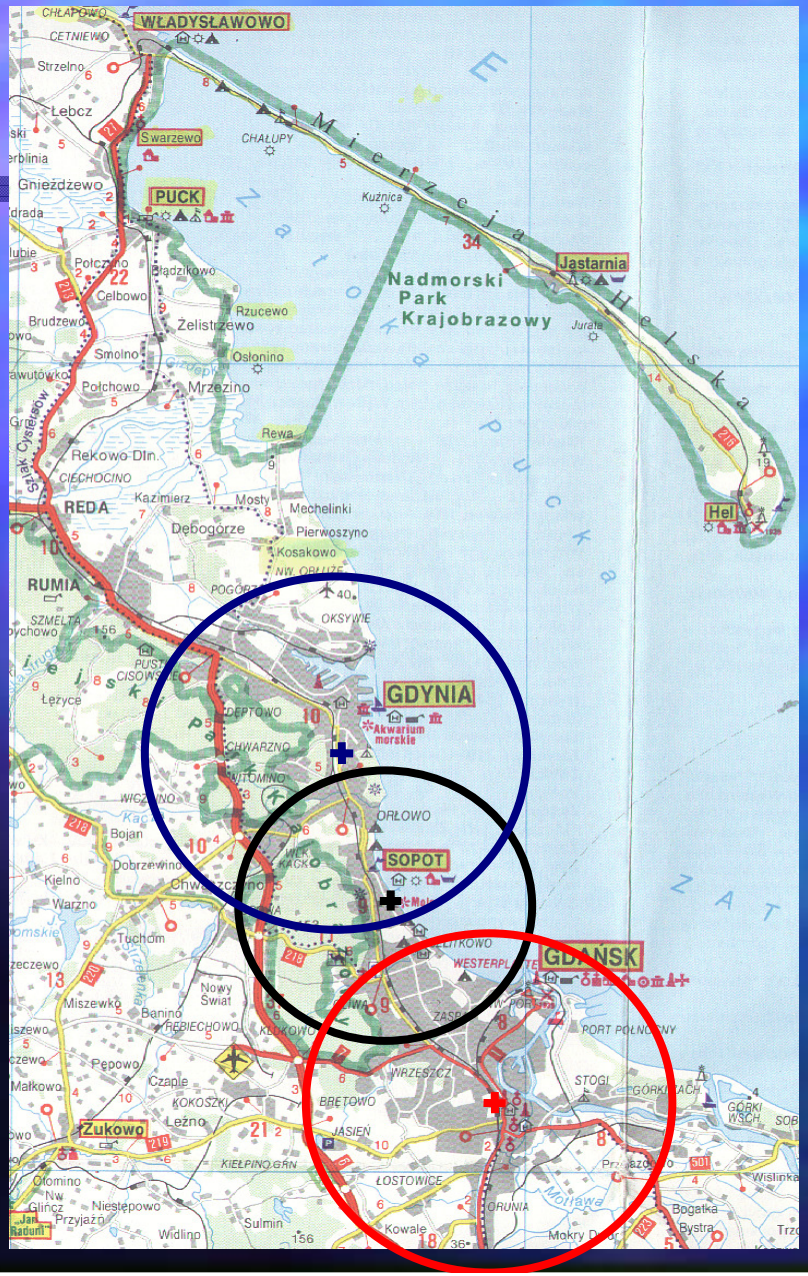


Fig.1. Map of the EUREF-POL'92 Network

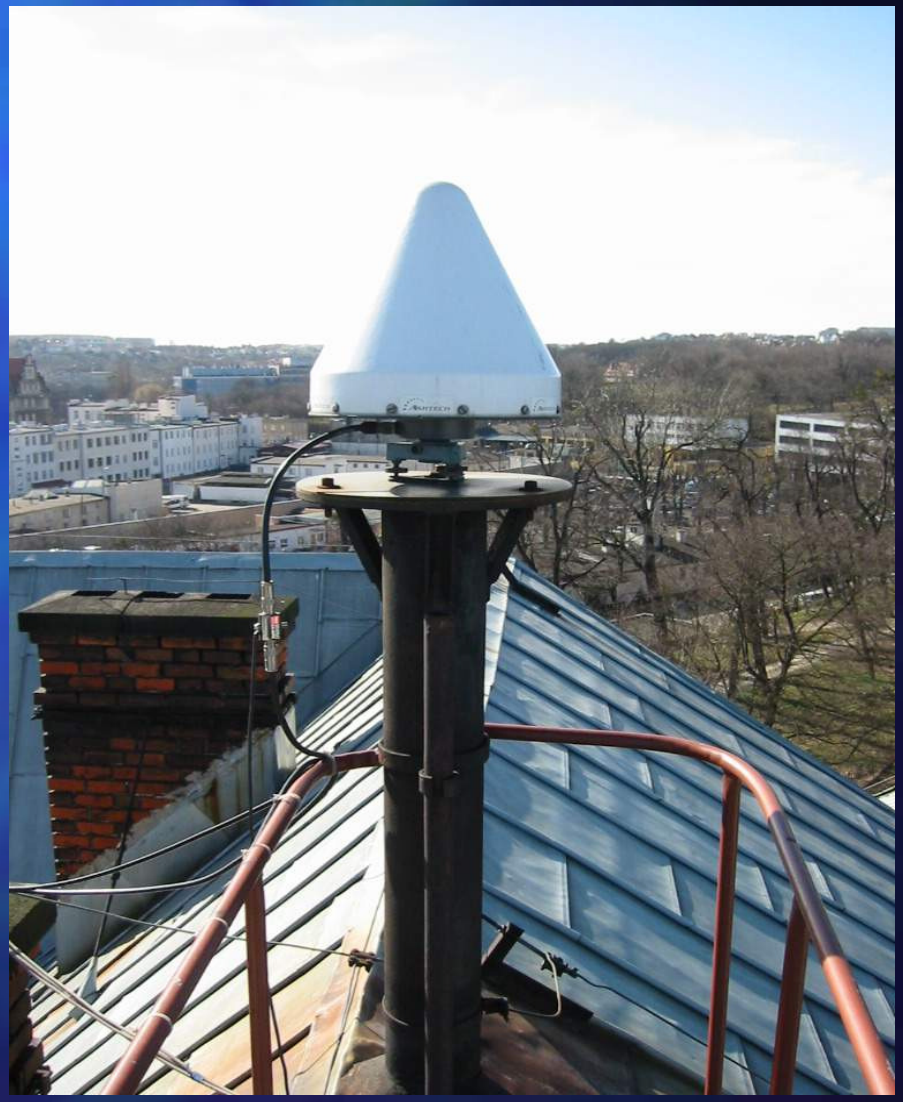
Satellite Observatory in Lamkowko
UWM Olsztyn

Local system of reference stations (2000)



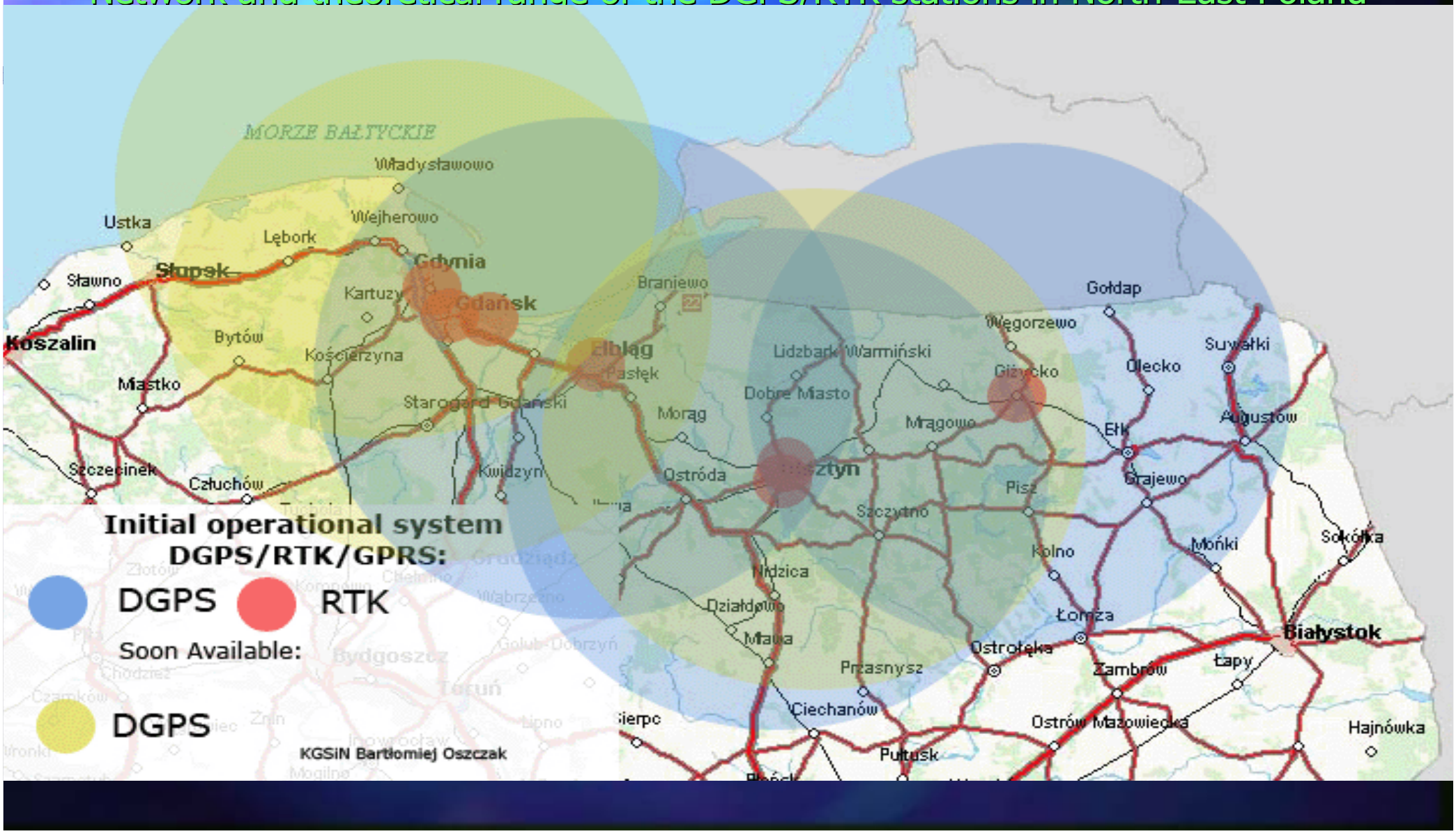
- Three multifunctional reference stations (DGPS/ RTK) placed in Gdańsk,
  Sopot and Gdynia
- Permanent observation and recording of raw data
- Permanent transmission of DGPS/RTK corrections in RTCM format
- Observation data available on-line at http://gis.gdansk.gda.pl/

Local system of reference stations – Gdansk Municipality (2000)



GSM/GPRS system for data teletransmission (2006)

Network and theoretical range of the DGPS/RTK stations in North-East Poland



GSM/GPRS system for data teletransmission (2004)

INTERNET

REFERENCE STATION 1

INTERNET

REFERENCE STATION 2

INTERNET

N-REFERENCE STATION

REPLICATOR DGPS/RTK SERVER

TERMINAL GPRS

USER RECEIVER 1

TERMINAL GPRS

N-USER RECEIVER

N - UP TO 65K USERS

» Fixed IP user number

Utilization of the GSM/GPRS system

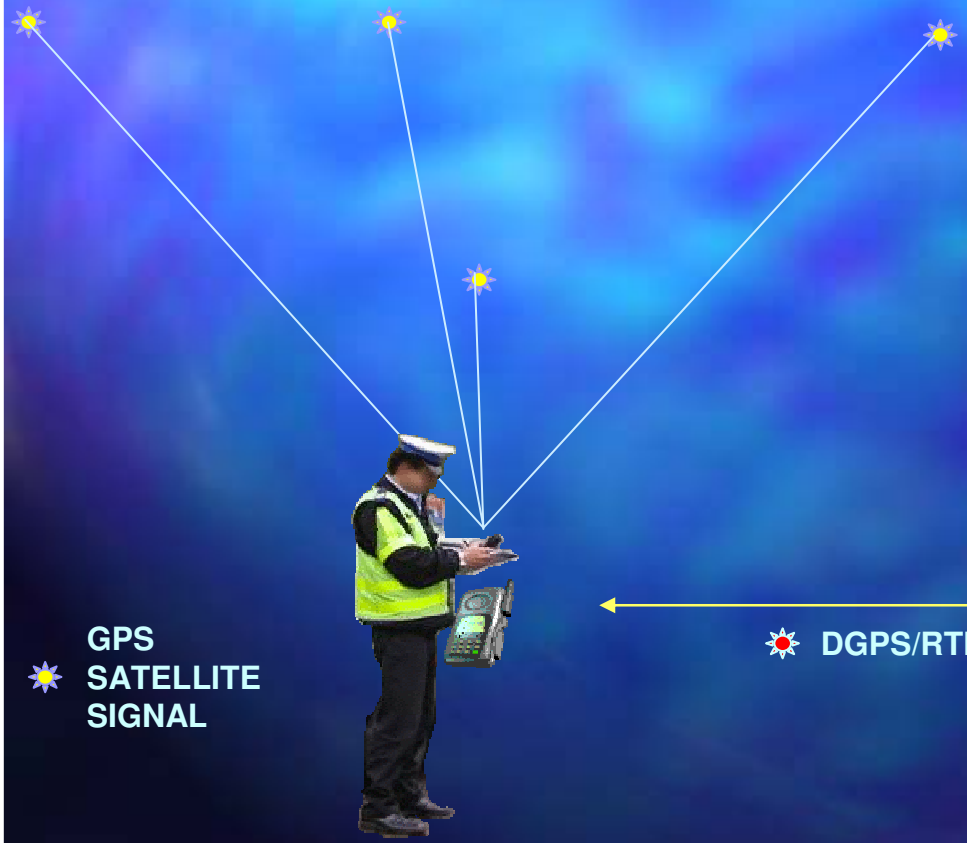
Monitoring of rally cars – 62 Rally of Poland 2005 – B. Oszczak

Utilization of the GSM/GPRS system

Monitoring of rally cars – 62 Rally of Poland 2005 – B. Oszczak

Utilization of the GSM/GPRS system

System of recording road accidents with DGPS/GPRS technique –
– S. Oszczak, T. Templin

