SATELLITES GOING LOCAL

SHARING GOOD PRACTICE
WATER EDITION

2013

eurisy

acting collectively to bridge space and society

Eurisy would like to thank the contributors to this publication for their readiness to share their experiences, and the time and effort they have put into helping Eurisy to produce this collection of good practices.

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Editorial

Dear Reader,

In its third issue this year, 'Satellites Going Local' is becoming a welcome staple in Eurisy's on-going contribution to raising awareness on how satellite applications are being used in very practical ways. Indeed they are being used in many areas which directly affect our daily lives, such as the environment, agriculture, energy, transport, territorial planning and many others.

Success stories of pioneering early adopters – the end-users themselves – have become a fundamental tool for Eurisy as it tries to challenge and change the general perception that satellite applications belong to the realm of R&D only.

This edition focuses on the water sector. We chose water as a timely contribution for 2013, the UN International Year of Water Cooperation. Water is also at the heart of many European policies and corresponding legislation related to the environment, the economy, and to quality of life.

References to relevant policies or legislation are linked to all the good practices presented. They also present examples on how public and private organisations are able to leverage innovation to improve their management of water and water-related issues.

We hope these examples will inspire many other water stakeholders to follow suit.

Colin Hicks, *President, Eurisy*

UNITED NATIONS
Office for Outer Space Affairs

"Earth observation from space, complemented with other applications, is a cost-effective method for effective management of water resources and it provides essential data to decision-makers. Upon conversion into practical information, the data could be used to support the development of policies and programmes at the various scales, from global to local. Our Office assists Member States in strengthening their capacity to use space science, technology and applications for sustainable economic and social development. We welcome this publication as a means to increase awareness on satellite applications for addressing water-related issues, as well as to demonstrate successful use of space-related technologies, applications, services and information for managing water resources and to promote international cooperation in these areas."

***Mazlan Othman**, Deputy Director General, United Nations Office at Vienna, and Director, Office for Outer Space Affairs - UNOOSA*

"Satellite information has great potential to ensure the proper implementation of EU maritime legislation and to help member states achieve a high, uniform and effective level of maritime safety, security, prevention of pollution and response to pollution by ships. Increasingly, maritime emergency services will rely on information from space. The full use of innovative operational services brought about by European investments in the satellite sector is essential for society to fully benefit from all the possibilities offered. EMSA welcomes this publication as a means to share good practices, foster cooperation and inspire all stakeholders involved in the monitoring and protection of European seas and coastal zones."

***Olaf Trieschmann**, Senior Project Officer, European Maritime Safety Agency - EMSA*

"Water issues are never contained between physical borders; by its very nature, satellite information enables a holistic approach to water management, of interest to AEBR's members. On their behalf, I welcome this water-focused edition of 'Satellites Going Local'. It will no doubt inspire a dialogue and an exchange of good practices among water stakeholders on innovative tools for implementing the European directives and policies in the water sector."

***Martín Guillermo Ramírez**, Secretary General, Association of European Border Regions - AEBR*

Introduction

Water is the most precious resource on Earth, essential to sustain human life, the environment and the economy. As accurately noted in the 2012 EC Blueprint to Safeguard Europe's Water Resources, water has a renewable but also finite nature, and competing demand for freshwater could lead to an estimated shortage of global water supply of 40 % by 2030.

In the EU, freshwater supply relies mainly on inflows from upstream rivers and on underground reservoirs that often cross several administrative borders. Today, the ecological and chemical status of these reserves, as well as the ecosystems depending on them are threatened by climate change, land use, industrial and economic activities, agriculture, tourism, urban development and demographic change, which result in water pollution, water stress, physical changes in the water bodies, and in an increasing number of extreme events, as drought and floods.

The trans-sectoral and trans-border dimensions of water issues have been already fully recognised by EU water-related policies and legislation, such as the Water Framework Directive, but also the directives on nitrates, ship-source pollution, habitats, floods and drinking water, to quote only some of the most significant examples.

