University of Hohenheim
Germany

UNESCO chair-
Life Sciences, Armenia

Development of Measures for a Sustainable Shore Management of Lake Sevan (Armenia) on base of Shore Vegetation as Bioindicators by Application of Remote Sensing and GIS techniques (SEMIS)

(funded by VW-Foundation)

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semis
Sevan Management Information System

VolkswagenStiftung

The SEMIS Project

A cooperation between :

- University of Hohenheim, Stuttgart (Germany)
- State Agrarian University, Yerevan (Armenia)
- University of Vanevan, Martuni (Armenia)
- EOMAP GmbH & Co. KG, Gilching (Germany)


Republic of Armenia (independent since 1991)
REP. of GEORGIA
GEORGIA
REPUBLIC of TURKEY
REPUBLIC of AZERBAIJANI
ISLAMIC REPUBLIC of IRAN
TCHILDIR
L. TCHILDIR
ARPA TCHAI
ASHOTSK
TASHIR
ALAVERDI
NOEMBERYAN
AGHSTEV
GHAZAKH
STEPANAVAN
TOVUZ
KOVLAR
AMASIA
SPITAK
Lori
IJEVAN
BERD
DZEGAM
SHAMKIR
GYUMRI
VANADZOR
Tavoush
DILIJAN
Shirak
KARS
ARTIK
ARTSVASHEN
NARALIK
APARAN
HRAZDAN
SEVAN
CHAMBARAK
KHANLAR
ANI
ARAGATZ
Aragatzotn
DIGOR
TALIN
Kotayk
KAMO
L. Sevan
ARAGATZ
ASHTARAK
ABOVYAN
ETCHMIADZIN
YEREVAN
ARMAVIR
VARDENIS
MARTUNI
Armavir
GARNI
MASIS
Ararat
Gegharkounik
ARTASHAT
IGDIR
YEDI
Vayots dzor
JERMOUK
ARARAT
YEGHEGNADZOR
VAYK
DOGOUBAKAZIT
MAKU
NAKHICHEVAN
Nakhichevan Autonomous Republic (Azerbaijan)
Syunik
KAPAN
KAJARAN
ZANGELAN
JOULFA
MEGHRI
Shahoumyan
SHAHOUMYAN
REPUBLIC
MARDAKERT
Mardakert of
KELBAJAR
AGHDAM
Askeran
KARABAKH
DALIDAGH
STEPANAKERT
MARTOUNI
Martouni
MURAD-TAPA
SHUSHI
LATCHIN
Shusha
Hadrout
FIZOULI
HADROUT
SISIAN
GORIS
HORADIZ
KUBATLY
JEBRAIL
BLACK SEA
CASPIAN SEA
RUSSIA
GEORGIA
AZERBAIJAN
TURKEY
IRAN
SYRIA
IRAQ
Scale
0 25 km.
0 20 mi.
National capital
Population over 100.000
Population over 50.000
Population over 30.000
Azeri enclaves annexed by Armenia
HISTORY OF ARMENIA

Study site

Lake Sevan (Armenia)

- **one of the greatest freshwater high-mountain lakes of Eurasia (1898m above Baltic Sea)**
- **largest water body in the Transcaucasus Region (surface area of 1243km^2)**
- **the biggest source of drinking water for Armenia and its adjoining countries**

