Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

New methods for environment monitoring and surveillance

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Monitoring strategy of the state of the environment 2020 (2011)

Goals:

- Cost-effective optimization of monitoring
- Utilization of new methods
- Wide range of actors
  - NGO's
  - Civil Science and observations
  - Private sector
- Effective use of versatile data
  - Integration of varied data
- Effective use of monitoring results
  - Administration, decision making
  - Commercial solutions
  - Development and Research

MONITOR 2020-programme ja ENVIBASE-project

- MONITOR 2020-programme (2013-2019) implements the goals of Monitoring strategy
- No permanent funding, resources are applied from different sources (EU-programmes, National development programmes, Academy of Finland etc.)
- Programme has a road-map ja timetable for development goals

- ENVIBASE-project (2015-2017) was a major investment for the development of new monitoring methods:
  - Earth observations (Sodankylä satellite datacentre)
  - Civil Science and amateur observations
  - Datamanagement development (SpeciesDataCentre, Metadata-platform, Data Integration Interfaces)

ROAD-MAP OF MONITOR 2020-PROGRAMME

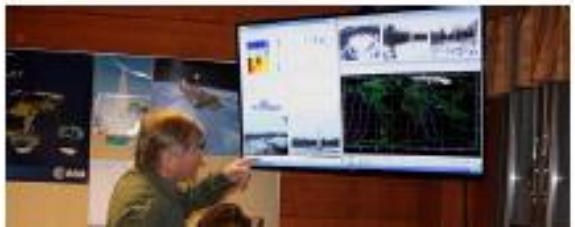
		2016	2017	2018	2019	2020
METHODS	A1: Remote Sensing and Earth Observations	National Aerial Photography Programme	ELECTRIC EYE, Pilots with Drones, Pattern Regocnition and Artificial Intelligence	Satellite Data ready for use in Status Assessment of Coastal Waters and Lakes	New Drone methods for Env. inventories (Vegetation, alien species, planning and monitoring of restoration projects etc.)	Satellite solutions for hydrology, Snow- and Ice characteristics, land-use etc. AI-tools pilots….
	A2: Manual In Situ-monitoring	Trimming of national network and Out-Sourcing of sampling and analysis	New methods supporting the traditional sampling of waters	Utilization of new datasources	Optimization and trimming of In Situ-network	In-Situ observations reduced, role increasingly in quality control
	A3: Automation	Guide for automatic water quality stations	Hydrologic stations mostly automatic	Quality control and plan for the automatic water quality station network	Utilization of automatic water quality monitoring in national network	Automatic stations provide quality control for satellite observations
	A4: Civil Science and Civil Observations	Civil observations-project in Schools Winter campaign with Finnish Nature and recreational organizations	School-project expanding Lake/SeaWiki; development of platform for civil water observations	Goal 2018: 30 NGO's involved in data production	Civil Science applied in yearly Winter Campaign (Snow and Ice observation-network under development)	Goal: Role of Civil Observations established as part of monitoring and surveillance

Earth Observations, Satellite data

- Utilization of EU:s Copernicus-satellite program and new Sentinel-satellites in environmental status assessment