Worldwide celebrations have been organised throughout 2013 to raise awareness on the challenges facing water management and on the potential for increased cooperation to ensure water environmental and socio-

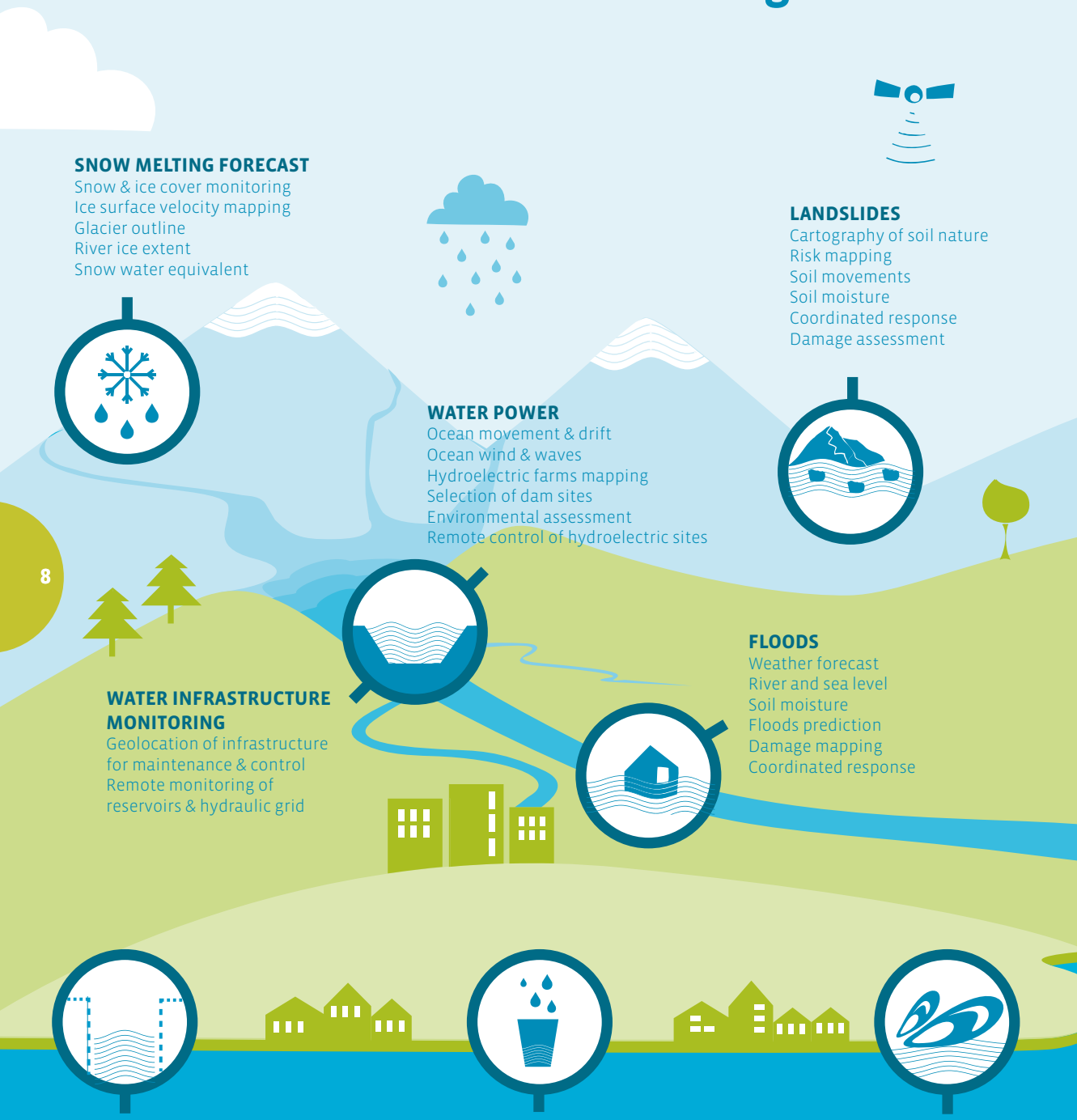
economical sustainability. Eurisy releases this thematic edition of "Satellites Going Local" with the aim of contributing to the debate on possible solutions to these challenges. The publication is a means to raise awareness on satellite-based services available to optimise water management, and to foster good practice exchange among public and private actors managing water at different levels.

The featured examples of public and private managers using satellite information in their daily tasks show the potential of satellite imagery, geo-location and communication to help preserve and manage water in the fields of environmental protection, risk management, water supply, agriculture/aquaculture and energy.

This non-exhaustive collection of examples will give the reader an overview of the satellite solutions available and of the actors intervening in the management of water and water-related activities. We hope these examples will be inspiring for other experienced and non experienced users of satellite-based services, and will pave the way for a more general discussion on ways to facilitate access to operational satellite services that are meeting environmental, societal and economic needs.