The Sevan Problem

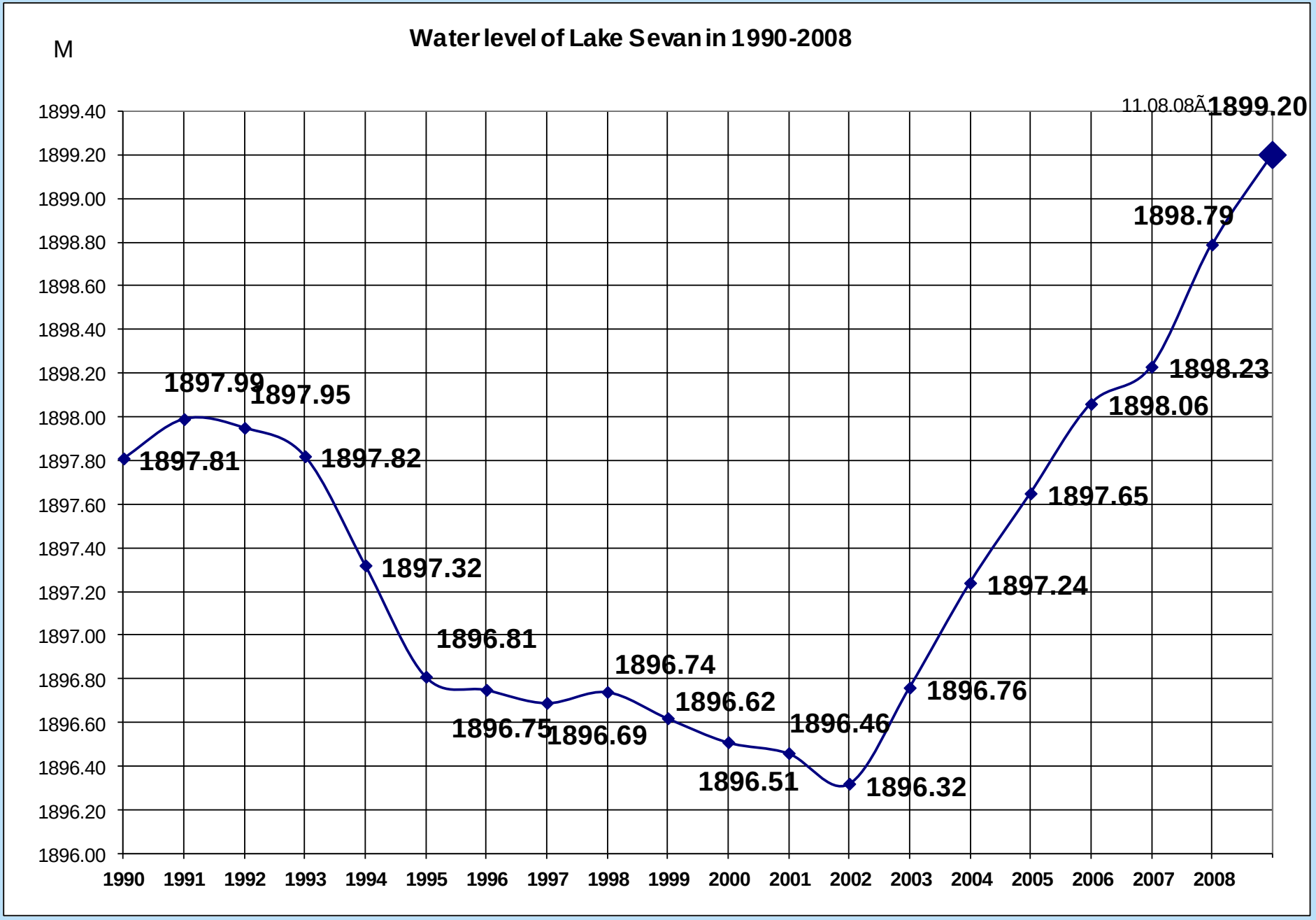
- **Lowering of lake level by 20 m for water power and irigation and uncontrolled pollution from agriculture, industry and municipalities**

Objectives:

- **Development of automated classification algorithms for shore vegetation from multispectral satellite data**
- **Setup of a geographic information systems of shore vegetation structures of lake Sevan**
- **Development of assessment tools on base of classifications of shore vegetation structures**
- **Prediction of changes in shore vegetation due to water level fluctuations**
- **Importance of macrophytes in accumulation of**

Lake Sevan, Armenia

- ❖Lake Level: 1921 m above the Baltic Sea level
- ❖Surface Area: 1243 km²
- ❖Length: 75 km
- ❖ An average Width of 19 km


Water level of Lake Sevan in 1990-2008
M
11.08.08Ã
1899.20
1898.79
1898.23
1898.06
1897.99
1897.95
1897.81
1897.82
1897.65
1897.32
1897.24
1896.81
1896.74
1896.62
1896.76
1896.75
1896.69
1896.46
1896.51
1896.32
1899.40
1899.20
1899.00
1898.80
1898.60
1898.40
1898.20
1898.00
1897.80
1897.60
1897.40
1897.20
1897.00
1896.80
1896.60
1896.40
1896.20
1896.00
1990
1991
1992
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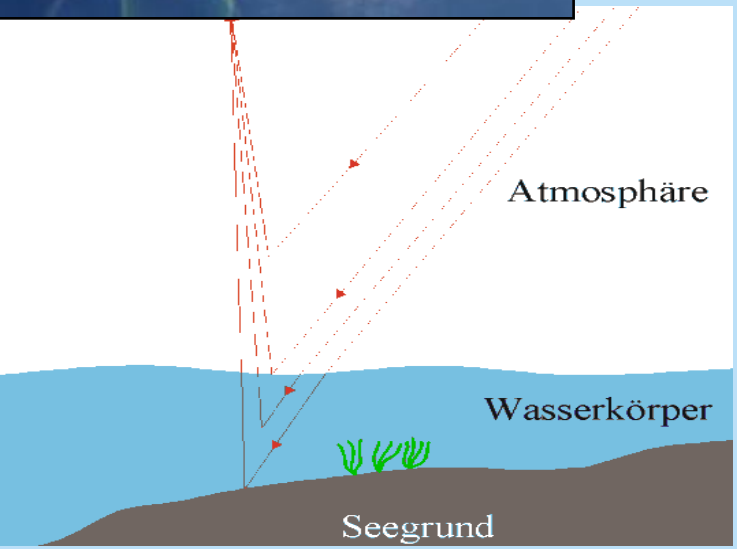
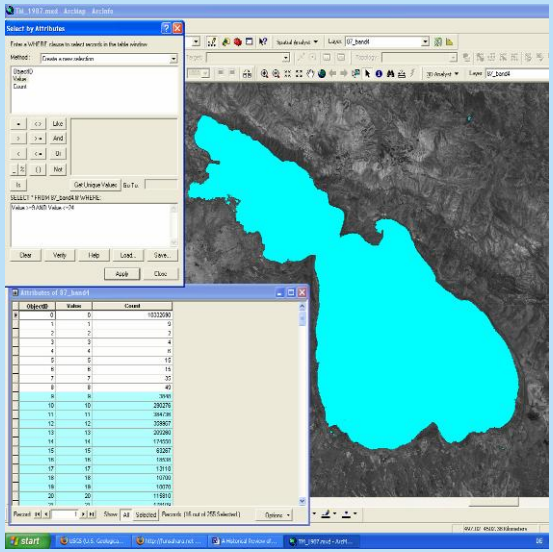
2003
2004
2005
2006
2007
2008