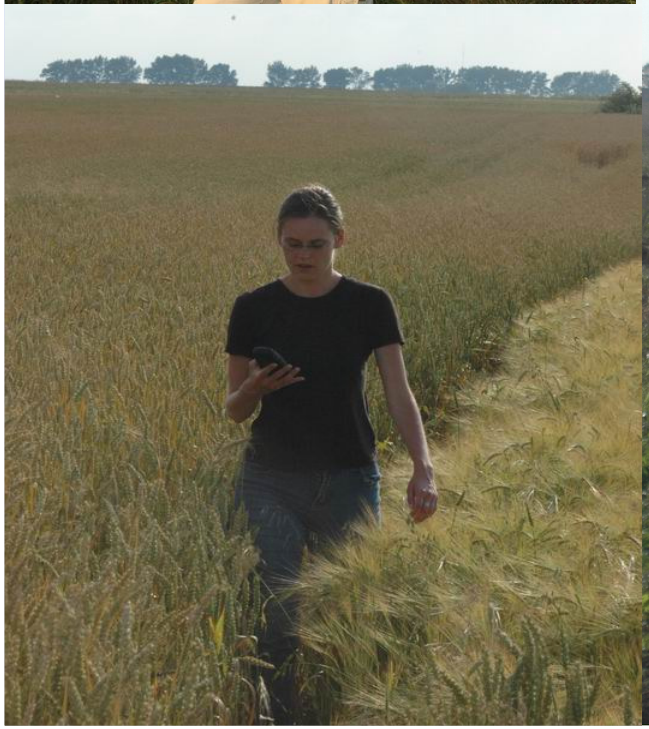


DGPS/RTK CORRECTIONS

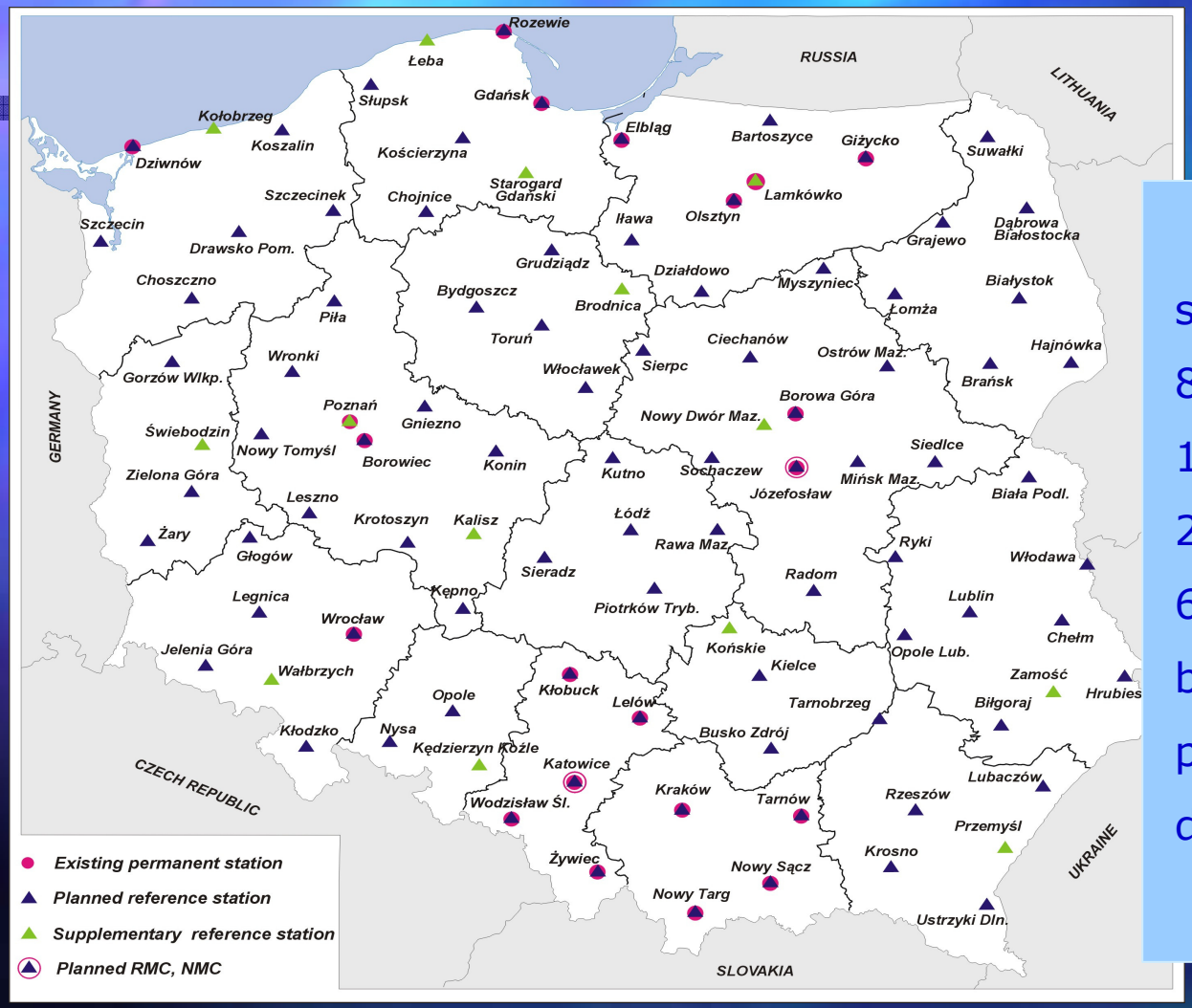
REFERENCE
STATION

Utilization of the GSM/GPRS system

IACS (Integrated Administration Control System) – subsidies for farmers



ASG/EUPOS – Multifunctional System for Precise Satellite Positioning in Poland (2008)



Krajowe Centrum Zarządzające

system wielofunkcyjny,

86 stacji referencyjnych,

13 rezerwowych lokalizacji

2 ośrodki obliczeniowe,

6 podstawowych serwisów,

budowa w latach 2005-2007,

planowany koszt 29.912.259 zł,

dofinansowanie 22.139.131 zł

ASG/EUPOS

EQUIPMENT

- ✓ REFERENCE STATIONS
  - Trimble Net RS (GPS) and Net R5 (GPS/GLONASS) receivers
  - Trimble Zephyr I an II antennas
  - Trimble GPS Net and Trimble GPS Base software
- ✓ PROCESSING CENTRES
  - Trimble VRS networking software
  - Trimble TTC post-processing software
- ✓ MOBILE EQUIPMENT
  - Trimble RS8 receivers
  - Trimble integrated antenna

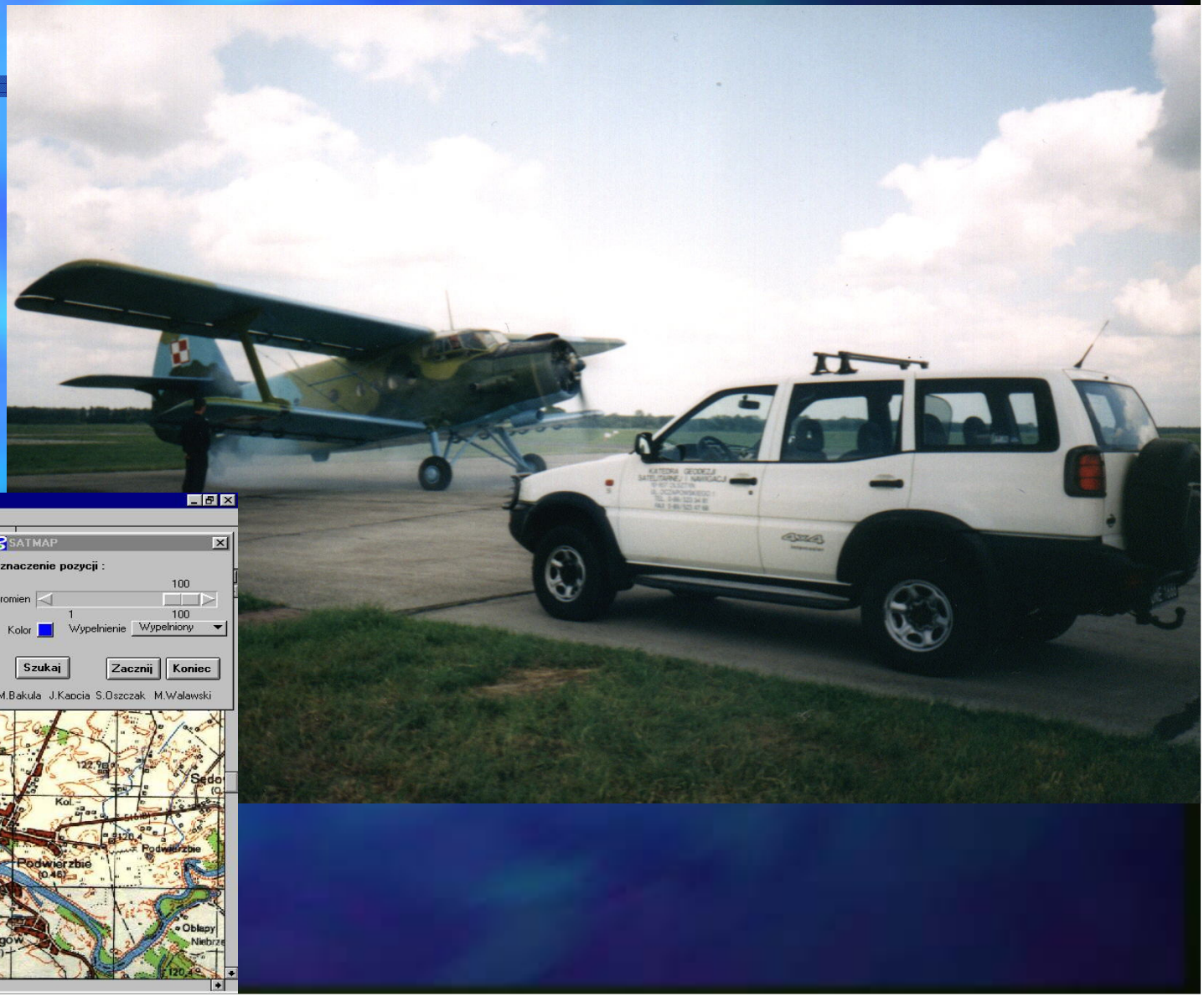
Real Time and Post-processing Services of ASG-PL/EUPOS

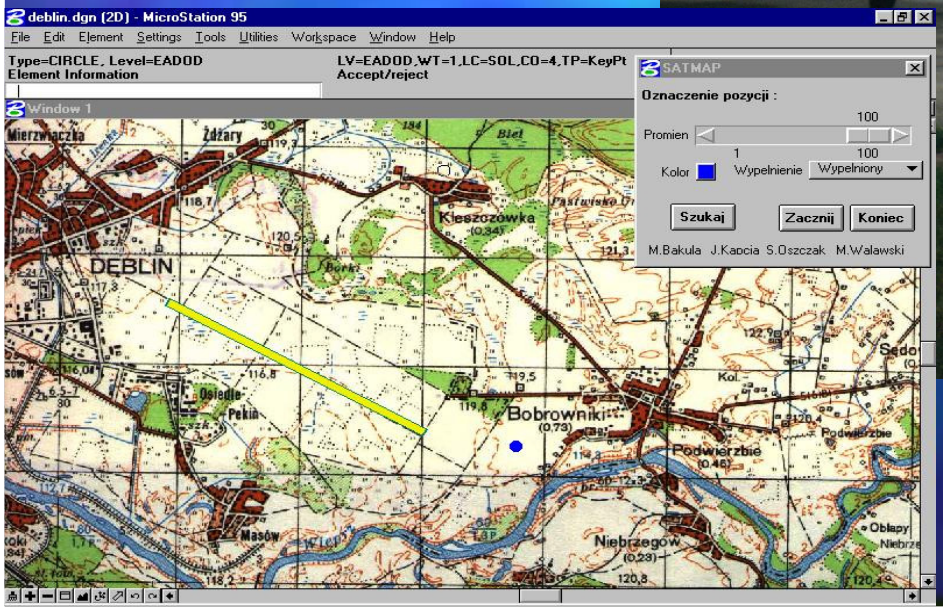
Usługa	RTK/ Post-processing	Transmisja korekcji różnicowych	Częstotliwość	Dokładność	Format
NAWGIS	RTK	FM/RDS, LW/RDS	3 - 5 sek.	1 - 3 m	RTCM 2.1
KODGIS	RTK	GSM	1 sek.	0.5 - 2 m	RTCM 2.3
NAWGEO	RTK	GSM	1 sek.	1-3 cm	RTCM 2.3, 3.1.
POZGEO	POST-PROCESSIG	Internet, GSM	1 sek.	≤ 1 cm	RINEX 2
POZGEOD	POST-PROCESSING	Internet, GSM	1 sek.	< 1 cm	RINEX 2