Eurisy wishes to thank the professionals who made available their experiences for this publication.

Satellite uses for water management



SNOW MELTING FORECAST
Snow & ice cover monitoring
Ice surface velocity mapping
Glacier outline
River ice extent
Snow water equivalent

LANDSLIDES
Cartography of soil nature
Risk mapping
Soil movements
Soil moisture
Coordinated response
Damage assessment

WATER POWER
Ocean movement & drift
Ocean wind & waves
Hydroelectric farms mapping
Selection of dam sites
Environmental assessment
Remote control of hydroelectric sites

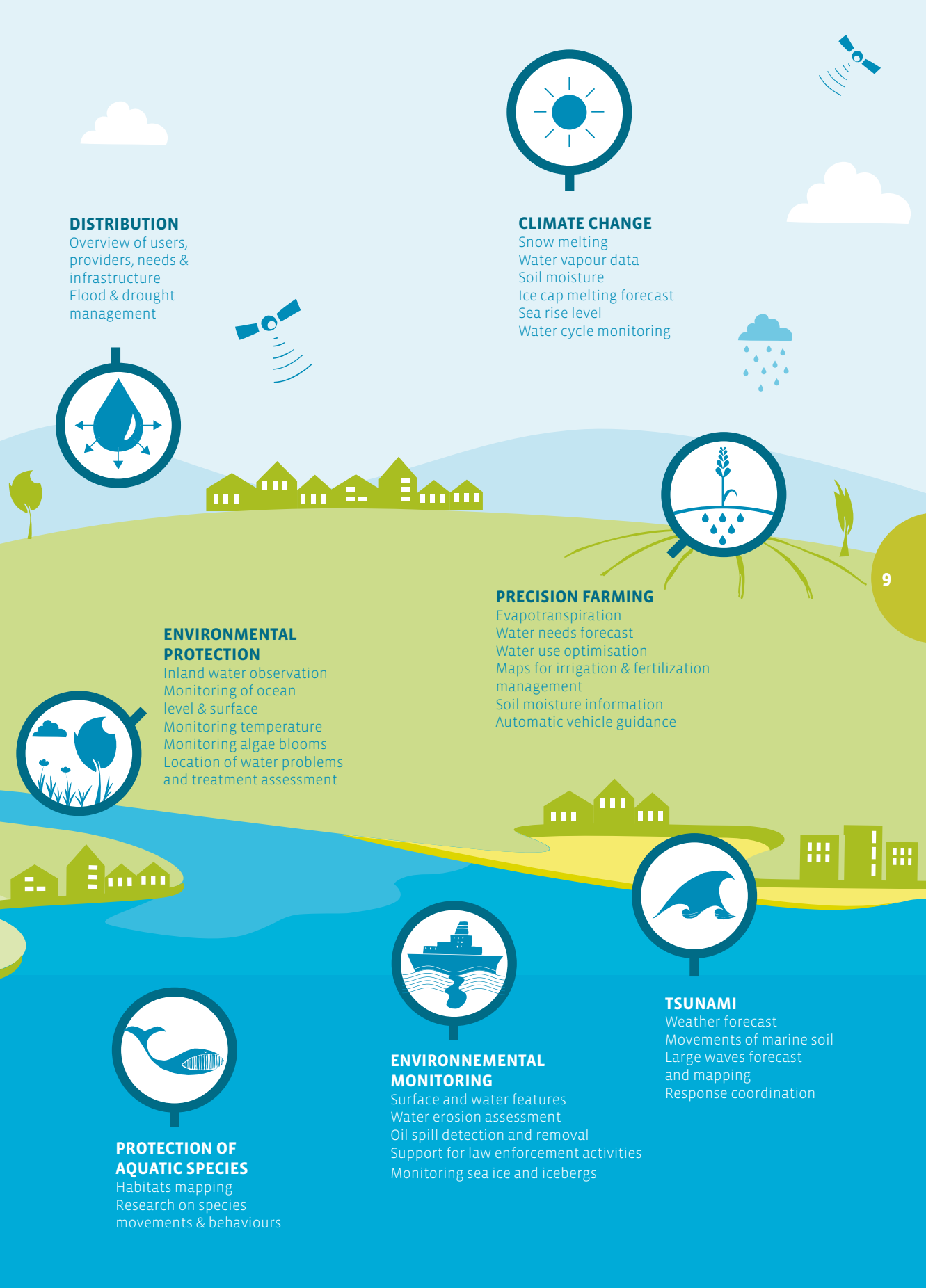
WATER INFRASTRUCTURE MONITORING
Geolocation of infrastructure for maintenance & control
Remote monitoring of reservoirs & hydraulic grid