Methods of SEMIS project

Remote sensing techniques



GIS-Analyses



Ground truth

Remote Sensing Data


EOS Terra/Aqua with MODIS sensor

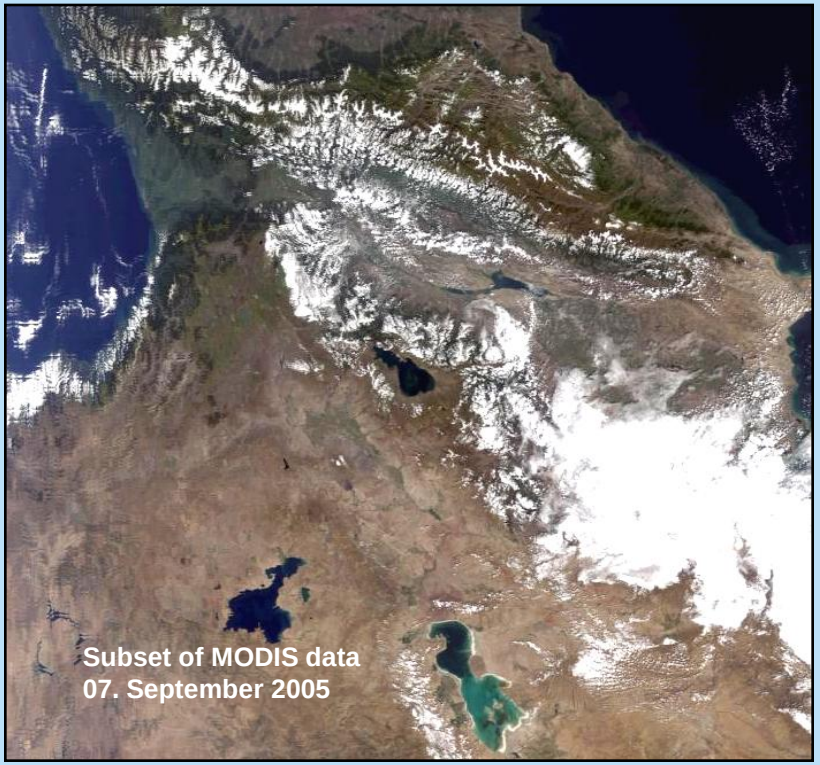
Satellite data from MODIS sensor

on EOS Terra/Aqua

- 36 spectral bands : 407nm – 14385nm
- Spatial resolution : 1km up to 0.250 m

- Used for algorithm :
  10 bands in VIS / IR,
  spatial resolution of 1km

- Input data for algorithm :
  calibrated radiances
  at sensor


Subset of MODIS data
07. September 2005

Remote Sensing Data

Landsat images

- from different decades with beginning of 1970‘s
- as snapshot of whole situation of lake Sevan
- Spatial resolution ~30 m, spectral resolution: 7 bands
- for historical review

Remote Sensing Data

QuickBird images of 4 ROIs (2006, 2007, 2008)

- on demand and from archive
- Spatial resolution 2.7 m
- for classification of **littoral zone**