RTK precise positioning
Asab Desert - United Arab Emirates

GPS/EGNOS POSITIONING OF ARCHEOLOGICAL SITE IN POMPEII – July 2003

Navigation and Real Time Trajectory Monitoring of Aircraft



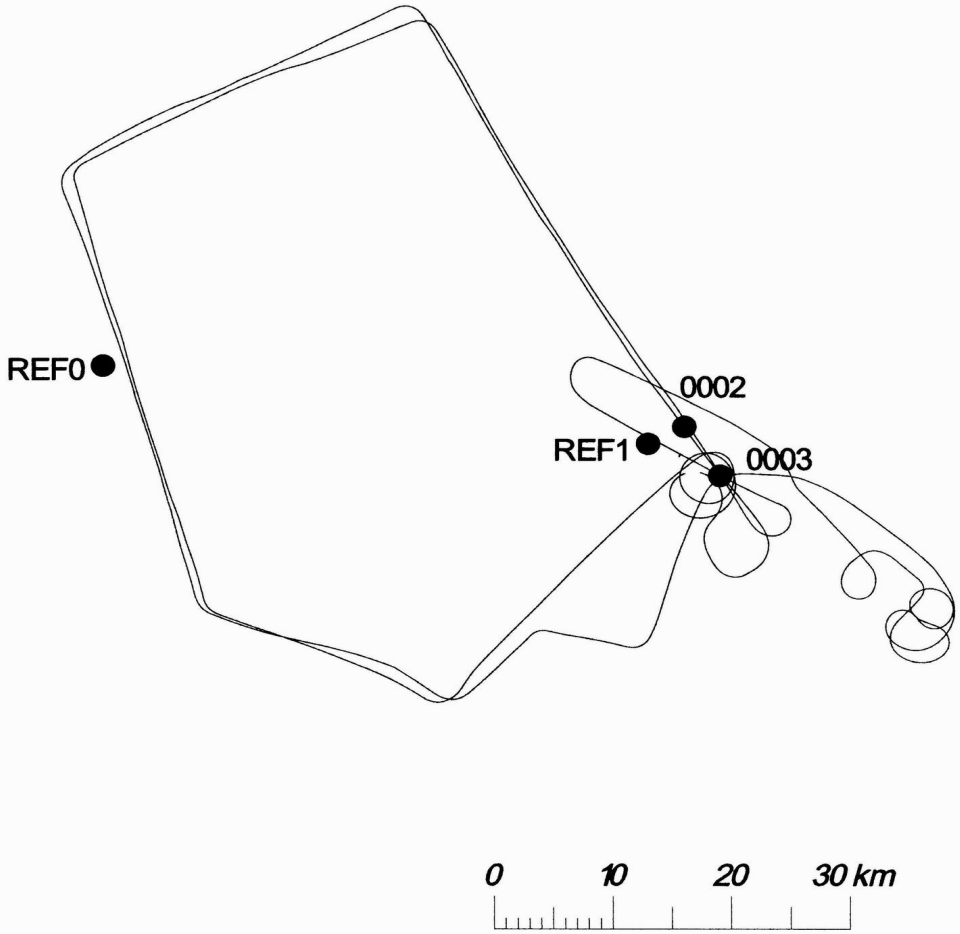


TS 11 Iskra

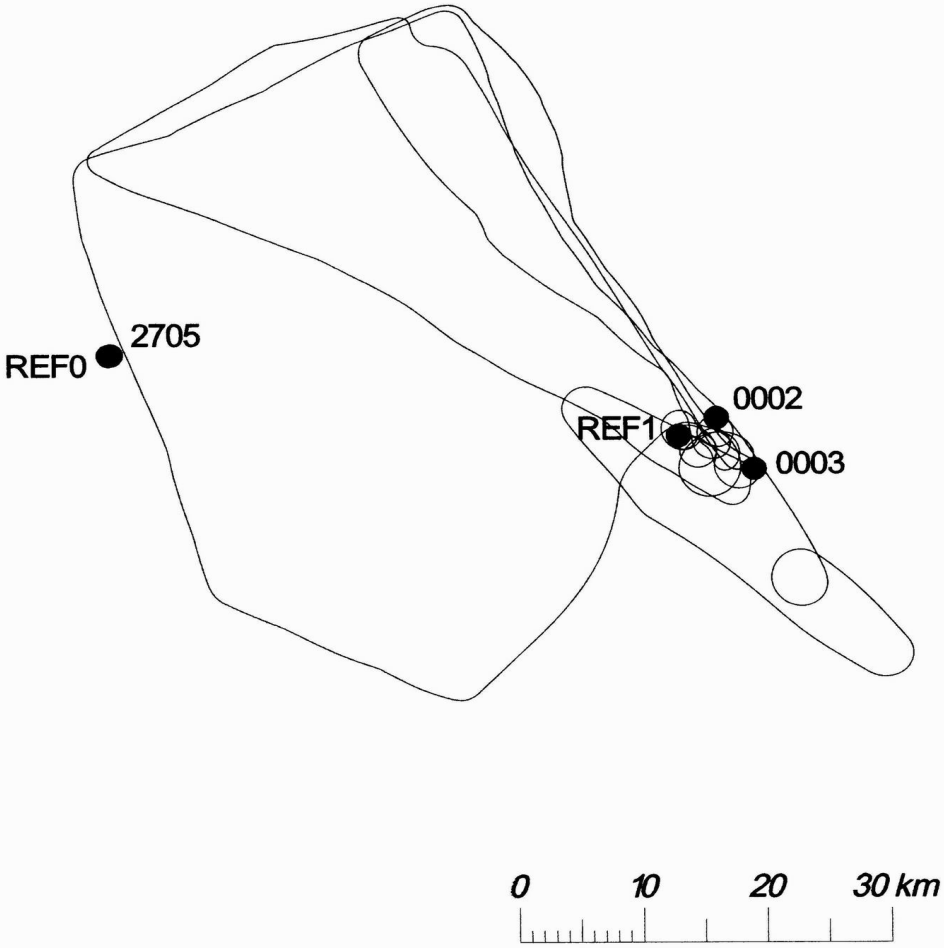
Cessna Aircraft

Example of jet plane trajectory

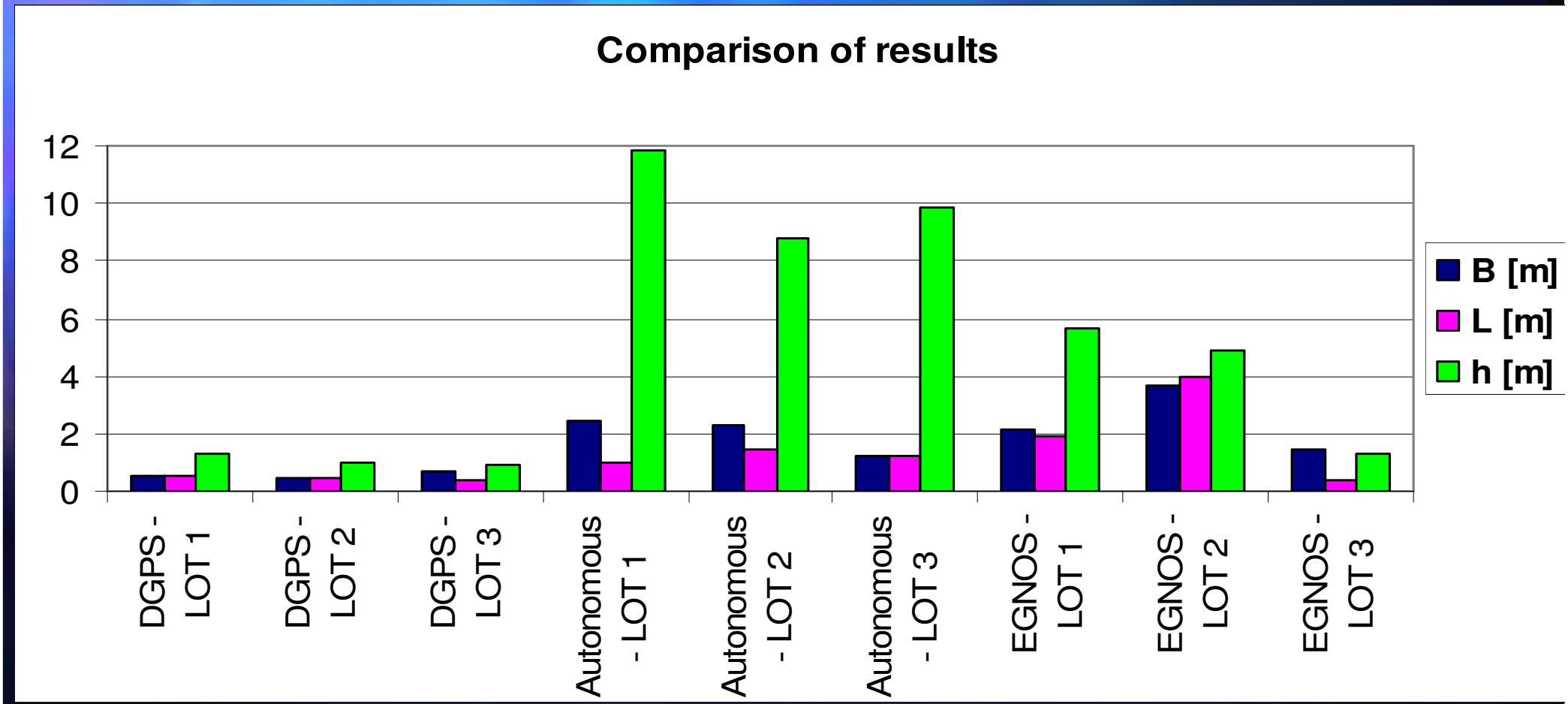
Trasa lotu samolotu TS11 Iskra, Lot nr 1



Trasa lotu samolotu TS11 Iskra, Lot nr 2



Comparison of flight tests results



EGNOS – ESTB positioning used for parcel measuremets – On the Spot checks – Equipment Testing Phase

GPS receivers subject to on-the-spot tests

Great Mazurian Lakes

- Warmia and Mazury is the Land of a Thousand Lakes
- The most popular – the Great Mazurian Lakes region
- 10,000 sailing boats – 50,000 tourist every day
- The largest lake – Sniardwy Lake (over 10,000 ha)

- Dangerous shallow areas with stones and reefs
- No cardinal buoys in IALA system
- No up-to-date bathymetric maps

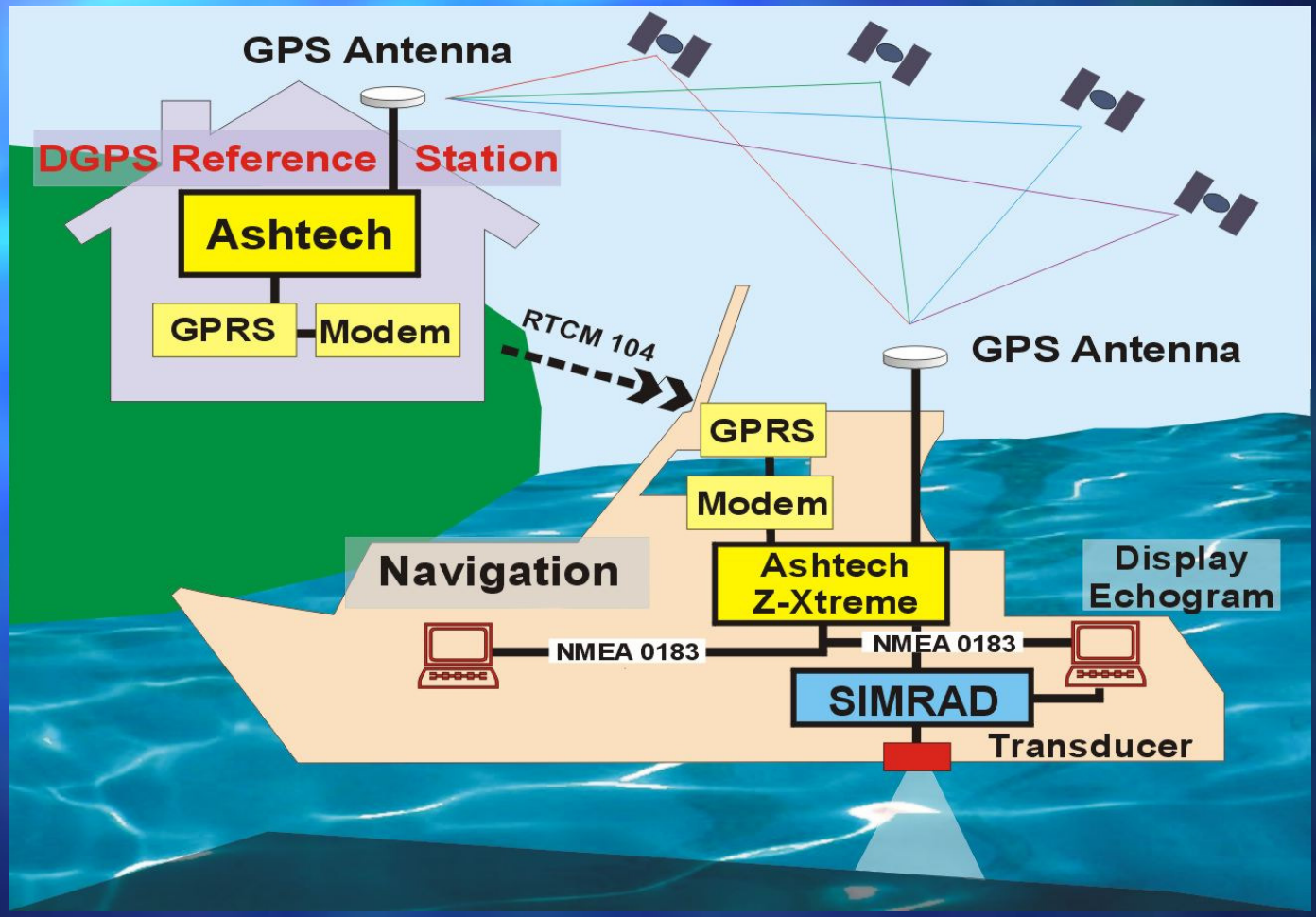
Integrated Bathymetric System

The team of Chair of Satellite Geodesy and Navigation has developed integrated technology of bathymetry surveying of Great Mazurian Lakes, which make possible navigation of the small hydrographic boat along the pre-defined profiles, examination of bottom shape, elaboration of bathymetric charts and localization of dangerous underwater stones.

Integrated Bathymetric System basically consists of:

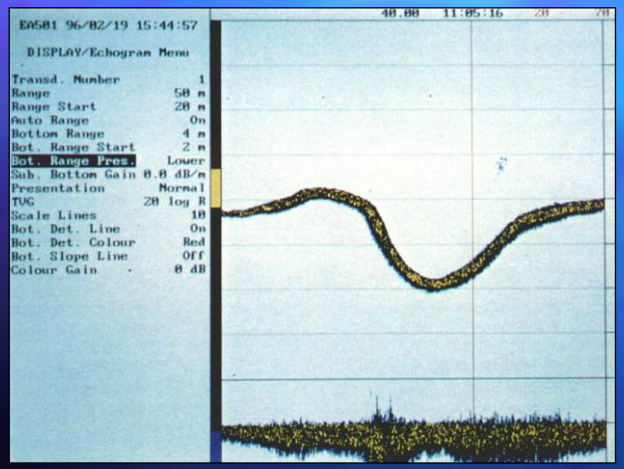
- The GNSS/RTK positioning system,
- The bottom detection system,
- The special GPS and CAD software,
- The hydrographic boat “ORBITA”.

Integrated Bathymetric System



The Bottom Detection System

Simrad EA 501 P



Display echogram

The **EA 501 P Simrad** single frequency digital hydrographic echo sounder was used for depth detection. The EA 501 P system basically consists of transducer, the EA 501 P transceiver and personal computer. The echogram is presented on the Laptop display. Sample data may also be stored on hard disk and replayed for demostration of survey echo data.

The EA 501 P Simrad general Specification:
The transceiver 200 kHz frequency (7°x7°),
Max. Freshwater detection depth – 600 m,
Transmitting power 50 to 250 W,
Calculation interval for 0 to 10 per second.

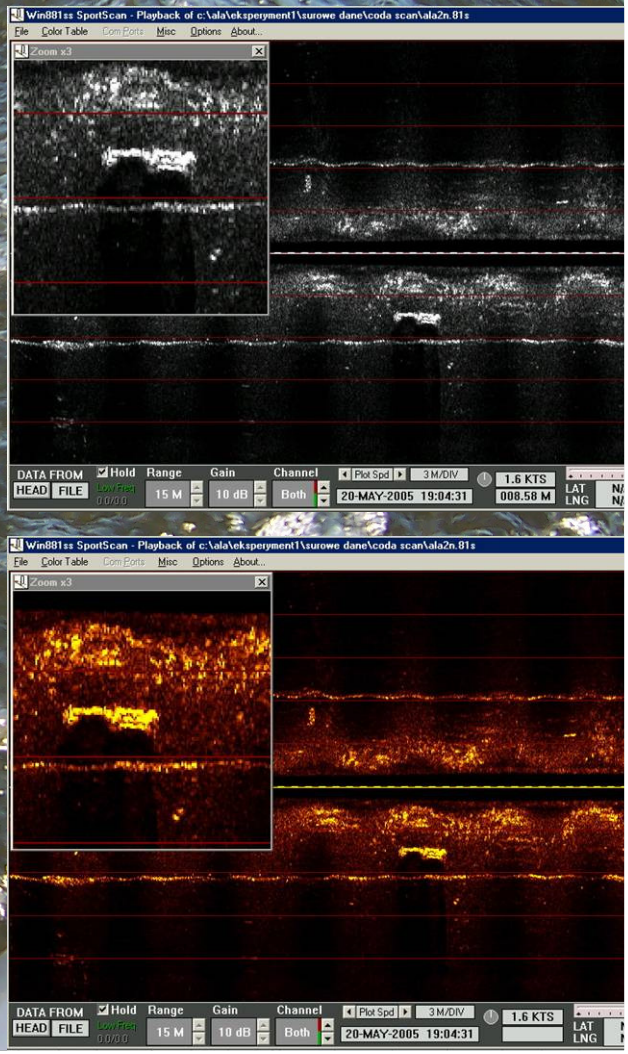
Sidescan Sonar Towfish

Sonogram

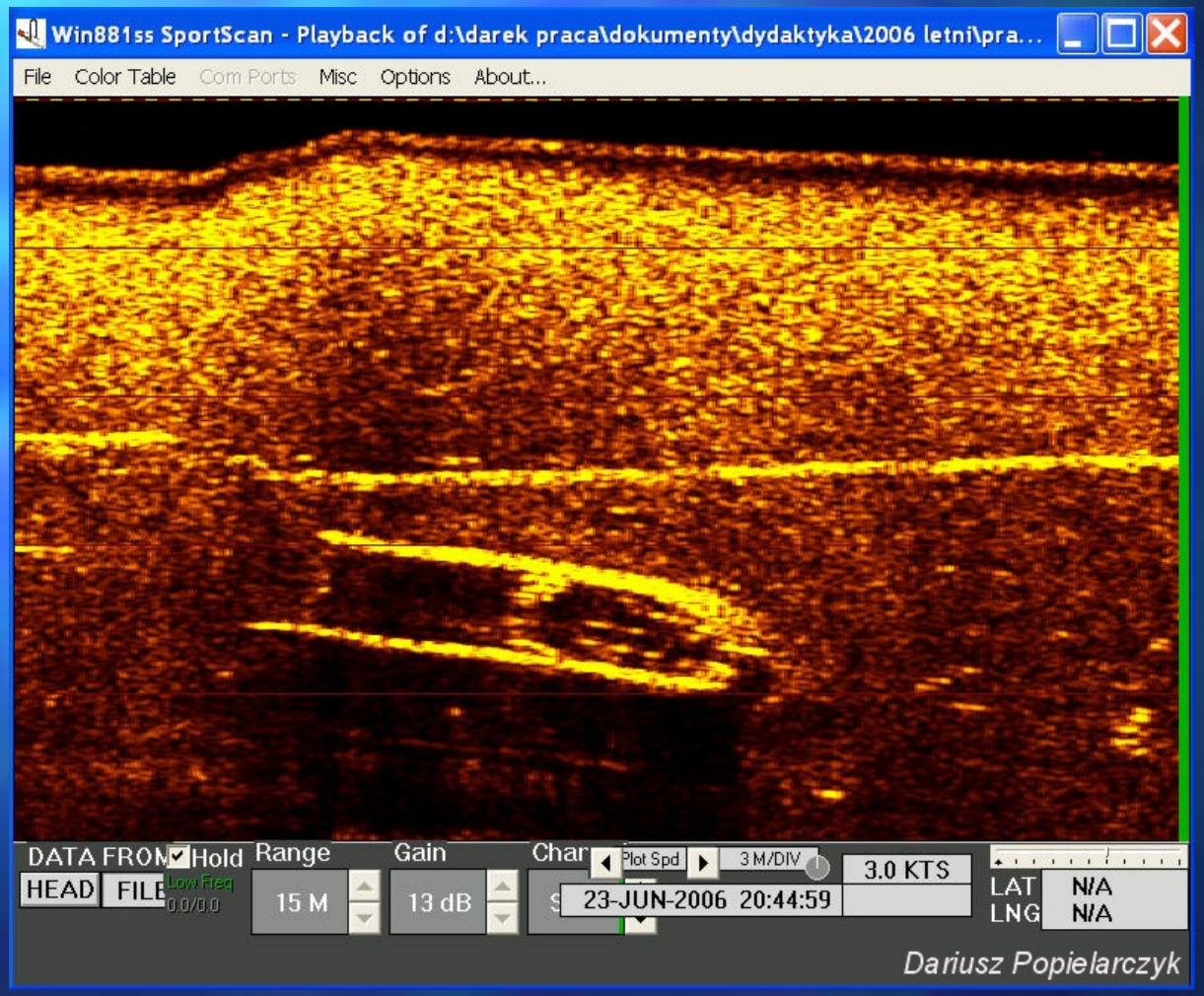
Imagenex SportScan

Basic parameters: Transducer: dual channel, 2x330kHz, 1,8°x60; max tow depth: 30m, operated directly from PC computer, All data can be stored on hard disk for later display and analysis, objects can have their height and length determined with the click on the sonogram.