FLOODS
Weather forecast
River and sea level
Soil moisture
Floods prediction
Damage mapping
Coordinated response

GROUND WATER
Measurement of soil resilience & uplift
Assessment of ground water levels
Land subsidence forecast

WATER QUALITY
Agricultural & industrial pollution
Turbidity; Chlorophyll
Concentration of suspended matter
Algal blooms monitoring
Remote monitoring of source quality

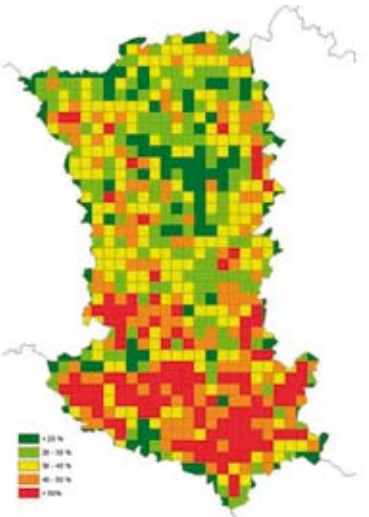
AQUACULTURE AND FISHERY
Origin tracing
Vessels monitoring
Algae and phytoplankton mapping
Water depth charting & bathymetry
Fish-shoals mapping
Research on species behaviour
Inventory and monitoring of aquaculture and fishery structures


DISTRIBUTION
Overview of users, providers, needs & infrastructure
Flood & drought management
CLIMATE CHANGE
Snow melting
Water vapour data
Soil moisture
Ice cap melting forecast
Sea rise level
Water cycle monitoring
PRECISION FARMING
Evapotranspiration
Water needs forecast
Water use optimisation
Maps for irrigation & fertilization management
Soil moisture information
Automatic vehicle guidance
ENVIRONMENTAL PROTECTION
Inland water observation
Monitoring of ocean level & surface
Monitoring temperature
Monitoring algae blooms
Location of water problems and treatment assessment
TSUNAMI
Weather forecast
Movements of marine soil
Large waves forecast and mapping
Response coordination
ENVIRONNEMENTAL MONITORING
Surface and water features
Water erosion assessment
Oil spill detection and removal
Support for law enforcement activities
Monitoring sea ice and icebergs
PROTECTION OF AQUATIC SPECIES
Habitats mapping
Research on species movements & behaviours

ENVIRONMENTAL PROTECTION

DEUX-SÈVRES COUNTY: FIGHTING WATER NITRATE POLLUTION USING SATELLITE DERIVED INFORMATION

Satellite maps provide local information to monitor the presence of catch crops, helping the Region to comply with the 4th Action Programme of the Nitrates Directive



Regional map of risk indicators © TETIS

The County Directorate for Territories

Deux-Sèvres is a county in the Poitou-Charentes French region. Its economy is mainly based on the rural sector, which provides jobs for a large part of the local population.
The County Directorate for Territories is the authority in charge of ensuring the sustainable use of the land, classified as a Nitrate Vulnerable Zone because of its intensive agriculture activities.

The challenge

Used as fertilizers, nitrates are a major source of water pollution. The Nitrates Directive makes it mandatory for farmers to grow catch crops between farming seasons, to prevent nitrates from permeating into the ground with the rain and then into fresh water.
To control crops are actually grown, the Directorate needs to send inspectors to the fields. However, there are too few inspectors available for the size of the land, so only a limited part is really done. To comply with the 4th Action Programme, setting measures from the Directive for 2009-2012, the Directorate needed a complete overview of the land by the end of 2012, so as to focus field controls on the most exposed areas.

The satellite solution

The Directorate started using satellite-derived maps to detect whether parcels are covered with catch crops, in cooperation with the Earth Observation and Geoinformation for Land and Environment Laboratory (TETIS) of the National Research Institute of Science and Technology for Environment and Agriculture (IRSTEA), and GEOSUD (GeoInformation for Sustainable Development) – a French database of satellite data, free for public authorities.
These data enable to better spot the areas with no cover and to prioritise site inspections. Four methods have been tested, and the last one, based on a risk assessment approach and taking into account various parameters such as crop types, seems to be very efficient and promising.