MIP Modular Inversion & Processing System

Software developed by

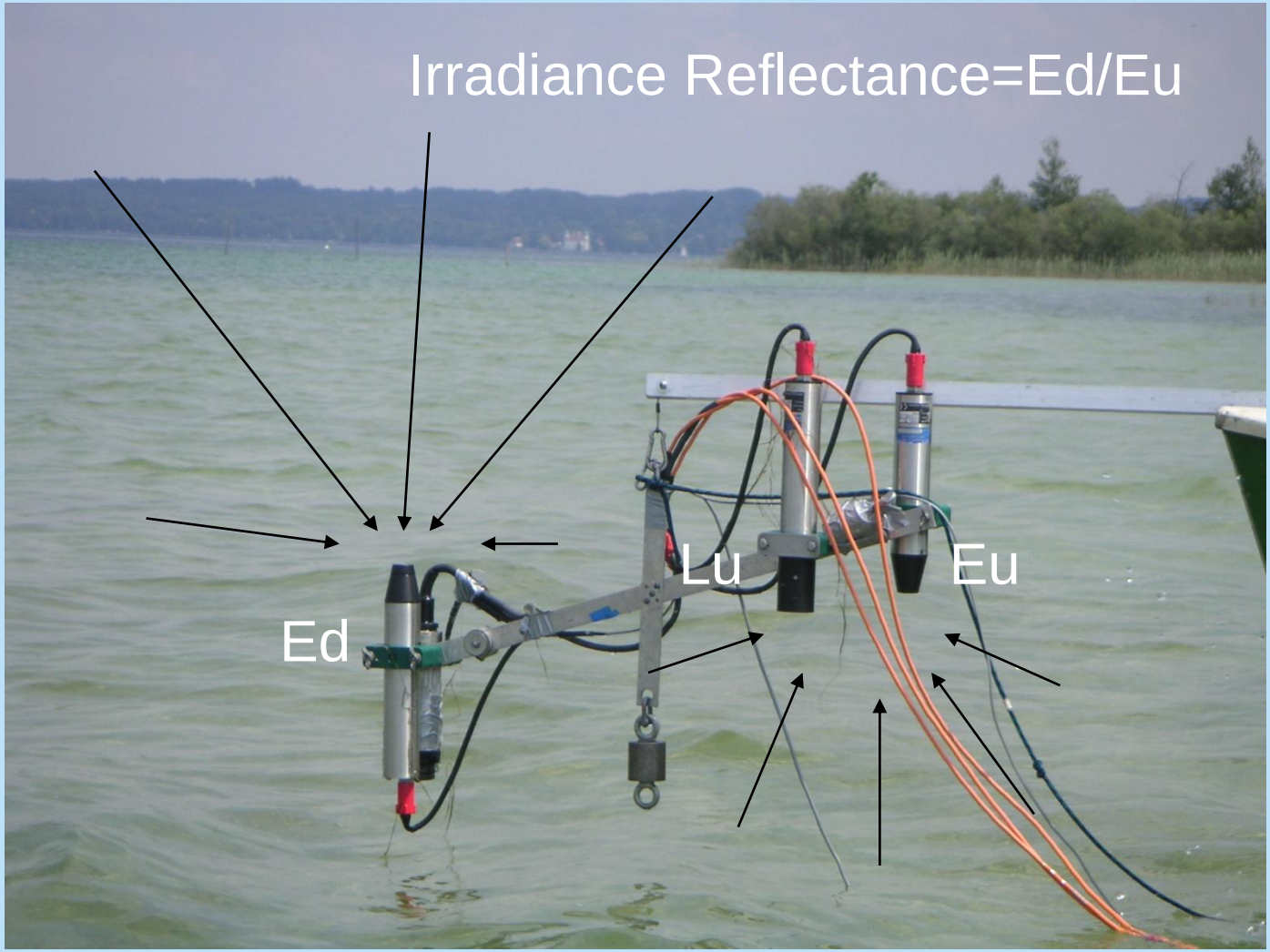
Dr. Thomas Heege, Dr. Viacheslav Kisselev & Sabine Miksa