Under water object detection

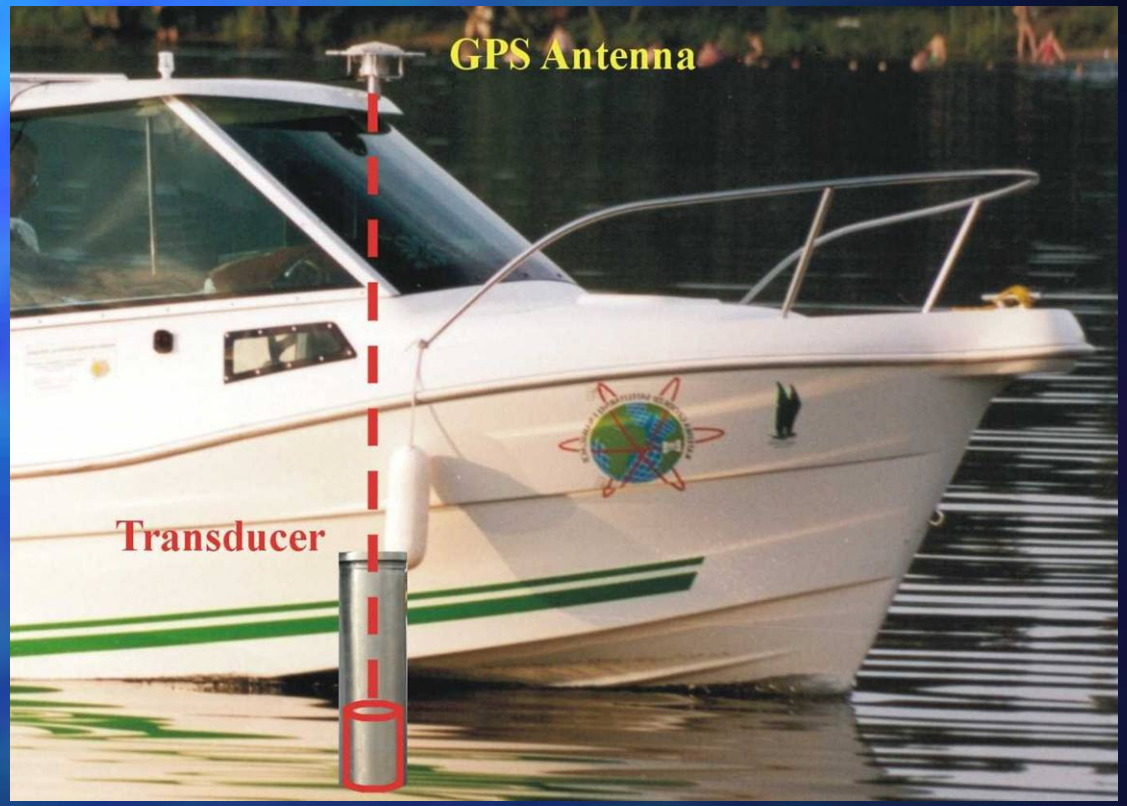


The wreck of motor boat in Lake Krzywe



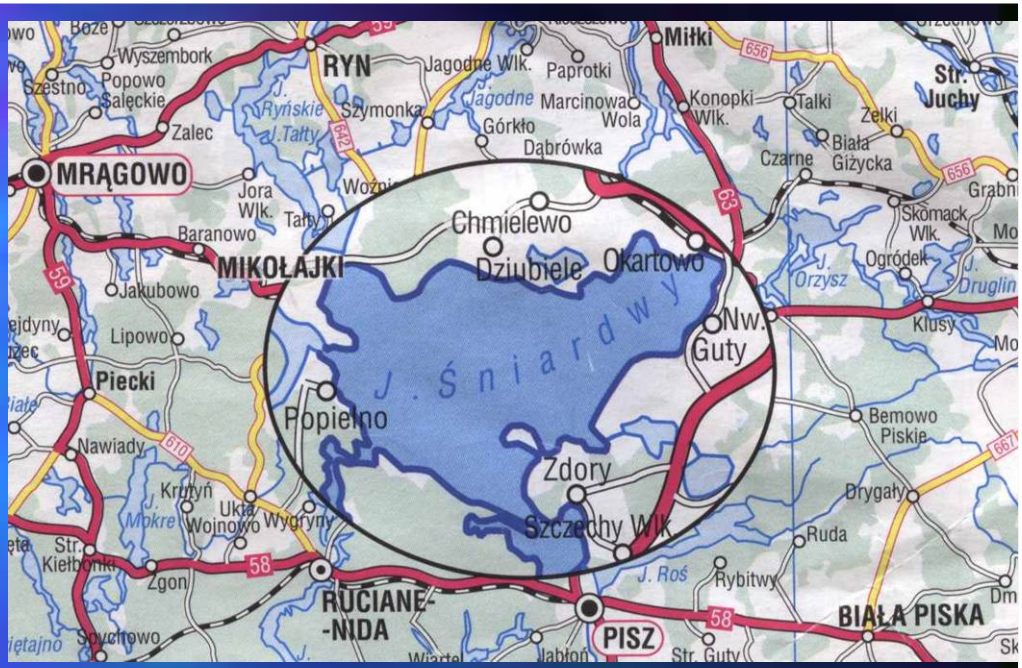
Hydrographic boat „ORBITA”

The Integrated Bathymetric System is mounted on board of small, but safe and easy to operate motorboat called “ORBITA”. It is perfectly suited for raw-data collection during measurements.



Lake Sniardwy Project

- The bigest inland water reservoir in Poland
  (over 10,000 ha, max. depth 23,9 m)
- This shallow reservoir has bad reputation due to unexpected strong winds and storms.



31 days of measurements

The first day: 5 June 2005, the last day: 8 September 2005

Project conducted by the team of the

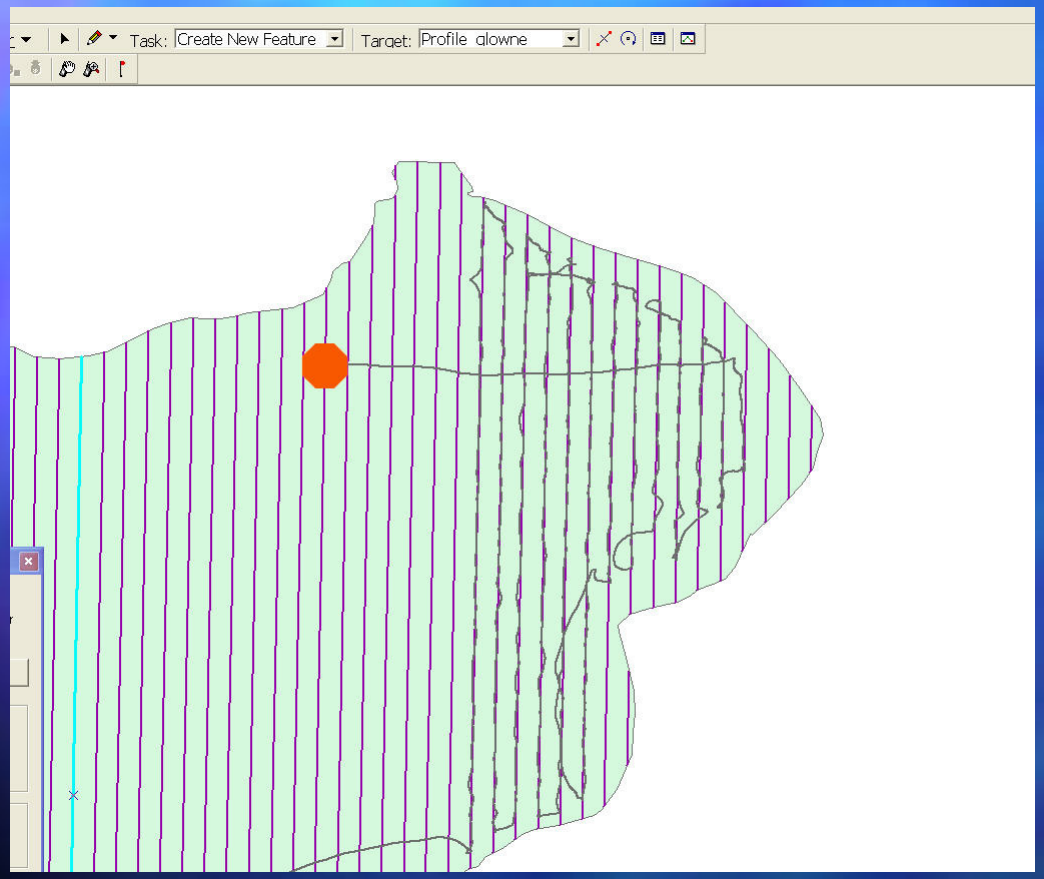
Chair of Satellite Geodesy and Navigation

Description of the Project

The measurements of the Sniardwy Lake included following stages:

- DGPS/RTK permanent and spare local reference station configuration,
- Designing of measurement profiles,
- Hydrographic system configuration,
- Bathymetric survey,
- Lokalization of underwater stone and reefs.
- Elaboration of measurement raw-data,
- Creation of bathymetric digital chart.

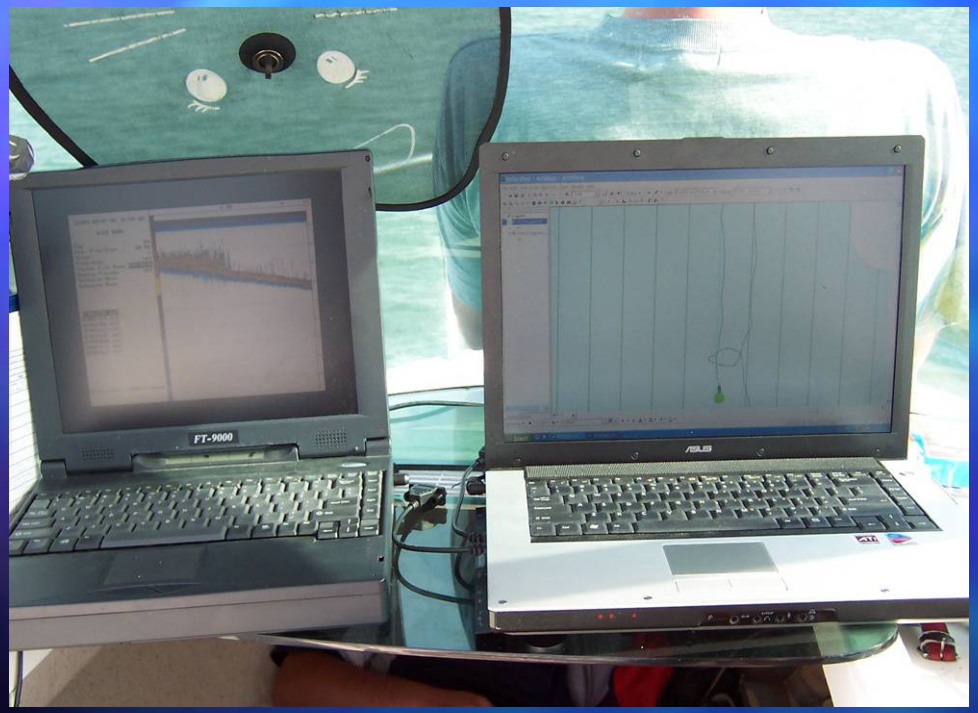
Designing of measurement profiles



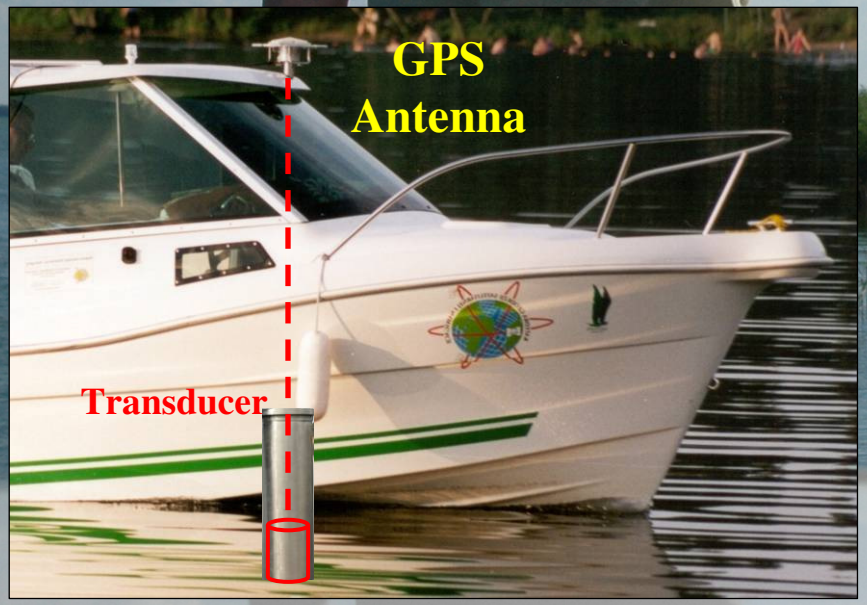
The profiles were designed parallelly every 50 meters one after another on digital shore map.

Red dot showed a boat position during navigation.

Bathymetric Measurements



Bathymetric Survey
Preliminary lokalization of stones



Various weather conditions

Smooth water surface

The storm

Dangerous reefs of stones

Dameged propeller

Hydroacoustic sounding took 31 days of field work.

The total length of boat track sounding was about 2000 km.

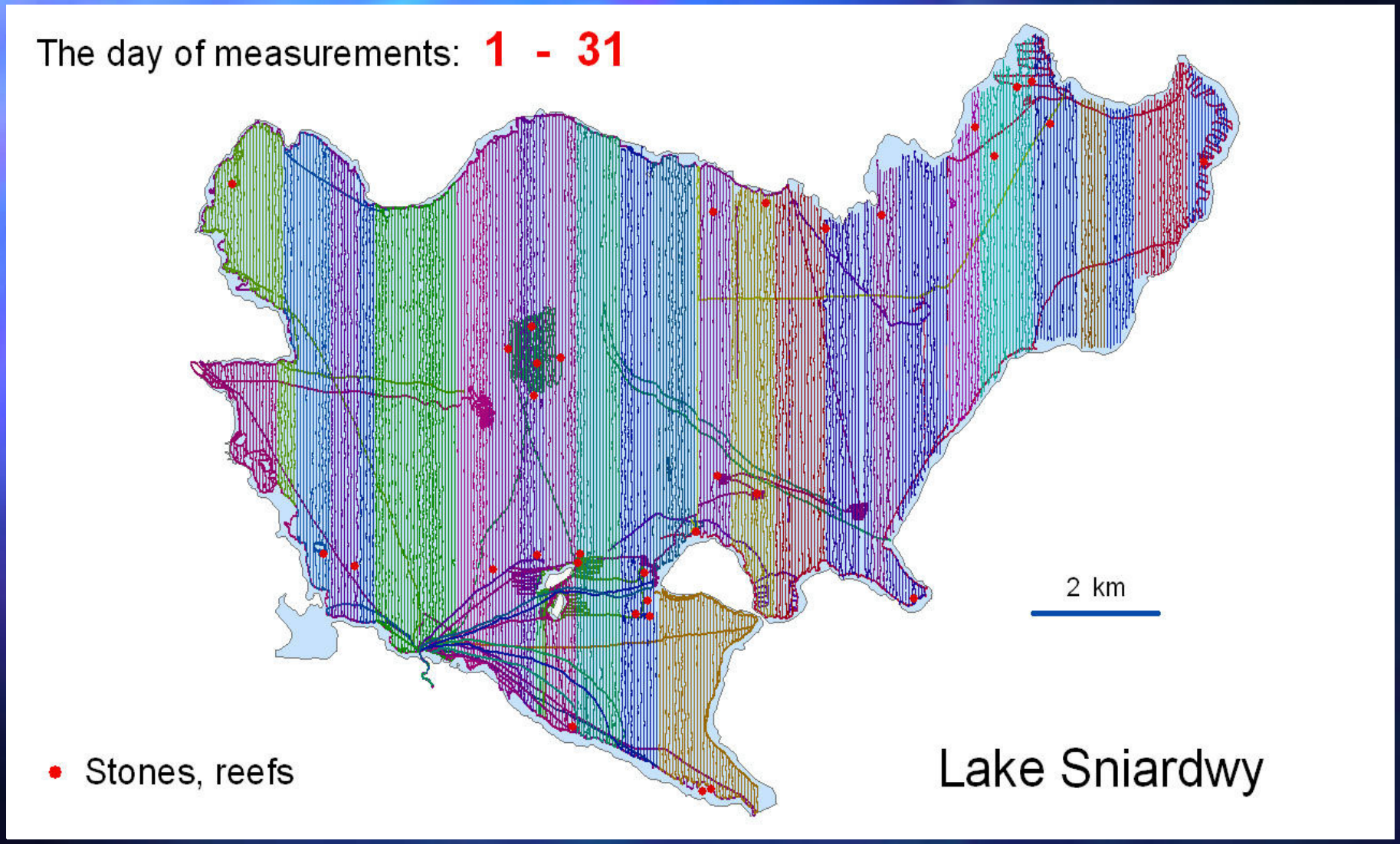
The raw-data acquisition took a lot of time and staff effort.

The amount of data record time was approximately 300 hours.