> *"(...) it is therefore necessary (...) to reduce water pollution caused or induced by nitrates from agricultural sources and to prevent further such pollution"* **EU NITRATES DIRECTIVE (CONSOLIDATED) 91/676/EEC**

The result

Thanks to satellite information, the Directorate is able, for the first time in France, to build priority maps focusing on the areas most affected by nitrate pollution risk, thus optimising field inspections and saving time. Obtaining free data has helped keep costs down. The approach makes it easier for the county to comply with requirements of the Directive, and prepares it for the 5th Action Programme to be enforced in 2014.

"Satellite imagery is a real asset to fight against nitrate pollution."

Nicolas Cornuault, Deux-Sèvres County

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THE CENTRAL COMMAND FOR MARITIME EMERGENCIES USES SATELLITE INFORMATION TO MONITOR SEA POLLUTION ON GERMAN COASTAL STATES

CleanSeaNet, an innovative satellite information service for Europe, enables the CCME to rapidly identify and intervene on oil spills in the sea

Ölbekämpfung © Havariekommando

The Central Command for Maritime Emergencies

The Central Command for Maritime Emergencies (CCME) is a joint institution of the German Federal Government and the five German Coastal States. The CCME is responsible for handling maritime incidents in the North and Baltic Seas, including on beaches, islands and inland sea. These tasks are carried out in close cooperation with all relevant authorities and institutions of the federal government, the coastal states and private organisations.

The challenge

To respond efficiently to marine pollution, oil spills in particular, the CCME needs to receive information on potential threats as quickly as possible, before the oil drifts away into the sea or reaches the beaches. It is in fact much more expensive to clean up the coast than it is to eliminate the fuels while still in the sea. Oil spills are not only a threat to the environment, but also to local economies, especially in the summer time, as beaches are an important source of revenue for coastal regions.

The satellite solution

The CCME uses CleanSeaNet, an oil spill and vessel detection service based on satellite data, provided by the European Maritime Safety Agency. The CCME receives 600 satellite images per year, containing a classification of the dark spots detected according to their resemblance with oil spills and their potential impact. By combining information on potential oil spills and their position relative to vessels, the CCME is also able to identify the potential polluters.

All this information is received within 30 minutes from the capture of the images. One hour after the satellite has passed over the German seas, the CCME sends an aircraft directed by the satellite observations to confirm the presence of oil spills and to inform the headquarters via a satcom connection. Then further measures are taken to remove the spills and to collect evidence.

> *"Member States (...) shall cooperate (...) to (...) establish common practices and guidelines (...) for the monitoring and early identification of ships discharging polluting substances (...)"* **EU DIRECTIVE ON SHIP-SOURCE POLLUTION 2005/35/EC**

The result

Thanks to the CleanSeaNet service, the CCME could improve its surveillance capacity by being better informed of incidents. The Command receives in near-real time, more satellite images than ever available before. The CCME can detect oil spills, verify them, and inform the competent authorities on the suspected polluters, as it happened during a minor spill in the North Sea in August 2013.

"CleanSeaNet helps us intervene rapidly in case of incidents, and identify potential polluters with more certainty. Sharing and comparing this information, allows for a coordinated protection across European seas."

Dirk Reichenbach, Central Command for Maritime Emergencies (CCME)

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ARCHELON: ENGAGING THE PUBLIC IN THE PROTECTION OF SEA TURTLES THANKS TO SATELLITE NAVIGATION

©ARCHELON

A satellite tracking system enables ARCHELON, the Sea Turtle Protection Society of Greece, to gain better knowledge of turtles' lives and raise awareness on threats to the species

The Sea Turtle Protection Society -ARCHELON

ARCHELON is an NGO working for the study and protection of sea turtles and their habitats in Greece. Its activities include monitoring of turtle populations, managing nesting beaches, rehabilitating injured turtles, and educating the public.

The challenge

Sea turtles are migratory species that may travel hundreds or thousands of kilometres across open sea between foraging and breeding areas. Learning about these migrations is important for a more thorough conservation of the animals across their territories, often involving several national jurisdictions. Information on foraging areas, where sea turtles spend most of their time, is sparse. Indeed the remoteness of these sites makes them more difficult to access than nesting areas, where monitoring tracks of emerged turtles is relatively easy. Finally, engaging with the public in attractive, innovative ways is crucial to raise awareness and to keep funding the tracking scheme.