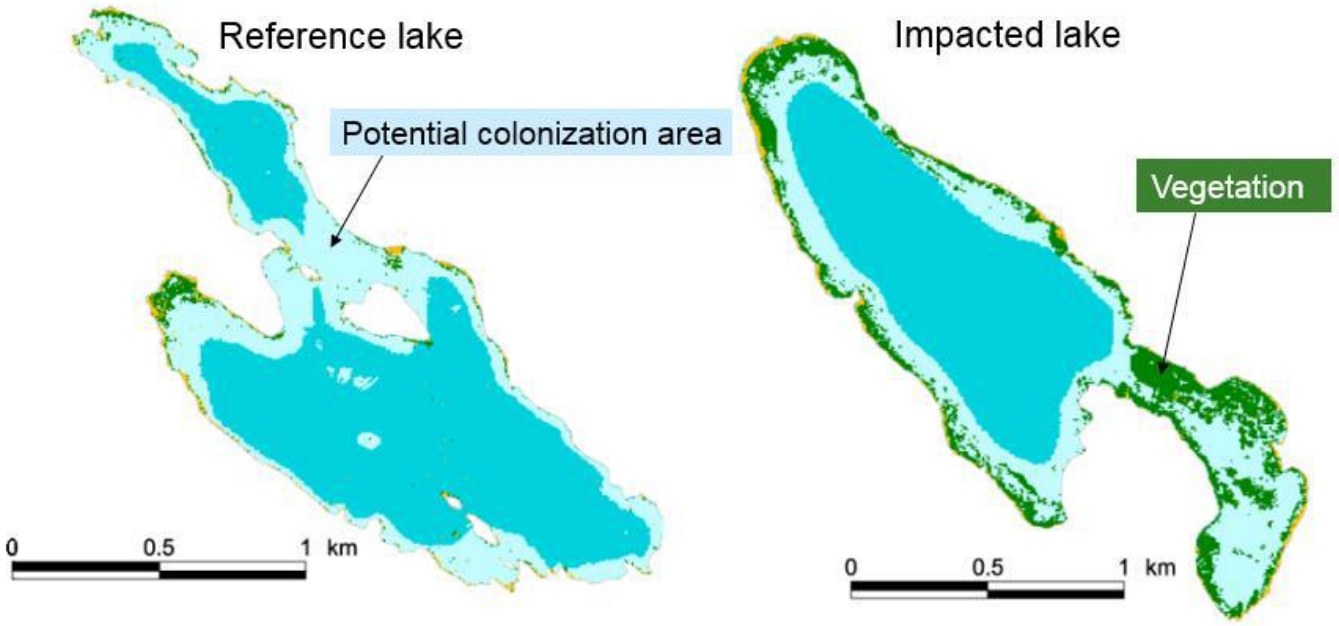
- **VESISEN-program**: Satellite observations in water status assessment of Baltic Sea ja lakes (2017-2018)
- Satellite observations (Chlorophyll-a and Turbidity) used as a supportive data in WFD status classification in 2019.
- First time in Europe?

- Finland promotes satellite products and other new sources of environmental data during 2019 EU-presidency period.



National Aerial Photography Programme

- Started 2016, integrates the needs of National Land Survey, Forestry and Agriculture
- Finland will be photographed in five Years rotation
- Aerial Photographs available as Open Data
- New opportunities for environmental status assessment; Planning and monitoring of restorations and land use
- ILMAVERSO-projects I and II: Use in status assessment with aquatic plants



DRONES- The Future of Field Work?

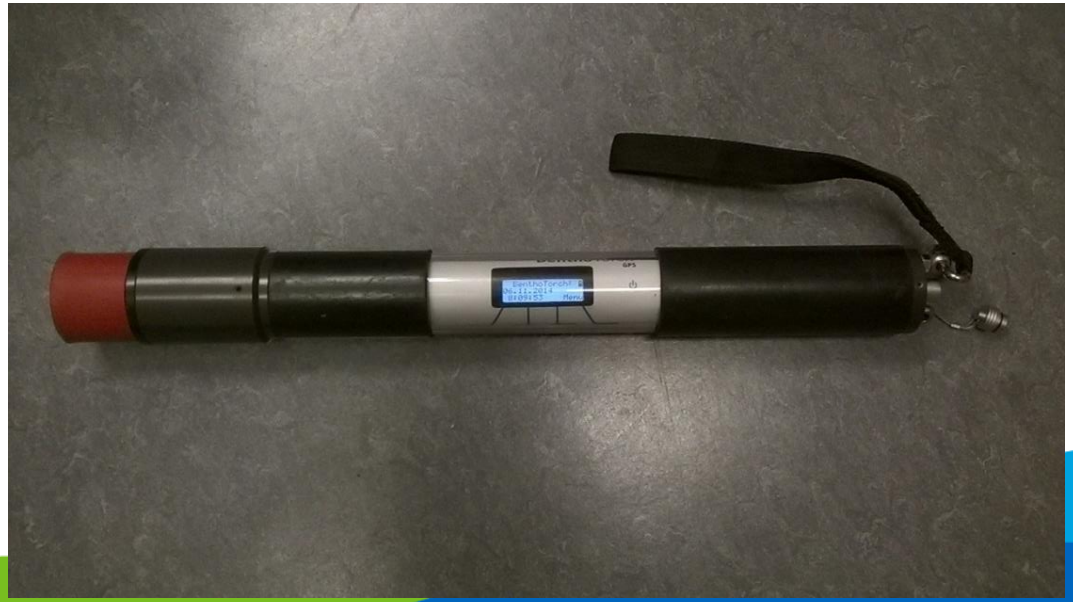
- Rapid technical development; Better quality, lower prices.
- Aerial and Aquatic Drones; Sampling Drones and continuous automatic Water quality observations
- Lots of solutions for environment surveillance:
  - Inventories, Assessment of Restoration needs (pilot with assessment of the status of aquatic Bird reserve areas)
  - Flood control, inventory of volume of snow and water
  - Largest Drones can perform ”traditional” sampling
  - Observations using varied wave lengths (ultraviolet etc.)
  - Environmental surveillance (area/volume of waste dumps)