exploited and enhanced

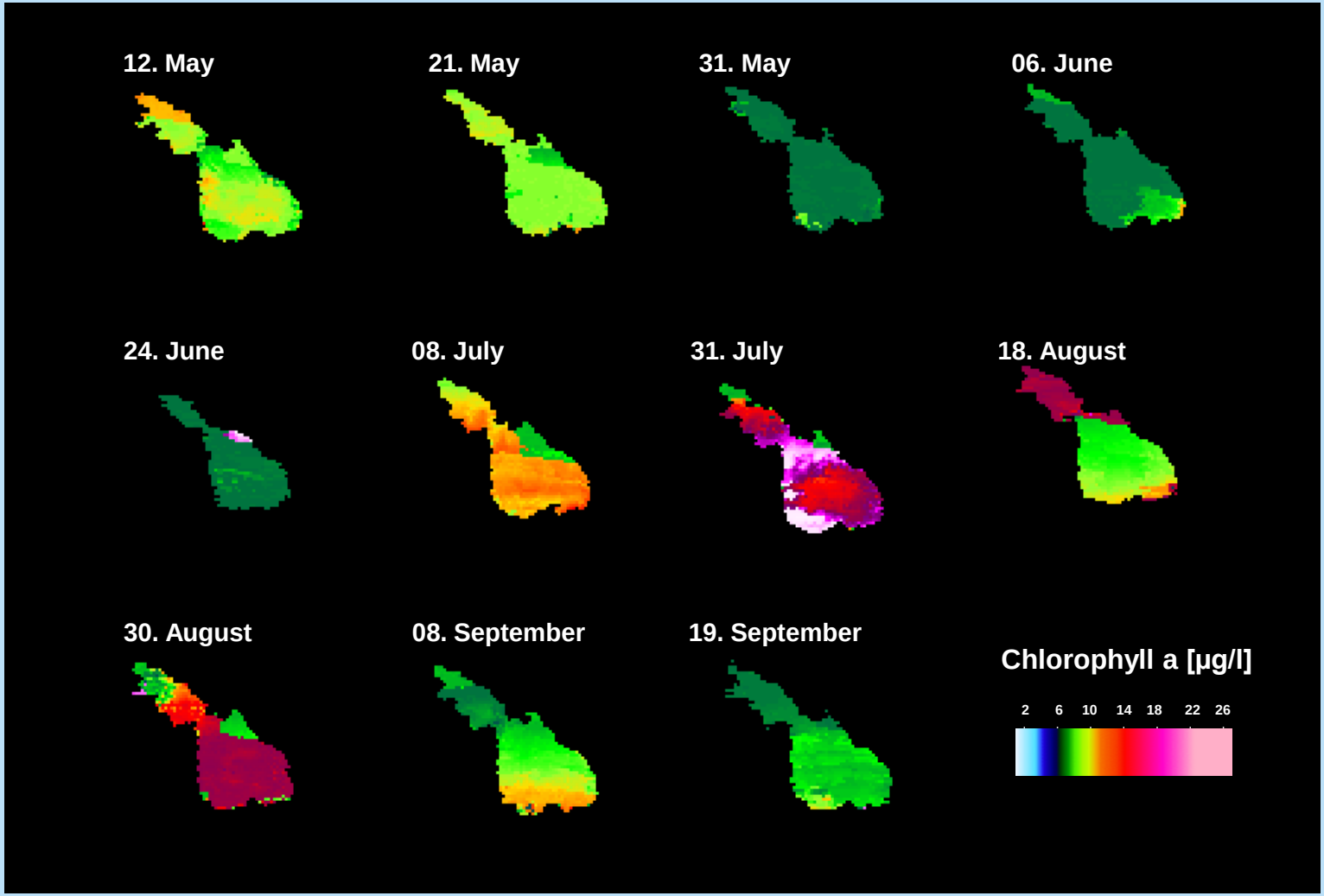
EOMAP GmbH & Co. KG, Gilching/Germany

http://www.eomap.de

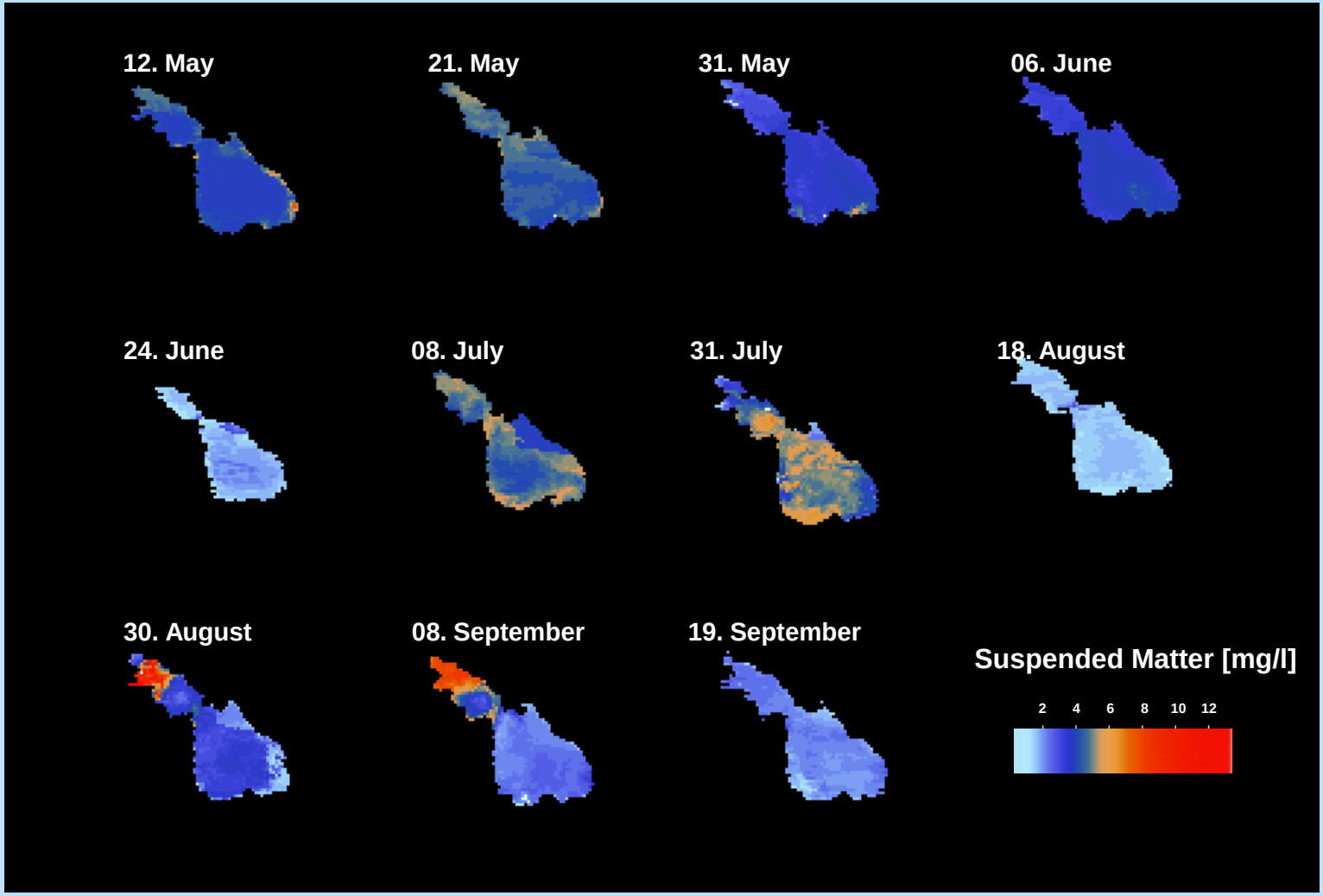