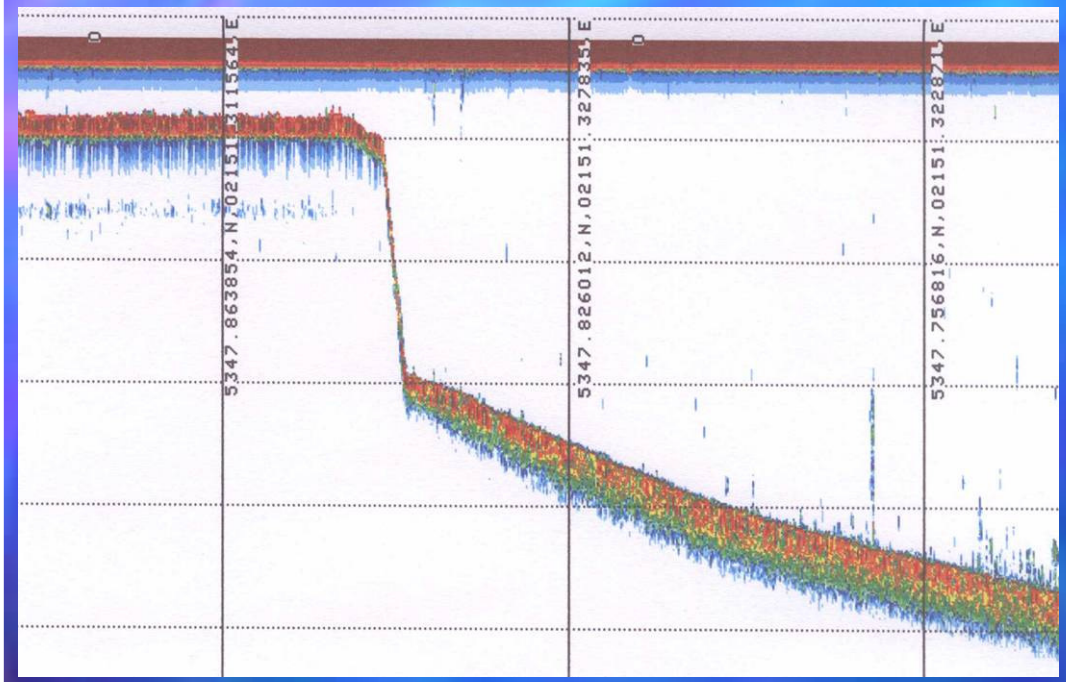
All collected hydrographic and GPS raw-data were initially processed and edited in the field and then recorded for further elaboration.

After field data acquisition was complete, the data elaboration started.

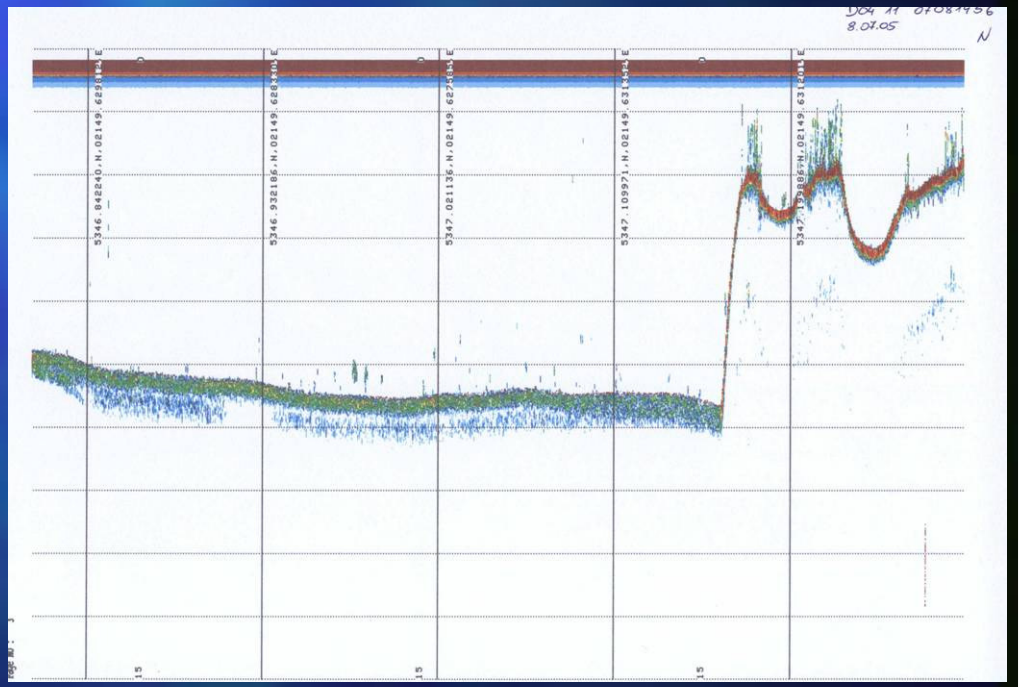
Navigation Tracks



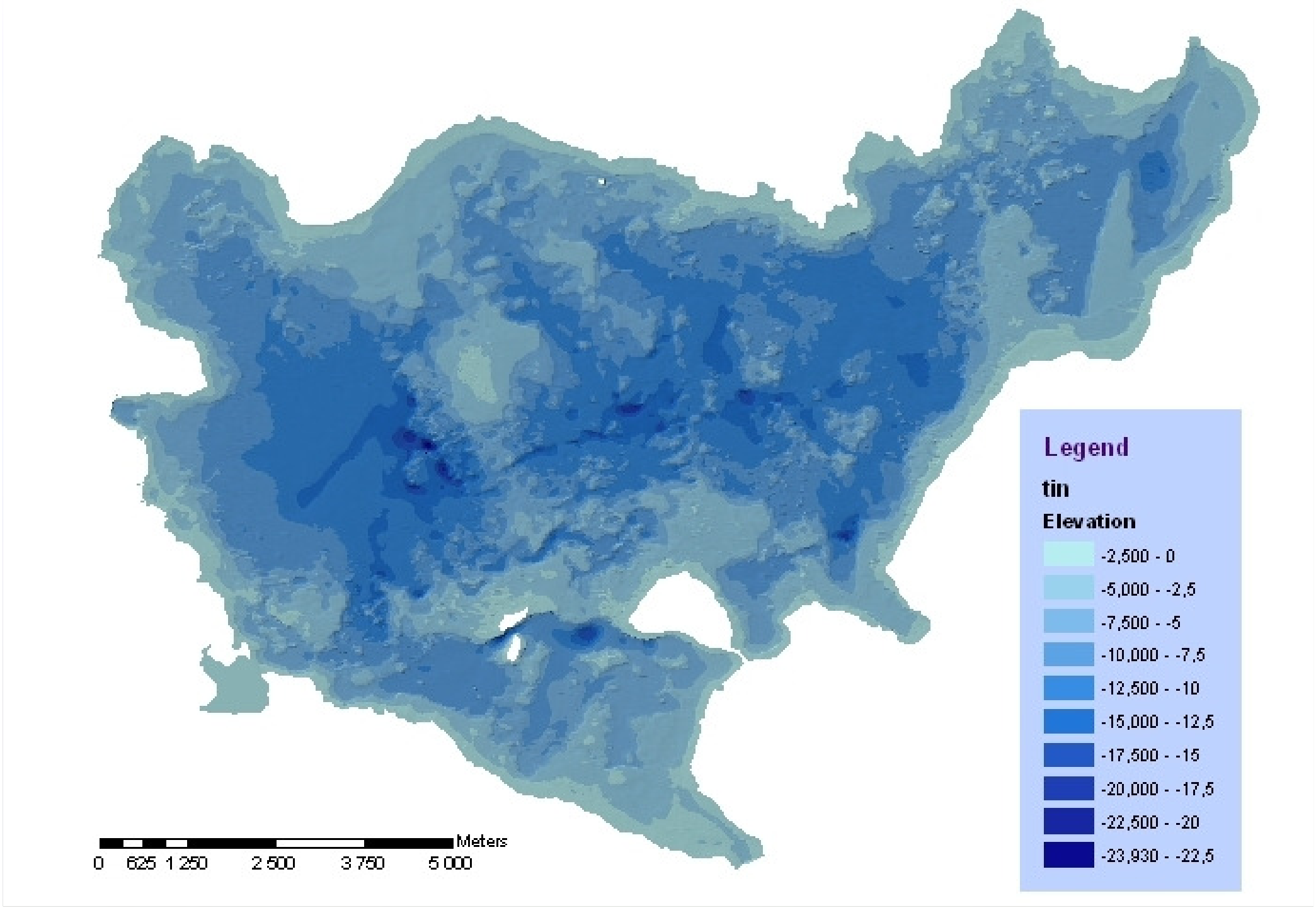
Bottom Echograms



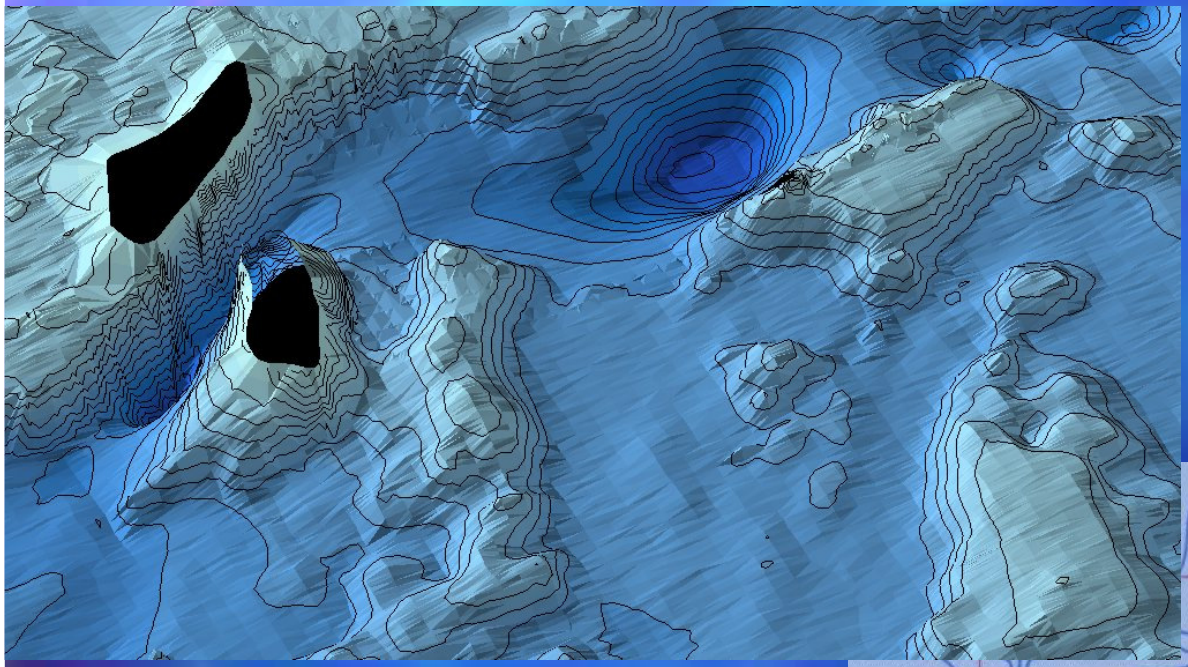
Steep slopes

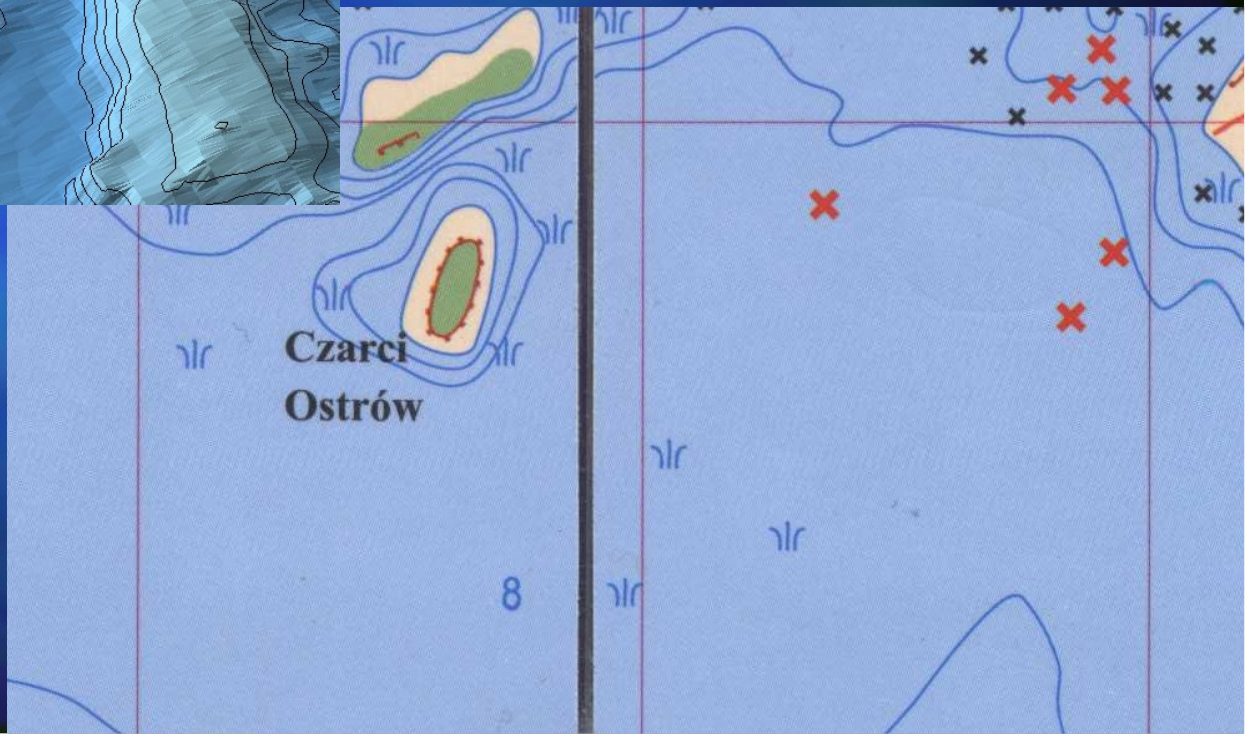


Some fragments of Sniardwy Lake have non identified on the old maps **steep hills** from 6-10 m depth to very shallow areas of 0.5-1 m with **huge stones**

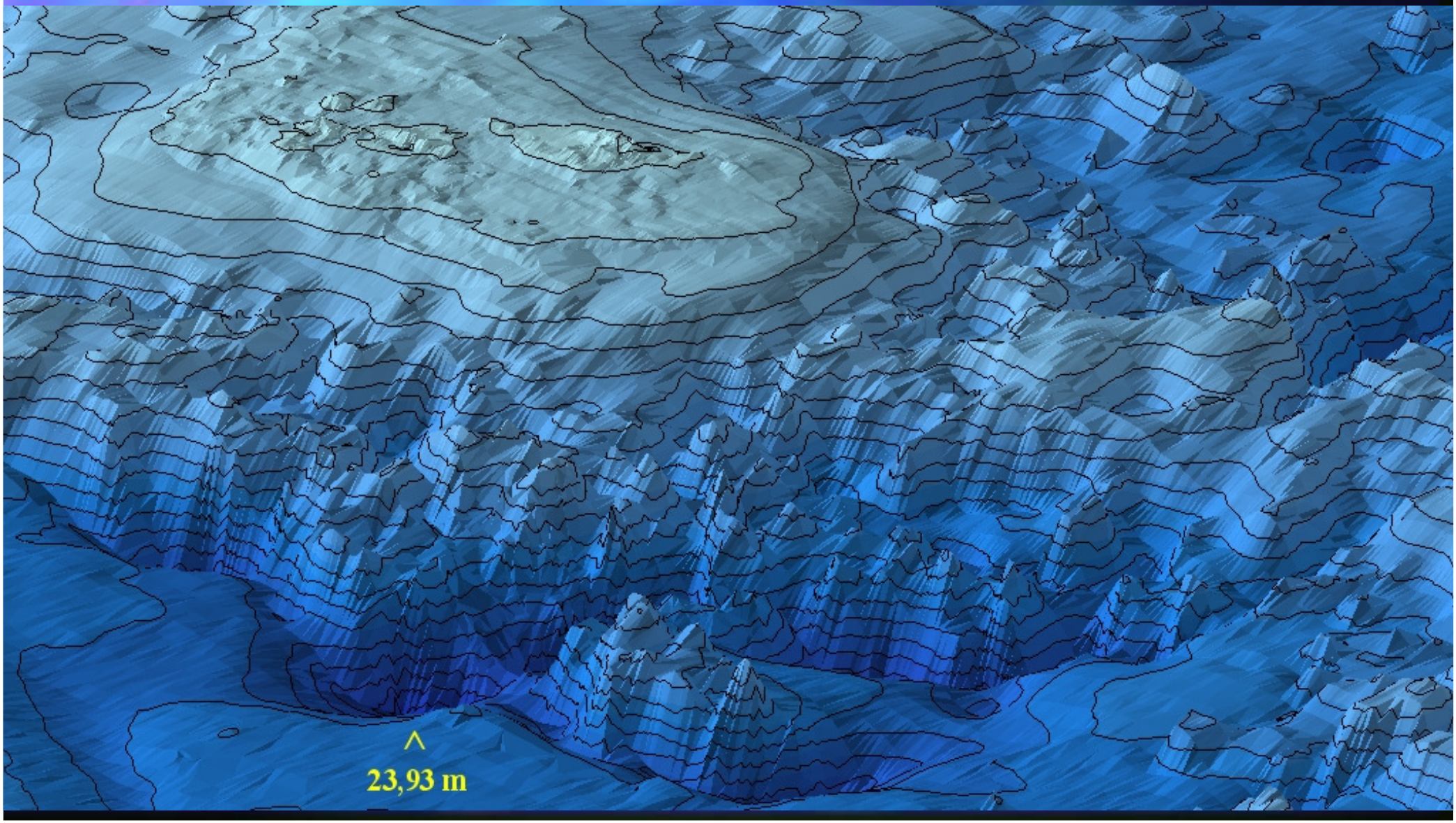

Legend
tin
Elevation
-2,500 - 0
-5,000 - -2,5
-7,500 - -5
-10,000 - -7,5
-12,500 - -10
-15,000 - -12,5
-17,500 - -15
-20,000 - -17,5
-22,500 - -20
-23,930 - -22,5
Meters
0 625 1 250 2 500 3 750 5 000