Automatic measuring stations

- Hydrological observations almost completely automated
- Quality for Water quality stations (a-chloro, nutrients, turbidity etc.) calibrated. Good accuracy, needed effort for instrument maintenance varies in different conditions.
- Utilization requires assessment of cost-effectiveness: Economical when large mass of observations is needed (nutrient loads etc.)
- **Finnish development project (2018)**:
  - plan for automatisation of national monitoring network.
  - Several Guides for quality control and use of stations published
- Automatic measurement devices installed in Freighters: Ample alg@-line-data from Baltic sea routes.
- Important source of calibration data for quality control on remote sensing.

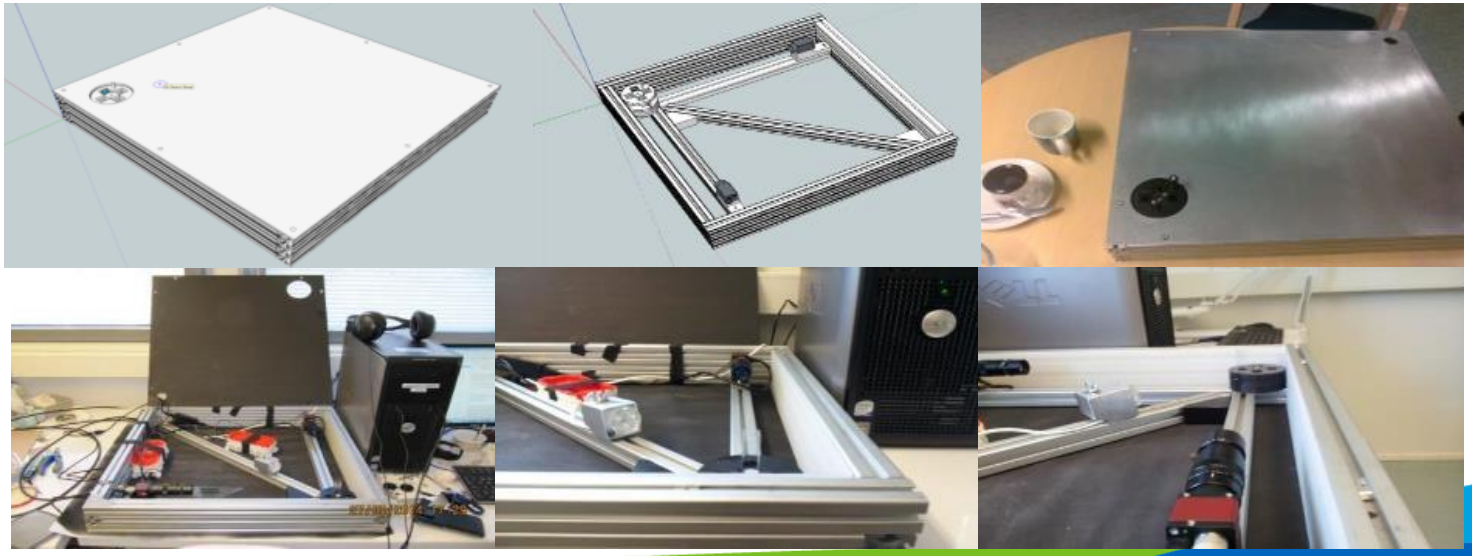
Automatic field instruments

- Testing going on in several projects
  - pH-meters commonly used, other variables developing and accuracy enhanced (nutrients, turbidity, chlorophyll etc.). Several manufacturers and models.
  - Decreasing prices allow use in Civil observations
  - Lower-than-laboratory accuracy can be compensated with large number of observations.
  - Need for Best Practices and standardisation.



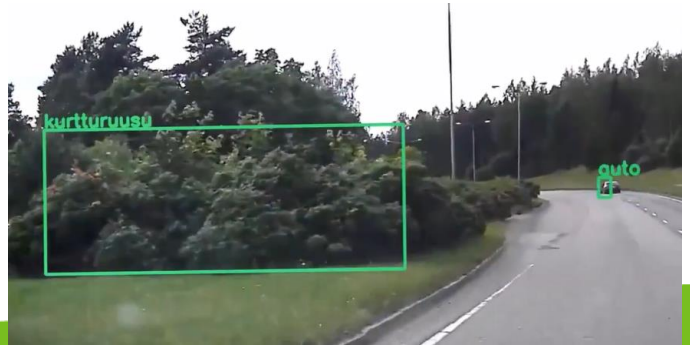
Pattern recognition and learning artificial intelligence in environment research

- Development very fast, every-day solutions in airport access control etc.