Ground Truthing



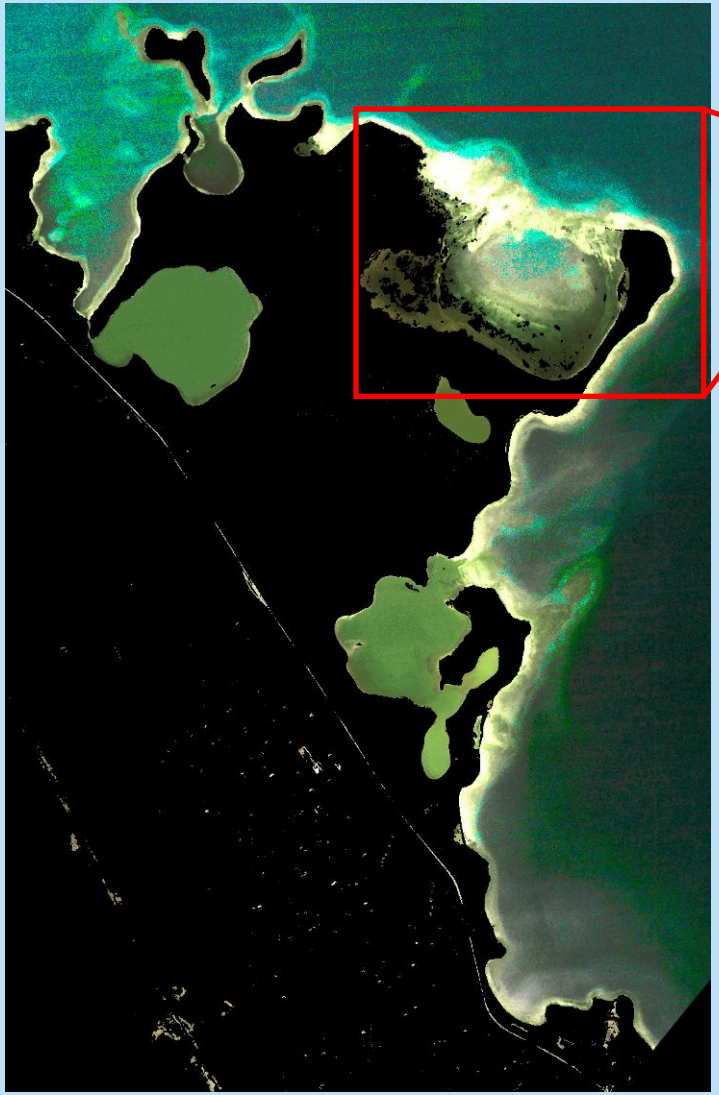
Time series of 2006 – Chlorophyll a

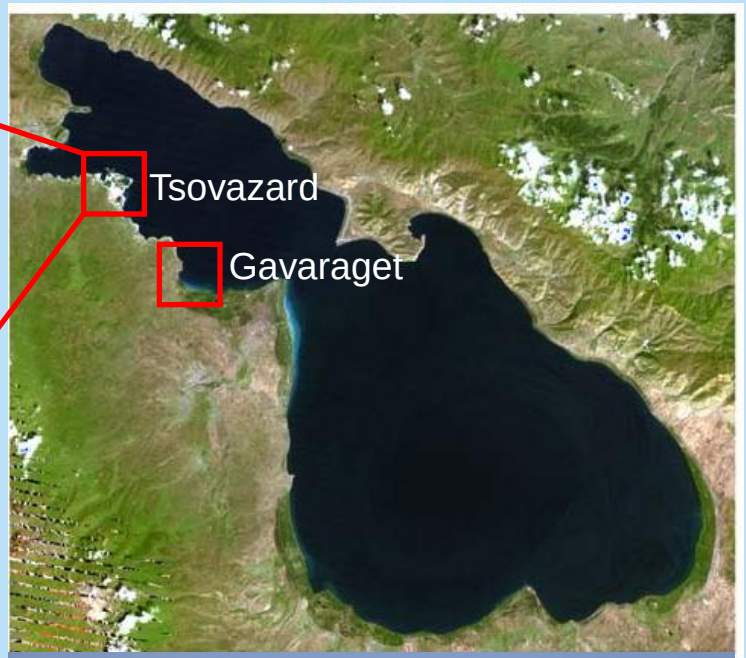