Digital Terrain Model

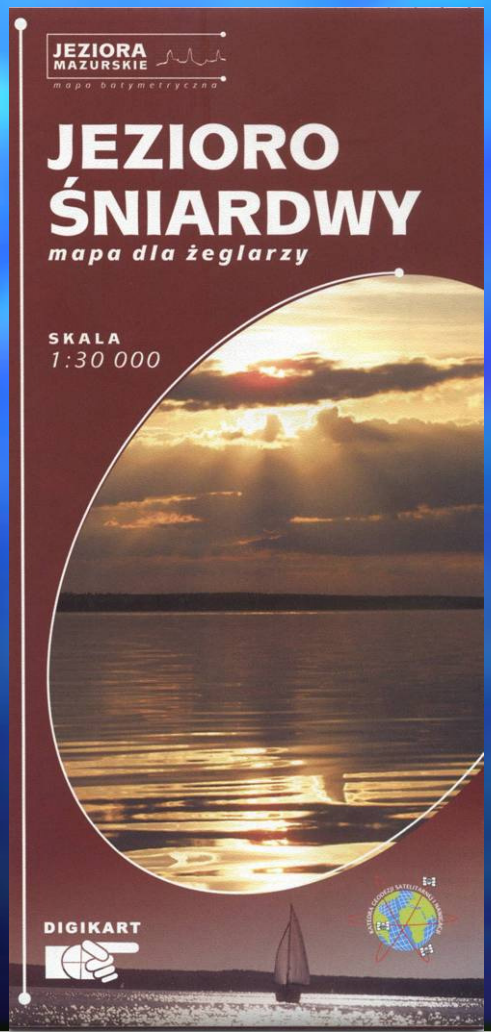


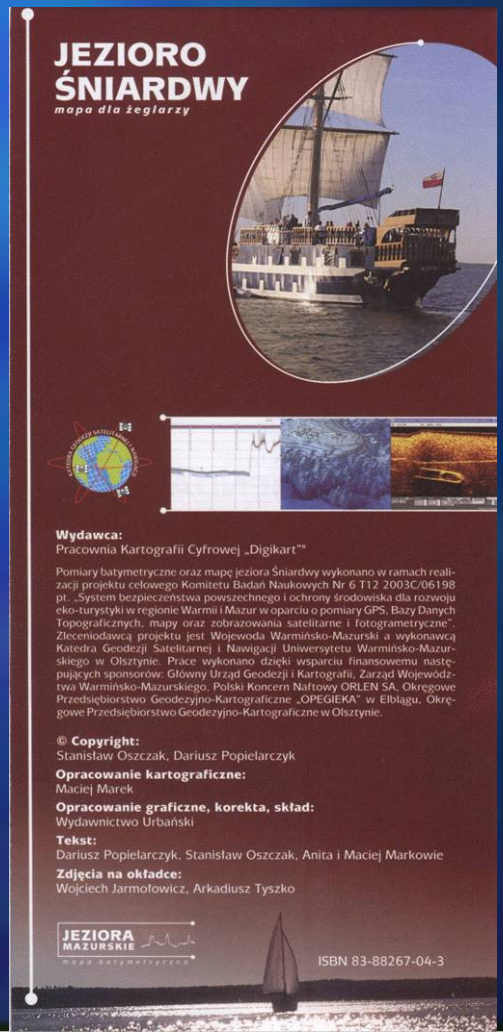


The deepest place of the lake, placed near the widest stone shallow



The new bathymetric map for sailors and fishermen





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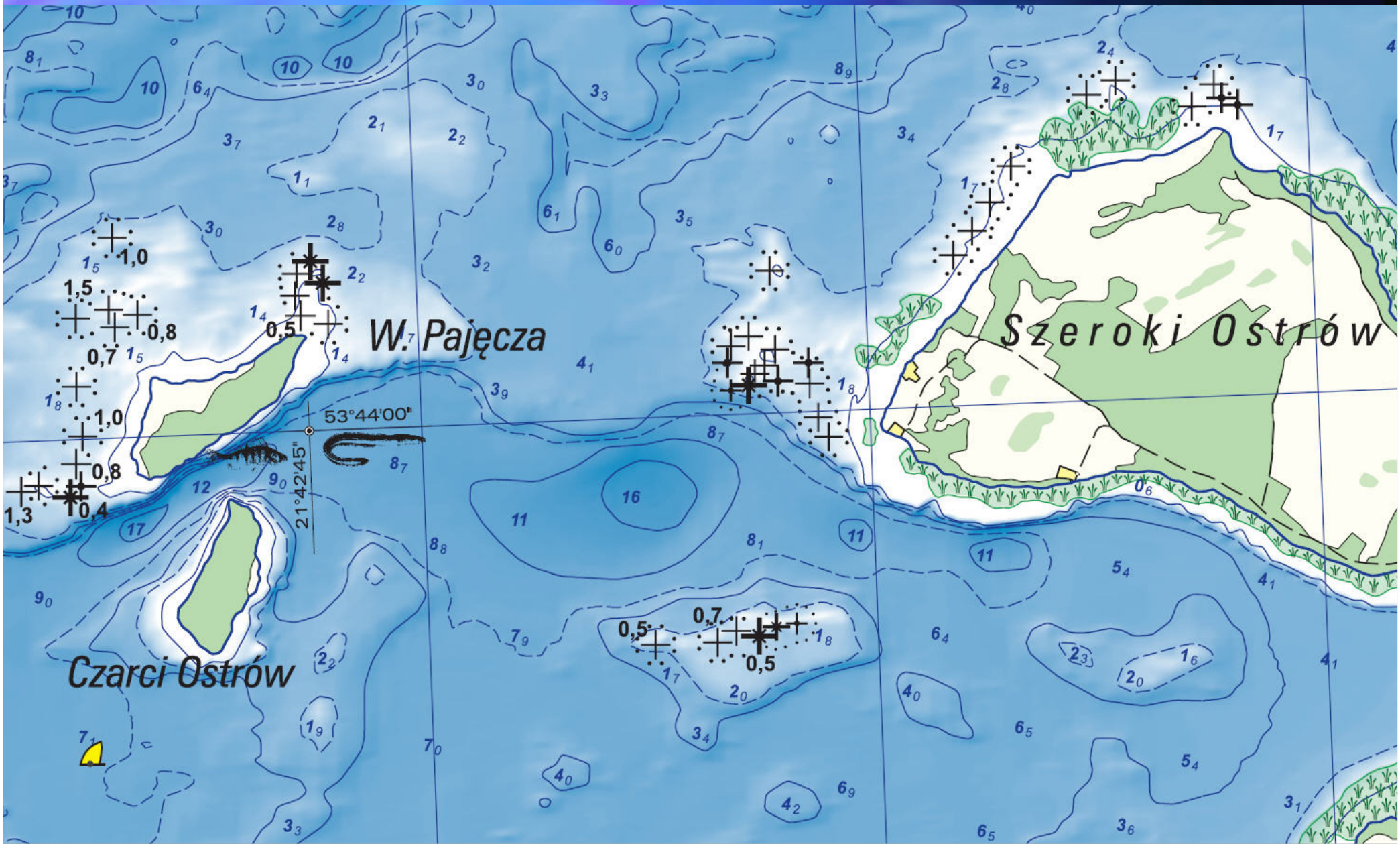
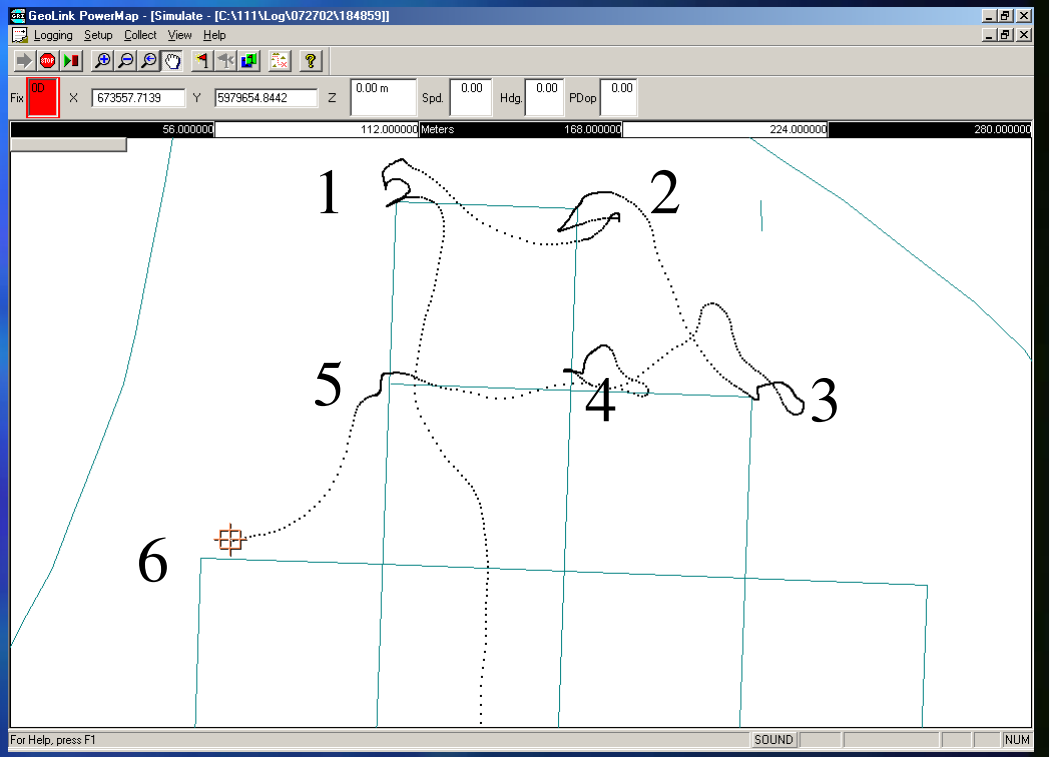