The satellite solution

ARCHELON uses the Argos/CLS global satellite navigation system to locate and track the turtles which are equipped with transmitters. This solution helps track turtles over great distances. The Satellite Tracking Analysis Tool from www.seaturtle.org is then used to manage the data to produce daily updated maps and to engage online with the public.

The satellite application is a result of an inter-governmental project between Greece and Italy, involving the Management Agencies of the protected areas of Amvrakikos Wetlands and Messologhi Lagoon, both Greek NATURA 2000 sites.

> *"Contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies"*
> **EU HABITATS DIRECTIVE 92/43/EEC**

The result

The costs for physically tracking turtles in the open sea are much higher than for deploying a satellite tag, so for relatively little money ARCHELON can gain great insights into turtle behaviour. The use of satellite navigation also enables ARCHELON to reach a global audience. Anyone with an internet connection can check the projects' web pages to see where the turtles are going. It is also possible to "adopt" one of these study turtles via a small fee, to support the continuation of the project.
ARCHELON intends to keep using satellite information to raise awareness on the turtles' plight as well as for lobbying, scientific, and fundraising purposes.

"This is a great benefit for raising awareness among the public and authorities. When we tell and show local residents in Greece that the very turtles they can see while taking their own morning swim have swum away to Italy, Tunisia or Syria they are invariably impressed."

Dimitris Margaritoulis and ALan Rees, ARCHELON Scientific Committee

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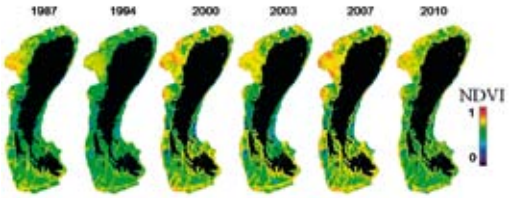
(PROJECTS 875 AND 887)

LAKE NEUSIEDL: MONITORING WATER QUALITY WITH SATELLITE IMAGERY

Satellite information helps monitoring the effects of climate change on the lake's ecosystem



Maps of Normalized Difference Vegetation Index (NDVI) of Common reed for different year obtained by Landsat-TM (NASA) images ©IREA - CNR

The Biological Station Neusiedler See

Lake Neusiedl, on the Austrian–Hungarian border, is the second largest steppe lake in Central Europe and a popular holiday destination in Austria. The Biological Station Neusiedler See ensures environmental protection and water quality in the area and raises awareness on environmental issues among local communities.

The challenge

The main effects of climate change on Lake Neusiedl are an increase in water level fluctuations and eutrophication (the ecosystem's response to the addition of substances), which also affect the lake's reed belt and wetlands. The increase of water fluctuations could impact negatively touristic and recreational activities, while external loads occurred during the 70s caused a considerable increase in phosphorus and nitrogen concentration, with massive effects on the biological structure, such as the increase in phytoplankton biomass and the formation of blooms after 1977.

The satellite solution

Since 2010, the Biological Station Neusiedler See has been receiving satellite images on water characteristics varying according to the temperature (as water clarity, algal biomass and class composition), which allow to assess conditions and changes of the reed area.

Such information is received within the framework of EULAKES (European Lakes Under Environmental Stressors), a European-funded project supporting local administrators to prevent and manage the impact of climate change on lakes.

> *"Member States shall ensure (...) the monitoring of water status (...) to establish a coherent and comprehensive overview of water status within each river basin district"*
> **EU WATER FRAMEWORK DIRECTIVE 2000/60/EC**

The result

Satellite-derived environmental stressor maps are available to the authorities in charge of environmental protection in the area around the lake and are used to monitor the effects of changing temperatures on the ecosystem, and to assess the level of pollutants and the potential risks for the environment, people and businesses. Compared to traditional methods, satellite imagery allows for more frequent, efficient and cheaper sampling on large areas. It also helps monitoring changes locally and over time, since images of the same areas can be produced every few days.

"The study of ecosystems with satellite imagery provides us with useful insights into water quality, supporting management of eutrophication, algae blooms and reed changes."