Time series of 2006 – Suspended matter



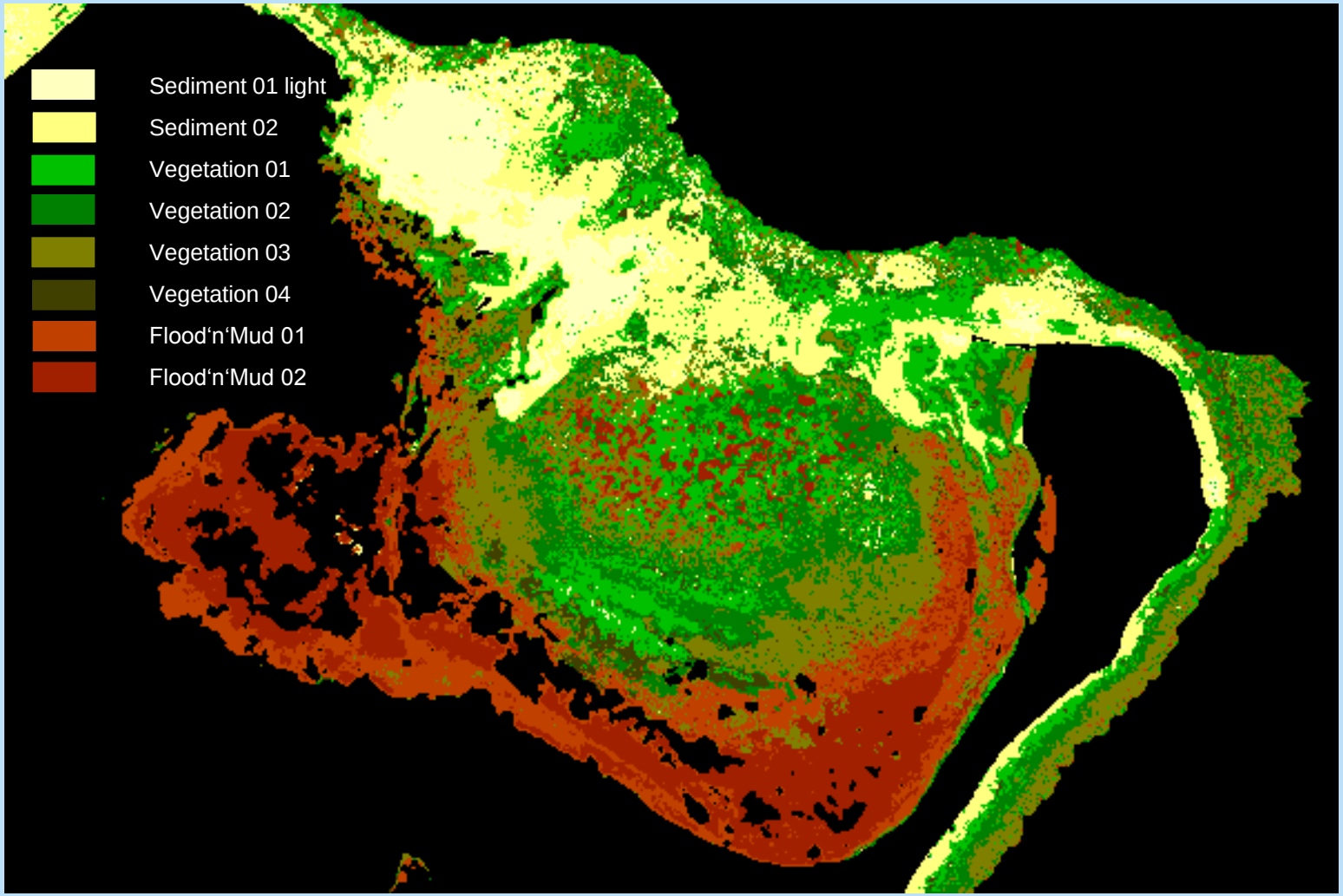
QuickBird 2007 Classification
- ROI Hrazdan-Tsovazard and Gavaraget