- Tested in the species identification of benthic macroinvertebrates
  - Promising results, machine can identify type-species accurately, quickly and cost-effectively
  - Number of identified species currently small, increases along with learning
- Similar applications for other taxonomic groups?



Pattern recognition and learning artificial intelligence in environment inventories

- Finnish Transport Agency conducted mobile-based videofilming of road-side greeneries for land-use purposes. Method allowed reliable estimation of area of greeneries using machine vision.
- Road-side video was used to teach artificial intelligence to identify 4 alien plant species. A.I. was able to identify species with 95% accuracy.
- A.I. and aerial photos taken by drone were used to identify aquatic plants in summer 2017 with promising results.
- Massive amounts of film and pictures are currently produced by variable sources (surveillance-, weather- and game cameras etc.). Material could be utilized in environmental inventories (Cultural landscapes etc.).



DNA-Barcoding in species inventories

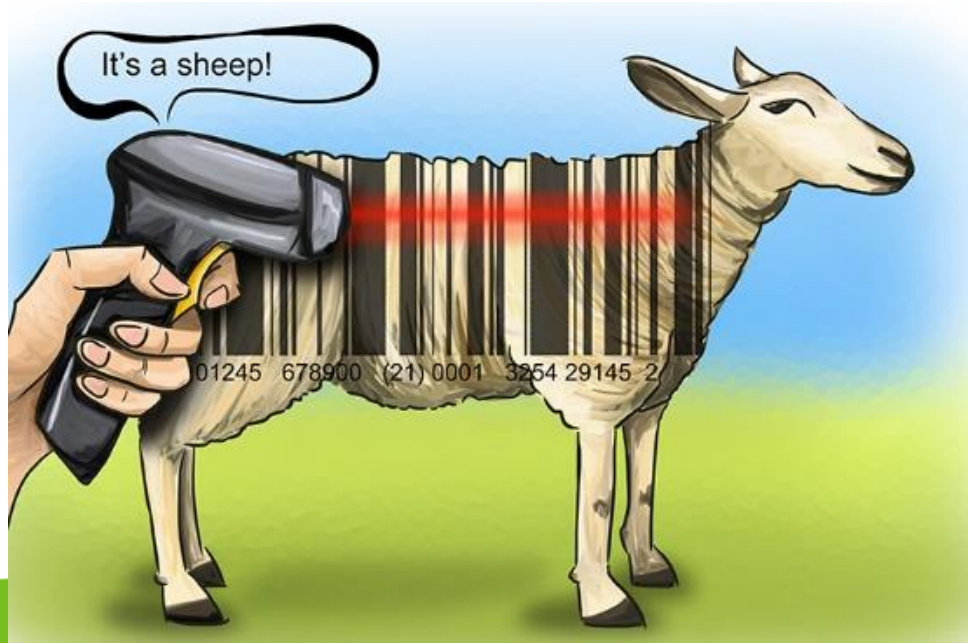
- Rapidly developing method, several projects create ”DNA-Barcoding Libraries” for different taxonomic groups.
- Method allows species identification from ”pooled sample” by sequencing species-specific fragments of DNA and comparing them to ”library-data”.