Thomas Zechmeister, Biological Station Lake Neusiedl

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BS Biologische Station Neusiedler See

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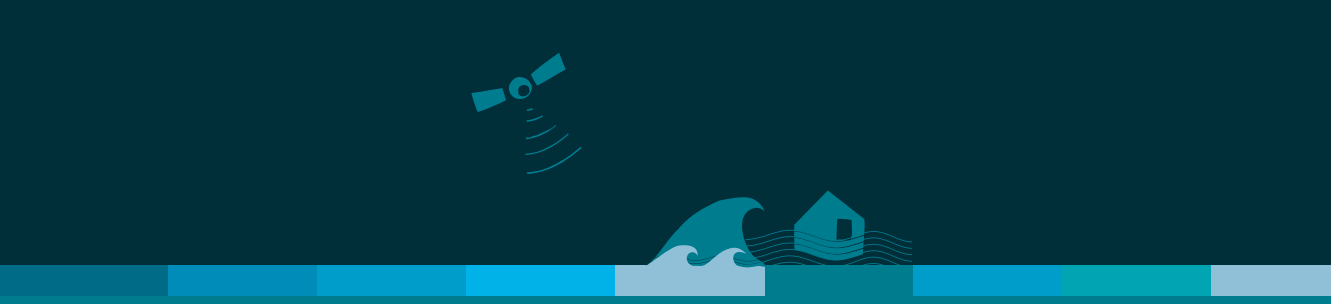


RISK MANAGEMENT

EPAMA USES SATELLITE INFORMATION TO FACILITATE TRANSNATIONAL COOPERATION ON FLOODS

Satellite imagery has helped EPAMA and its 17 partner organisations from North-West Europe to better understand the common, transnational flood risks they are facing and to organise cooperation to tackle them

EPAMA

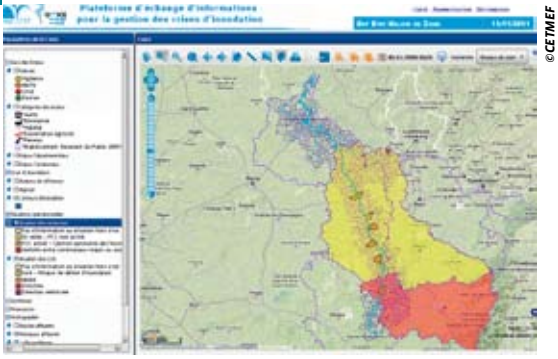
The Meuse river basin, with a drainage area of 34 548 km² and nearly nine million inhabitants, is a major geographic link between Belgium, France, Germany, Luxembourg and the Netherlands. In addition to sustaining the living ecosystem, the water of the basin is used for domestic, agriculture, industry, navigation and recreation purposes.
In France, EPAMA (the Public Entity for the Management of the River Meuse and its Tributaries) supports local authorities and communities in the Meuse watershed to better prevent and manage flood risks.

The challenge

The discharges of the Meuse river fluctuate from 3 100 m³/s in winter 1993 at the Dutch/Walloon border to only 20-40 m³/s in summers. Precipitations impact directly high and low waters, leading to more floods in winter, which threaten assets in the basin, including major infrastructure, industries, and historical and ecological heritage.

The satellite solution

Convinced of the need for better international cooperation to address these risks, EPAMA teamed up with partners from Germany, the Netherlands and Belgium in AMICE, an EC INTERREG IVB project, to improve transnational flood management on the Meuse basin.



©CETMEF

A web-based platform with information on water-related risks was set up by combining the available tools and data from national organisations. During a 10-day simulation exercise, satellite maps combined with a virtual representation of the extent of the flood produced by Sertit, a French regional centre for satellite data interpretation, were used to better understand the full dynamics and impact of floods along the basin, and to test the possibility that satellite information can be fed in the platform in real time in case of disaster. Indeed, thanks to the International Charter "Space and Major Disasters", it is possible for regions affected by disasters to obtain free satellite maps in near real time.

> *"In the case of an international river basin district falling entirely within the Community, Member States shall ensure coordination with the aim of producing a single international river basin management plan"*
> **EU WATER DIRECTIVE 2000/60/EC**

The result

The platform is key for partners to coordinate prevention and preparedness strategies. It provides free and easy-to-update preparedness information for flood crisis management on a local level. Notably, the platform helps local authorities to set up their community safety plans and it could permit partners to benefit from free satellite maps in case of disasters, thanks to the International Charter.

"Thanks to their accuracy, reliability, large scope and timeliness, flood satellite maps are a most needed component of an integrated emergency response system."