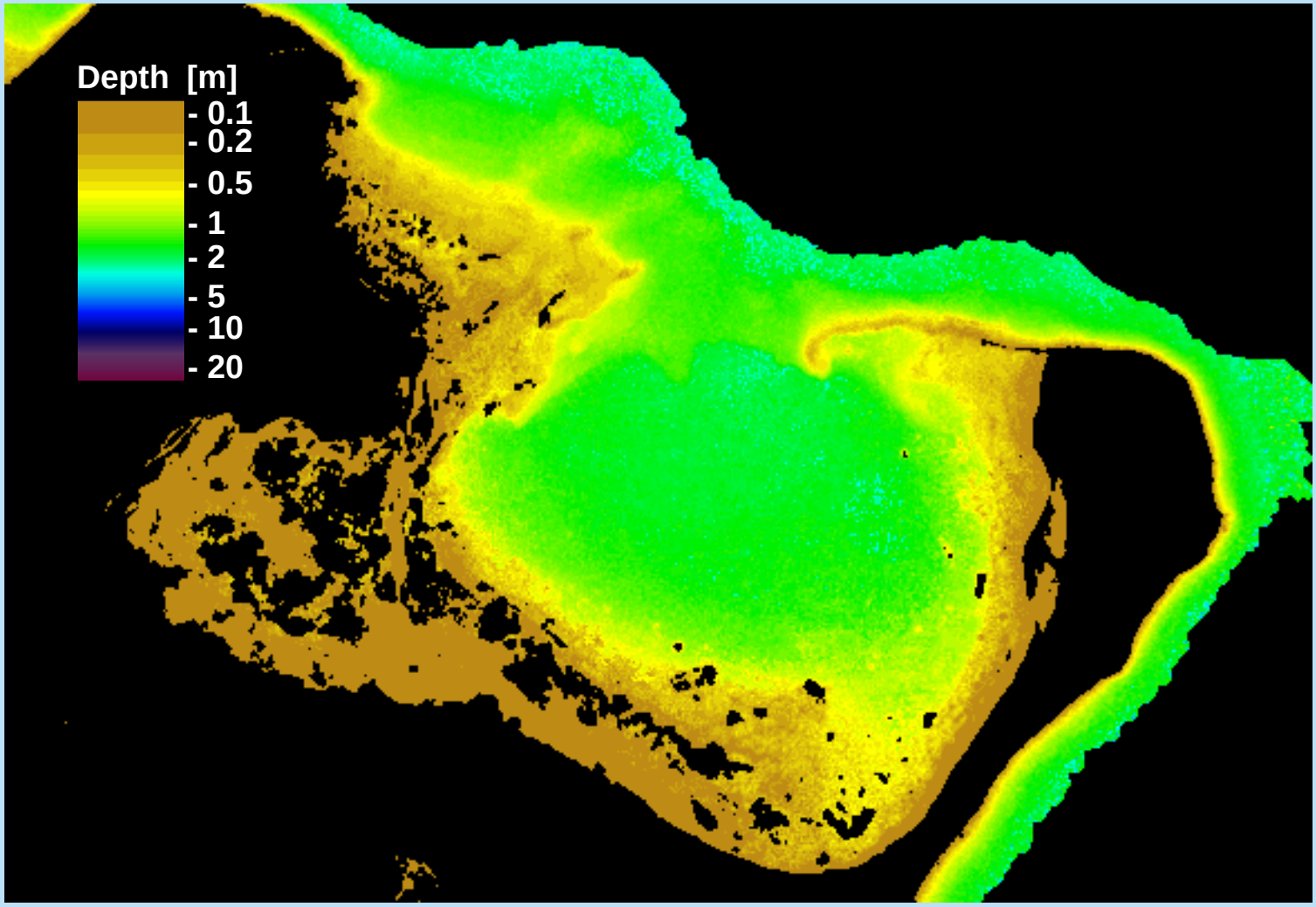


QuickBird 2007 Classification - ROI Hrazdan-Tsovasard

QuickBird 2007 Classification - ROI Hrazdan-Tsovasard



Water depth retrieval QuickBird 2007 - ROI Hrazdan-Tsovasard



Consequences for Lake Sevan

- The littoral zone of Lake Sevan plays very crucial roles in its ecological functions
- It is critical that sustainable lake management systems take into account littoral zone development
- Lake level fluctuations affect predominantly the littoral zone

Mapped Macrophytes

SPECIES	Veg_Type	Growth_Type
Agrostis stolonifera	Emersed	
Bolboschoenus maritimus	Emersed	
Carex disticha	Emersed	
Ceratophyllum demersum	Submersed	*Low*
Chara spp.	Submersed	*Low*
Cladophora spp.	Submersed	*High*
Cyperus spp.	Emersed	
Hippuris vulgaris	Submersed	*High*
Myriophyllum spicatum	Submersed	*High*
Phragmites australis	Emersed	
Persicaria amphibia	Emersed	
Potamogeton filiformis	Submersed	*High*
Potamogeton pectinatus	Submersed	*High*
Ranunculus circinatus	Submersed	*High*
Ranunculus spp.	Submersed	*High*
Schoenoplectus lacustris	Emersed	
Sparganium erectum	Emersed	
Sparganium ramosum	Emersed	
Thypha angustifolia	Emersed	
Thypha latifolia	Emersed	
Zannichellia palustris	Submersed	*Low*

Outlook

- Improvement of classification algorithms of satellite images to obtain accurate classifications of shore vegetation structures
- Development of tools for the assessment of the ability of the littoral zone to provide its ecological functions
- Model of development of shore vegetation and ecological functionality in dependence to further water level rise

The SEMIS team

Questions and discussion