- Accurate: Finnish butterfly species (c. 2600 specimen) were identified with the accuracy of 97 %. Difficult species were closely related, evolutionary ”young” species.
- Pilot conducted with Benthic Macroinvertebrates.

- Species abundances are still a challenge, therefore the use with community-based status indicators is restricted. Method is readily applicable in biodiversity studies.
- Needed machinery and analyses expensive, but prices are coming down with increasing use.

DNA Barcoding

Fantasy to reality in species identification



Civil Science and observations

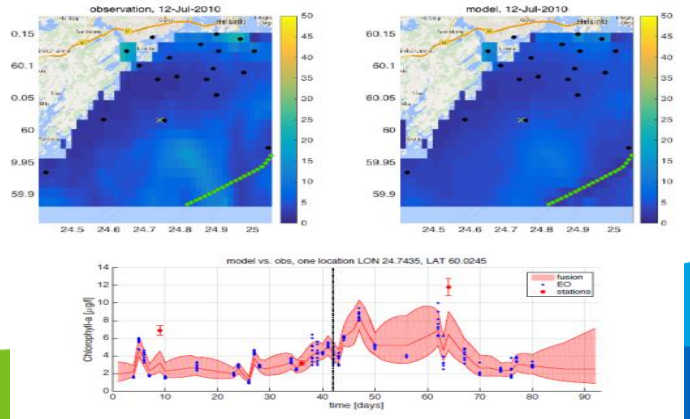
- Potential for large datasource. Large data mass can compensate varied data quality.
- School project in Rauma: Students measure basic parameters of surface waters as part of teaching plan (DIY water quality meters, mobile solutions, database-input). Co-operation with schools in Portugal. Project will extend to other cities in Finland.
- Winter observation campaign with Nature- and recreational organisations: Snow-, ice- ja species observations.
- Need for voluntary observers increases, as present observers go into retirement. New observers are hard to find especially in remote areas.

Intergration of data from variable sources

- Effective utilization of new information demands flexible data management in order to store, calibrate and integrate different datasources.

- Q/C of Databases needs ”alarm systems”, which can point out possible outliers. First versions of these algorithms are being developed in research project ”ENVIQROBO”.

- DATAFUSION-project integrates water quality data from remote sensing, automatic measurement (stations and ships) and traditional sampling. Data is fused using algorithm and model which creates status estimation for larger water areas.
  - Model for coastal area ready
  - Pilot for large lakes
  - Reliability of model estimated
  - Estimates updated constantly



FUTURE

- Utilization of new technology and methods require established and validated practices and guidelines. Ultimately, methods should be standardized.

- This in turn demands wide promotion, acceptance and use of new methods by different stakeholders (Management, Private Sector, Research Institutes).

- Quality Control is based on traditional monitoring methods and accurate laboratory analyses. Therefore we need to have representative national monitoring network also in future.

- With new methods the limited resources can be focused more cost-effectively from inventory-based monitoring to more targeted, risk-based surveillance (risk-areas, human impacts and effectiveness of restoration measures)

ROAD MAP TO FUTURE IN FINLAND

- New Monitoring strategy for the state of the environment (2020-2030)
- New Implementation Programme for new Strategy
- EU: ”Digital Review” on Environmental Directives (reporting, monitoring) and validation of new methods
- Integration of new methods and data sources in routine monitoring and national monitoring program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Thank You!
FUN FACT: Ex-particle-physicists make the worst biologists.