Monitoring of inland water contamination

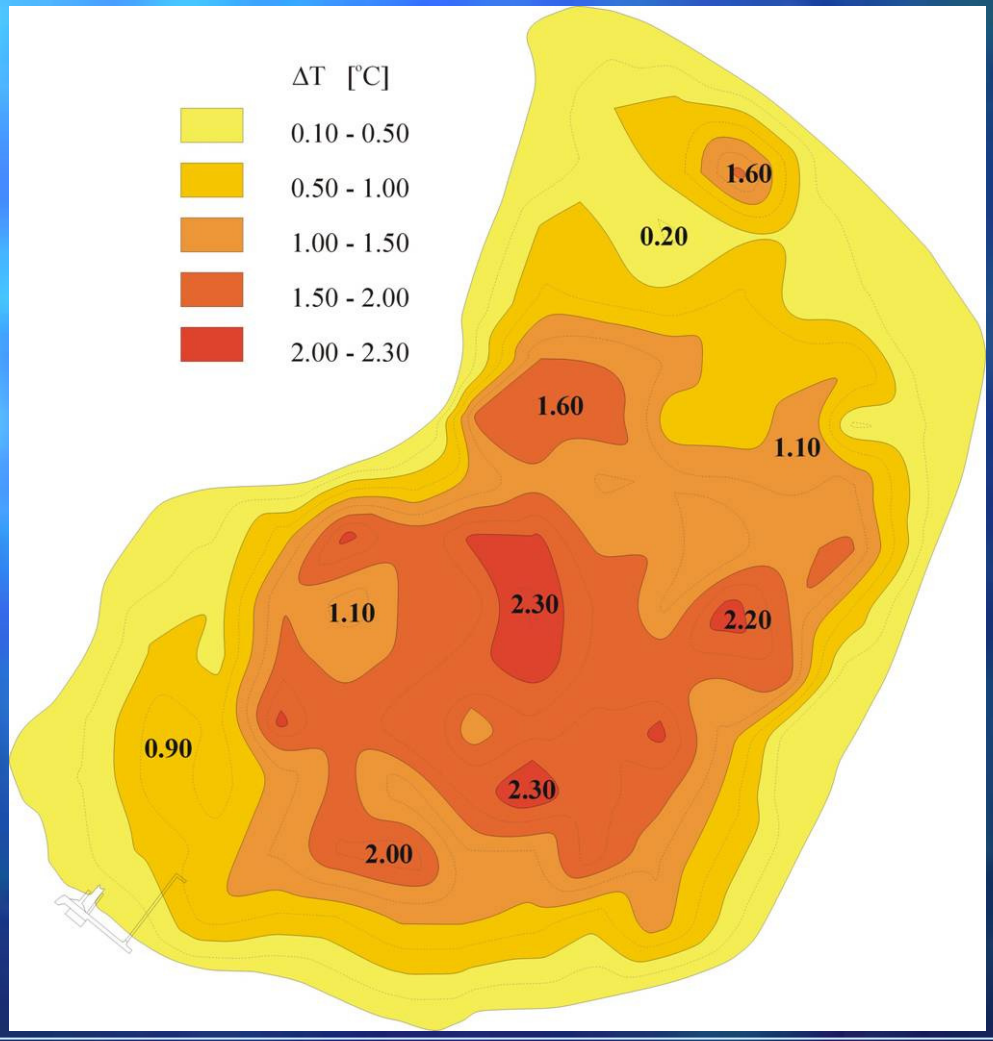
The Underwater Environment Monitoring

The sediment specimen taking

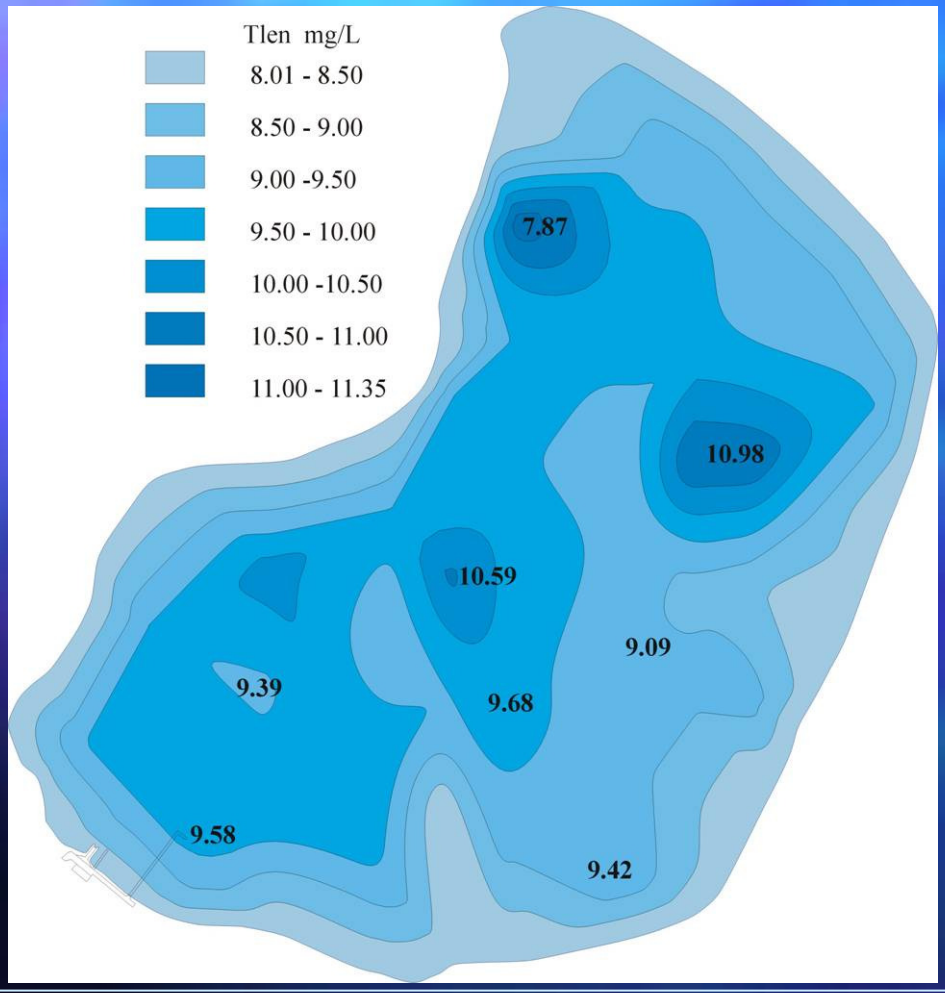


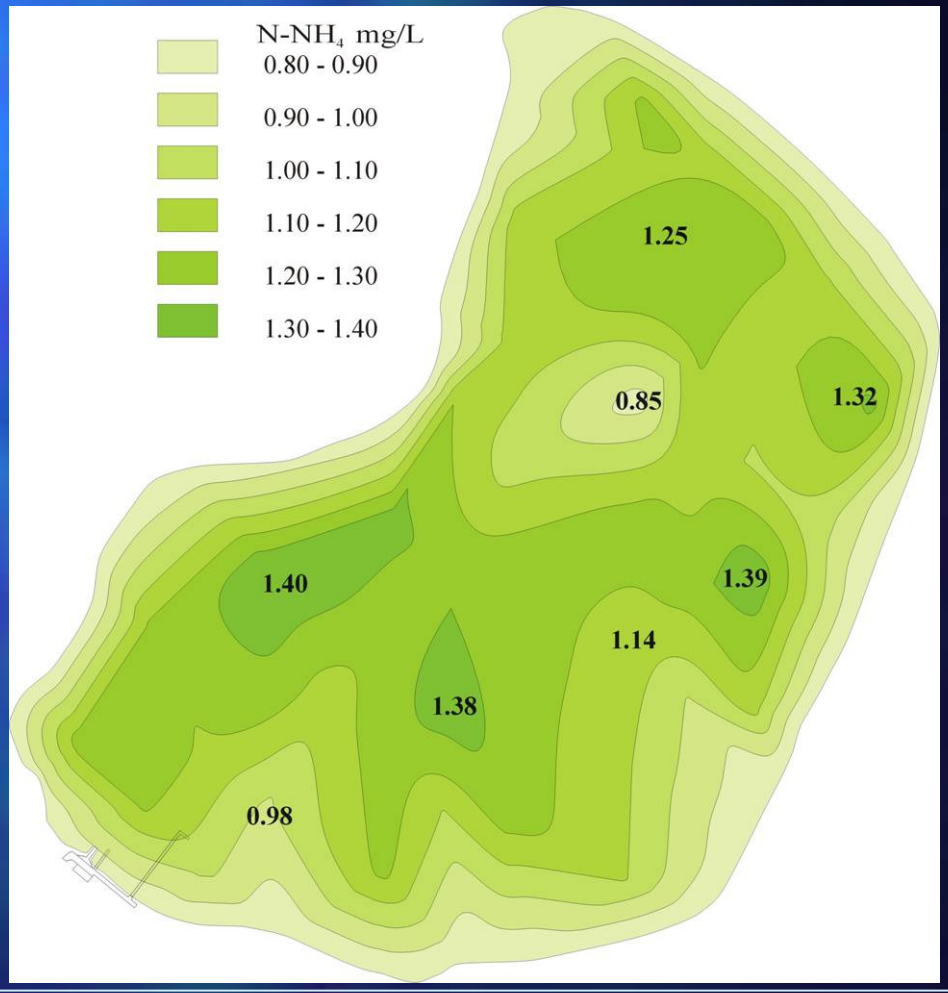
Navigation to pre-defined points

The Temperature Differences Between the Bottom and the Water Surface



The Concentration of the Oxygen and the Ammonium





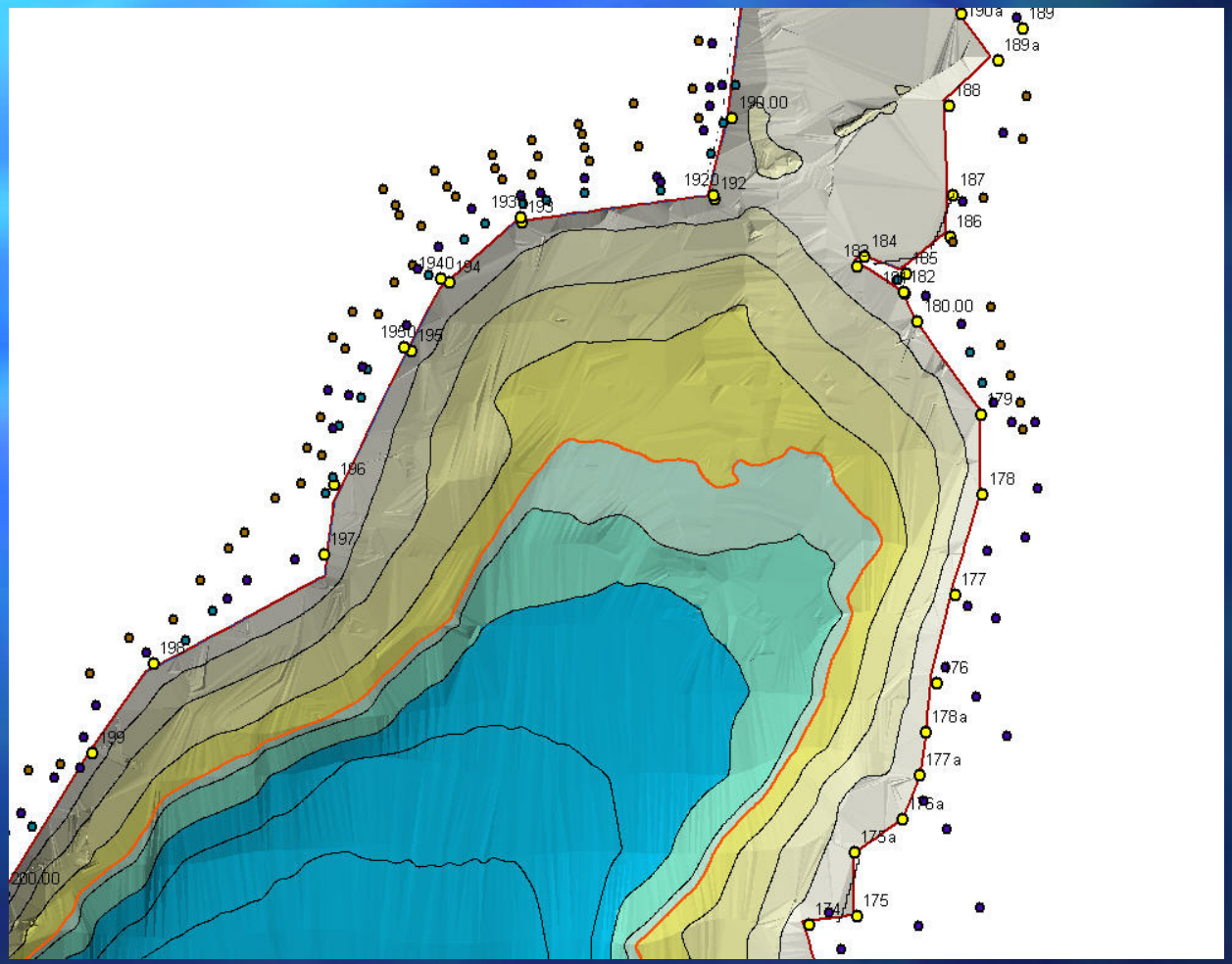
Powerplant water basin controlling

Pumped-storage power station in Żydowo - Poland

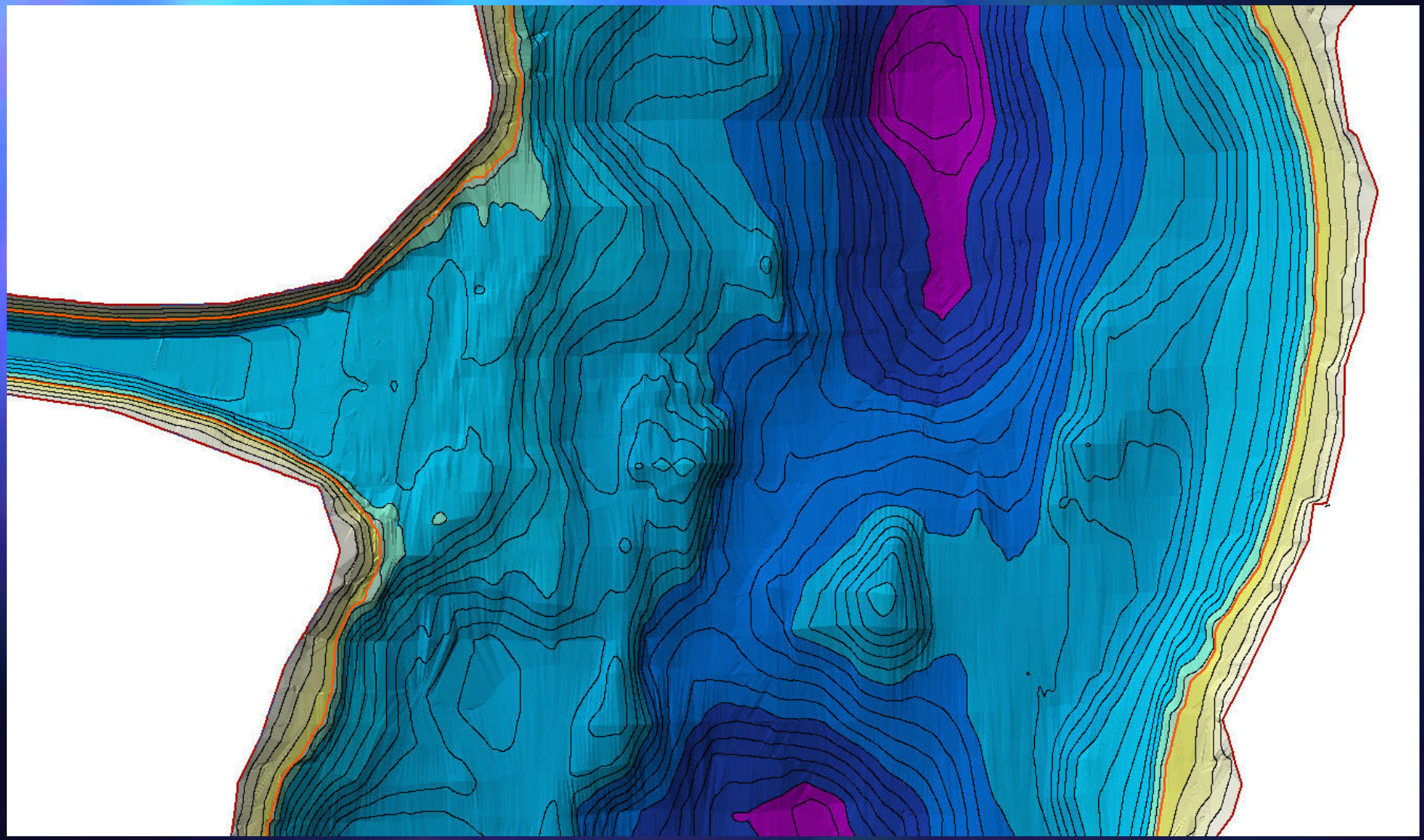
Water supply canal

Hydrographic measurements

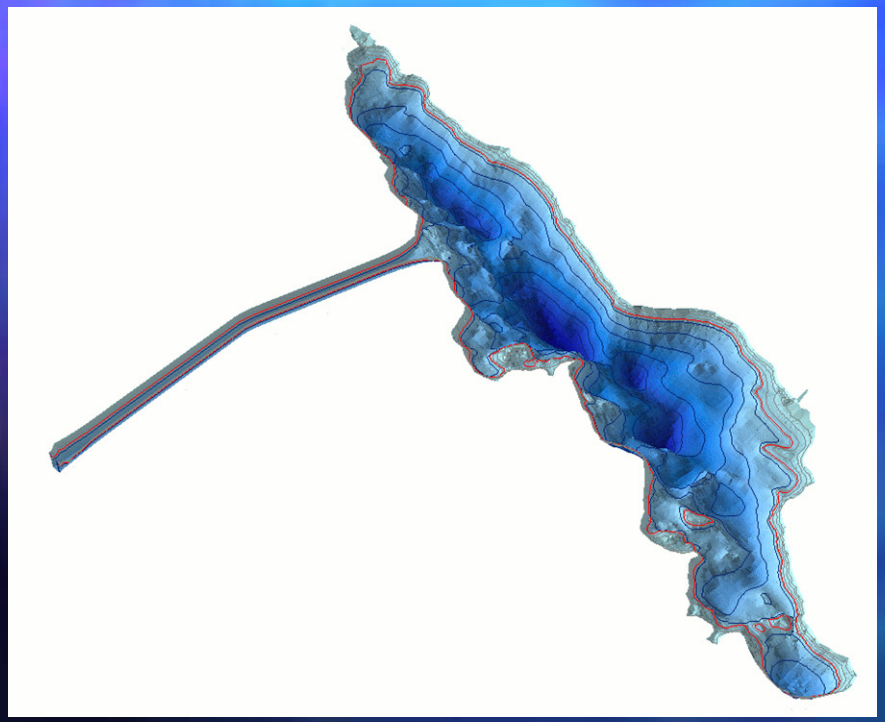
Digital Bottom Model Creation

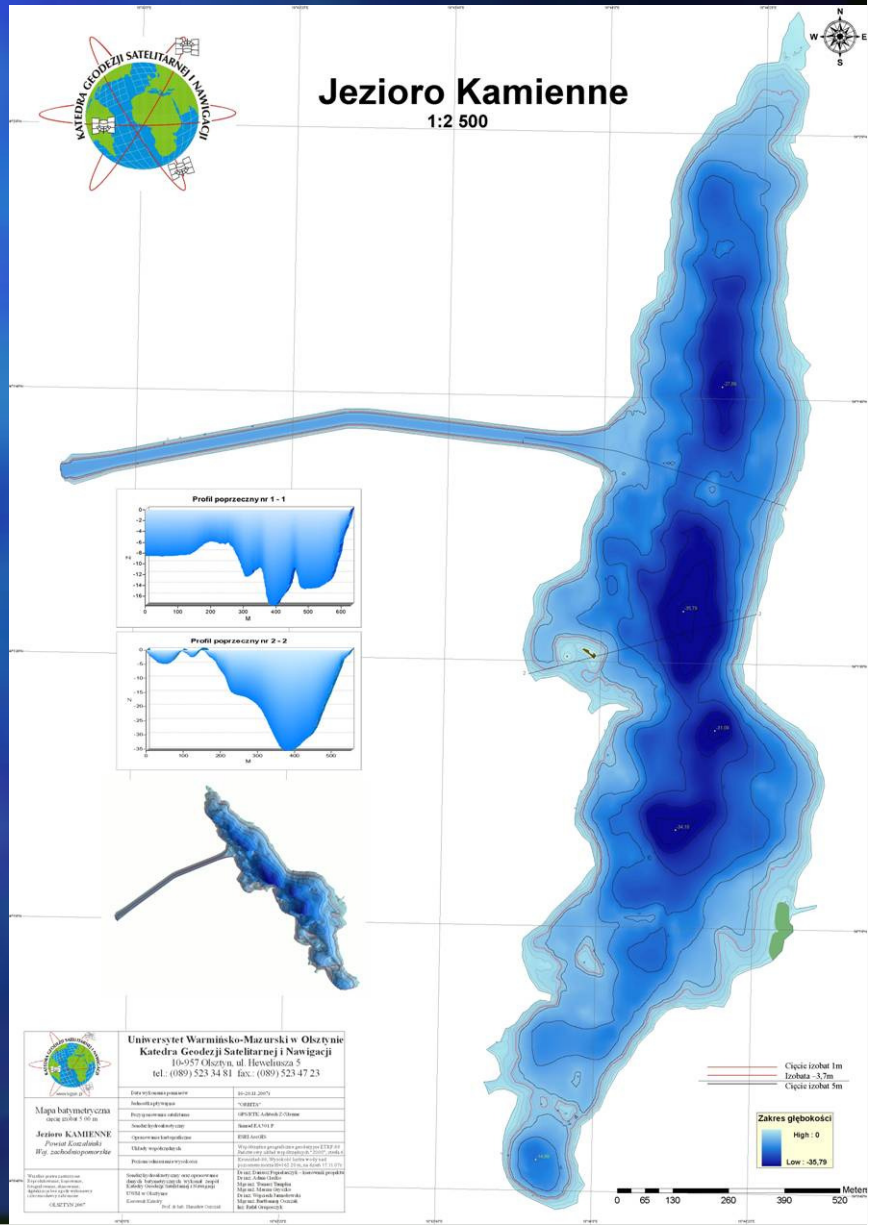


Lake Kamienne

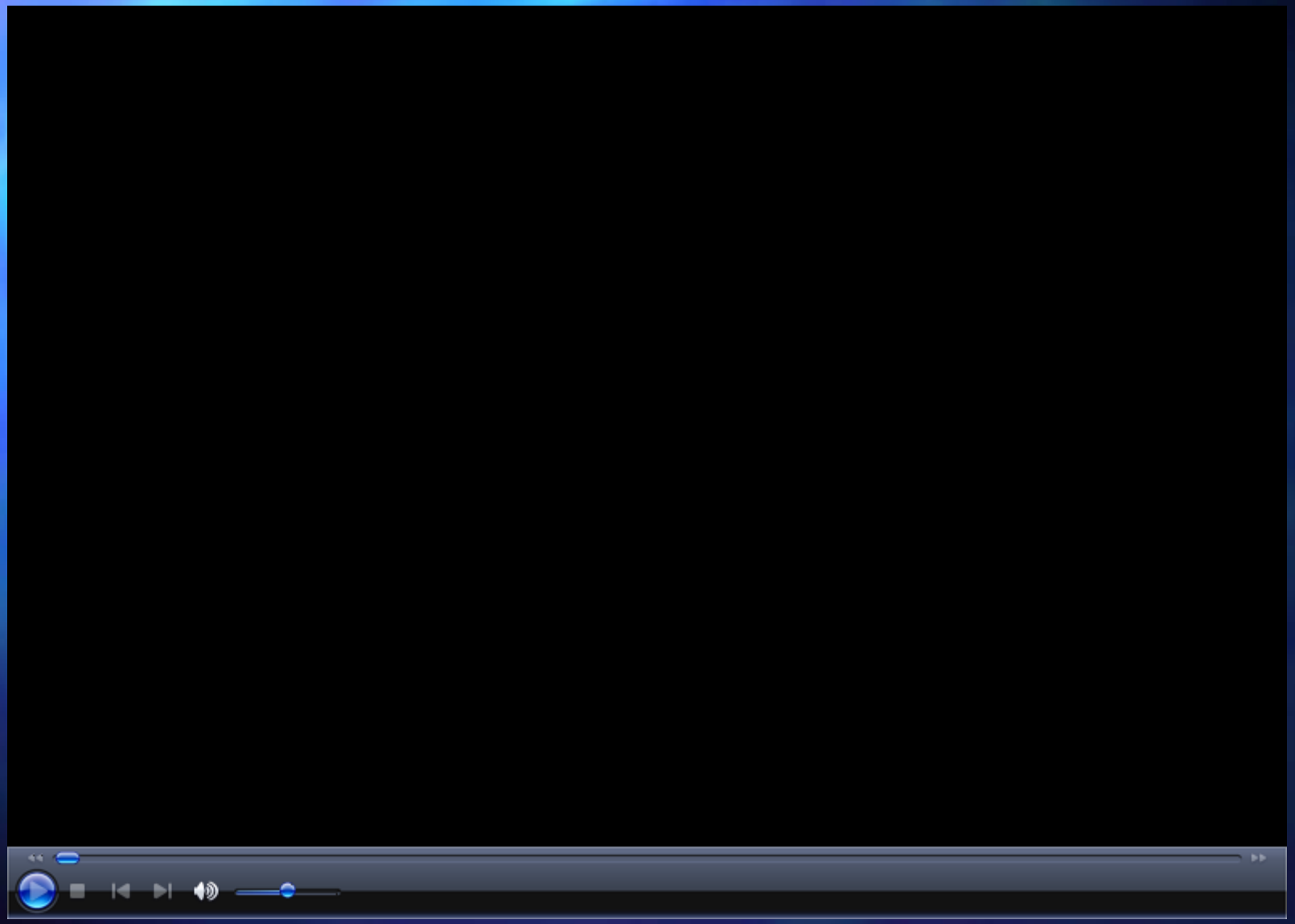


Bathymetric chart elaboration





3D visualization



3D visualization

Dynamic Digital Terrain Model (DTM) creation

Measurement of the profiles

Dynamic DTM creation

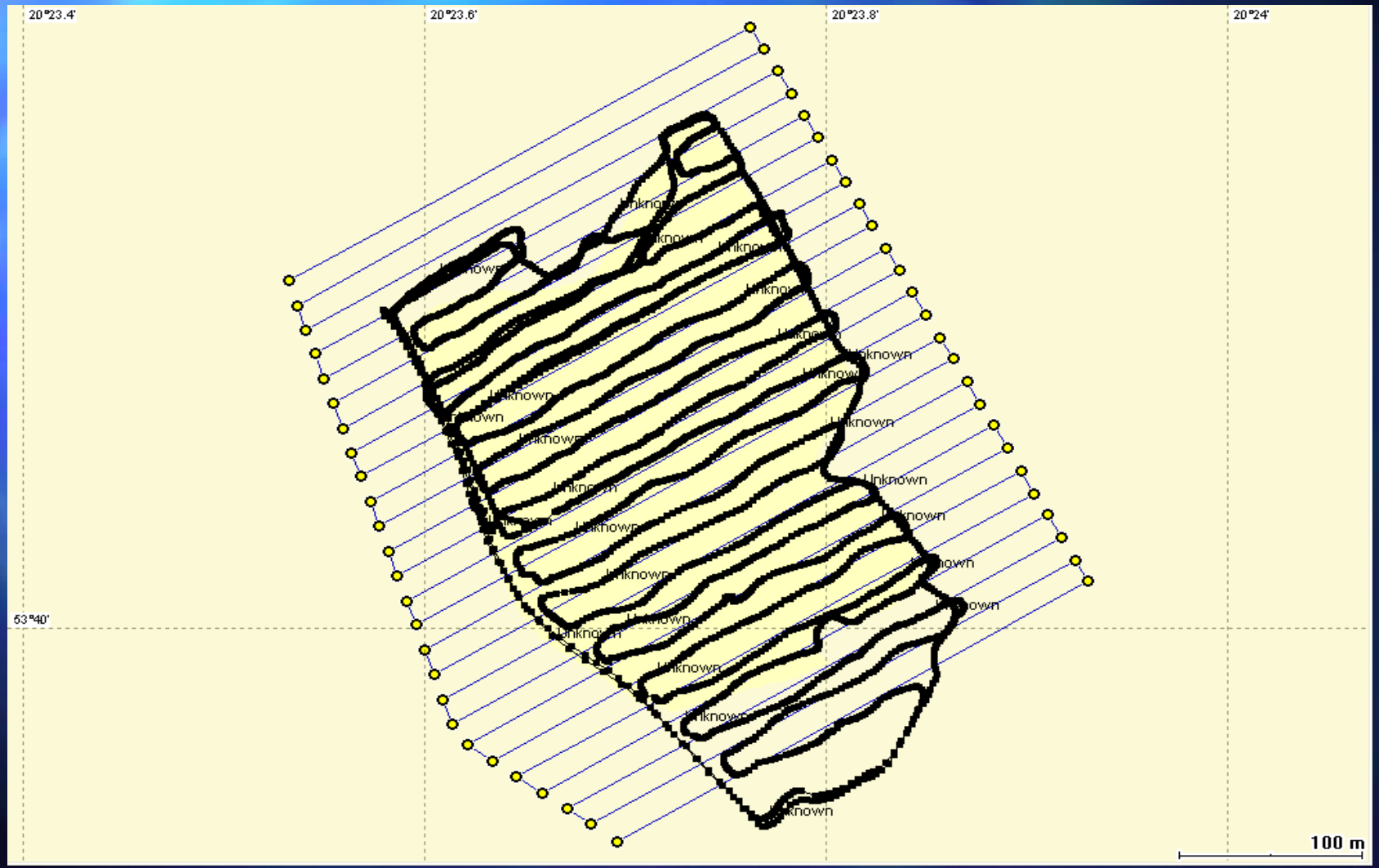
Vehicle taking part in the measurements

Dynamic DTM creation

Real time navigation along measurement profiles

Dynamic DTM creation

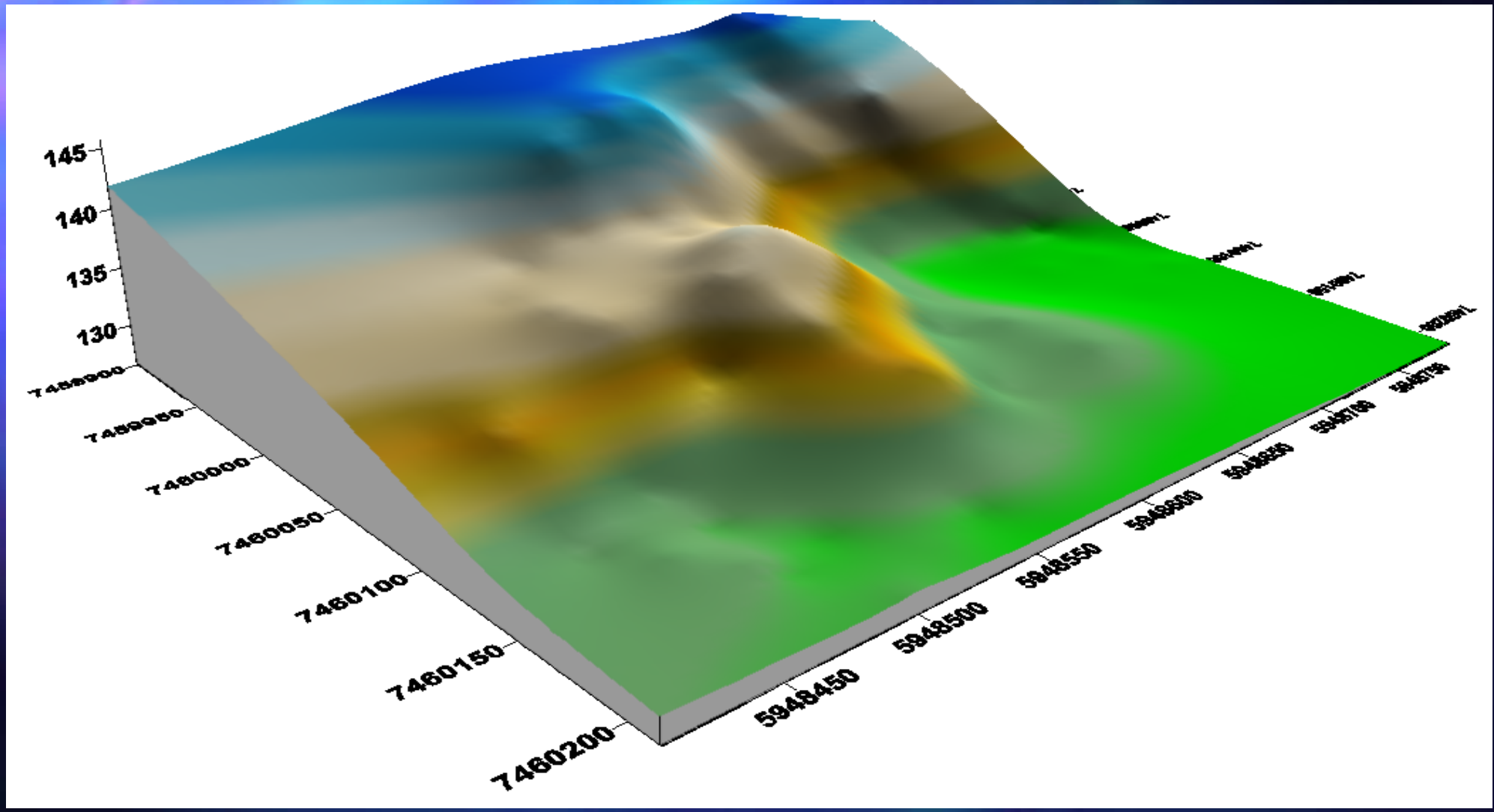
Designed profiles and actual track of the vehicle



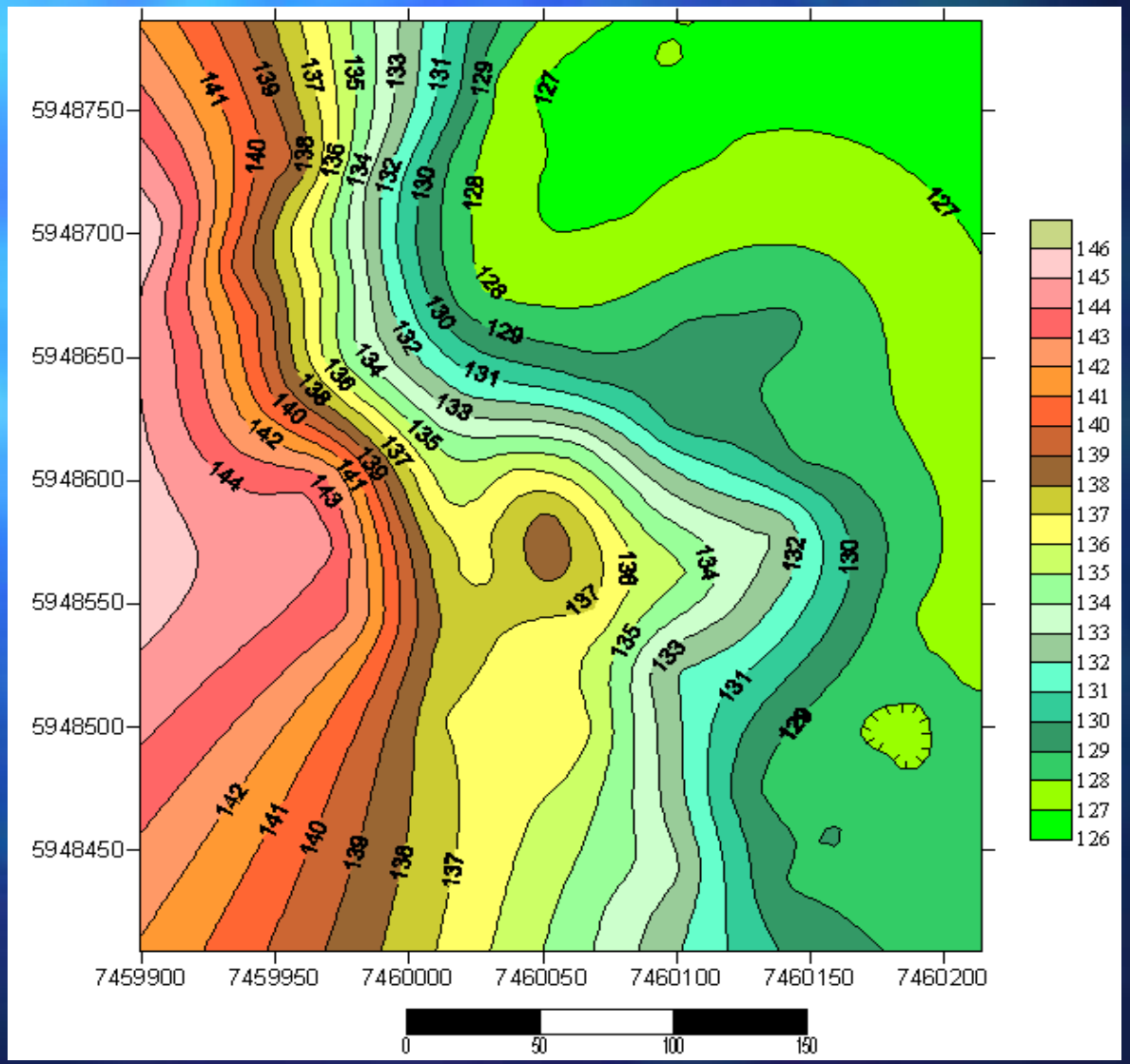
Dynamic DTM creation

Measurement of the profiles

Generation of DTM



Generation of DTM



Conclusion

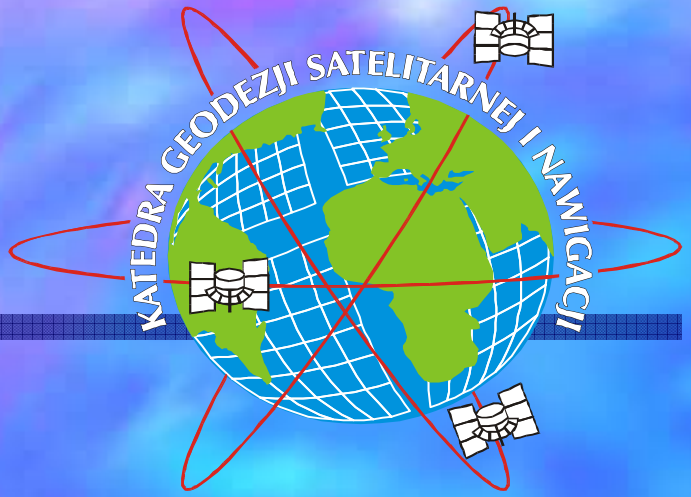
The low cost and high efficient GNSS Integrated Technology on board of motorboat called “ORBITA” has been used for bathymetric measurements on Lake Sniardwy, the largest inland reservoir in Poland. Digital bathymetric chart of the lake was elaborated and published.

Having actual and up-to-date chart of the lake the DGPS/GPRS system provide reliable and precise satellite navigation service for users, as well as the precise monitoring service for sailing boats in the case of emergency, mainly due to the unexpected strong winds and storms.

Having actual charts the inland waterways should be physically localized by buoys or by navigation signs in the case of underwater stones and reefs.

The bathymetric system combined with additional sensors makes possible to study the underwater environment and monitor of positions of inland water contamination sources. The DGPS satellite navigation system can be used for precise navigation from one test point to another during pollution monitoring.

Very efficient and cost-effective generation of DTM (5 ha = 90 min) with centimeter level of accuracy. Using ATV allows driving in any kind of terrain quickly and effectively. The whole process concerning preparation phase and actual measurement phase can be done by just one person.



Thank you for your attention

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