François Hissel, Vice Scientific Director, CETMEF France

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DANUBE FLOOD HAZARD AND RISK MAPS ATLAS: AN INTEGRATED APPROACH FOR MANAGING THE DANUBE BASIN

Satellite imagery is combined with in-situ information to provide countries of the Danube river basin with an integrated system to prevent and manage flood risks

The Danube River Basin

The Danube is the longest river in the European Union. Originating in the German Black Forest, it crosses ten countries (Romania, Hungary, Serbia, Austria, Germany, Bulgaria, Slovakia, Croatia, Ukraine and Moldova), before flowing into the Black Sea. Its drainage basin also extends to Italy, Switzerland, the Czech Republic, Poland, Montenegro, Serbia and Bosnia and Herzegovina.

The challenge

In the Danube Basin, climate change-related floods are a threat to industrial activities, crops and urban settlements. In 2006 for instance, exceptionally high river levels caused considerable economic losses in Serbia, Bulgaria and Romania; numerous buildings were destroyed, leading to the evacuation of thousands of people. Danubian countries which had used until then different hydraulic models and planning systems were led to reconsider their risk prevention strategies and to look for common solutions.

The satellite solution

Since 2010, under the lead of the Romanian Ministry of Environment, 24 public and research bodies from eight Danubian countries partnered to implement the EU-funded Danube Floodrisk project. After an in-depth consultation on the requirements of water managers and stakeholders, satellite imagery was combined with other sources to produce a common cartography of flood hazards and risks in the whole basin area. The carthography can be accessed on an online portal.

© INHGA

The flood hazard maps show extreme event scenarios, displaying the water at 1000-years return period and flood extent for 100-years return period. Furthermore, they show potential flood damages in euro/m^2 for various land use types (industry, residential areas, forestry, cultivated fields and other areas) and the number of inhabitants likely to be affected.

> *"In the case of international river basin districts (...) Member States shall ensure that exchange of relevant information takes place between the competent authorities concerned"*
> **EU FLOODS DIRECTIVE 2007/60/EC**

The result

These international flood hazard and risk maps offer a more global, EU-scale overview on the Danube flood-risks than maps produced by single member states, and allow them to coordinate their mitigation efforts, according to the EU Flood Directive. Finally, by creating the risk maps jointly, each country was able to save money and resources.

"The use of satellite imagery allows us to integrate a big amount of data to assess, prevent and manage the flood risk, in common maps shared among all stakeholders responsible for flood management in the Danube basin."

Mary-Jeanne Adler, Scientific Director, Romanian National Institute of Hydrology and Water Management

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Danube FLOODRISK

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ARNO RIVER BASIN AUTHORITY: USING SATELLITE MAPS TO IMPROVE MONITORING OF HYDRO-GEOLOGICAL PHENOMENA

Satellite-derived information helps monitoring old and new unstable areas and to plan conservation measures along the major river in Tuscany

The Arno River Basin Authority

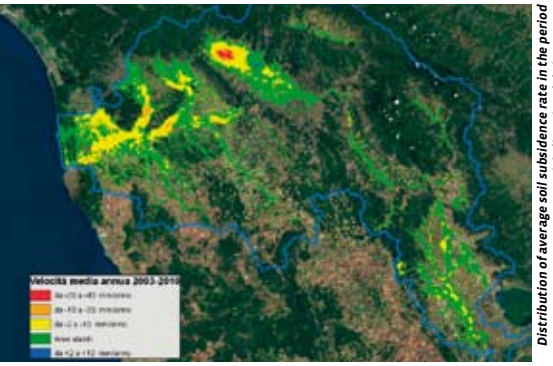
The Arno is the second most important river in Central Italy. The Arno River Basin Authority is in charge of safeguarding and valorising the soil, and of ensuring the correct use of the water resource in the basin, covering a densely populated area of about 9 131 km^2.

The challenge

The Arno basin is rich in superficial and underground water resources, intensively exploited in the past for drinking and industrial uses. Soil deformation and landslides are usual phenomena in the region: more than 2 500 areas are at high risk of landslides and more than 600 landslides have been mapped between March and April 2013 only.
The Basin Authority is responsible for annually updating the Inventory of Landslides in Italy (IFFI) for the Tuscany Region and for using it to implement the Basin Plan, including a description of water-related risks, water quality, excavations, and the actions planned to reduce hydro-geological risks. To perform its tasks, the Basin Authority needs uniform information about water and soil that can be compared over time.

The satellite solution

In 2005, when the IFFI was first built, the Basin Authority benefited from the ESA-funded project SLAM (Service for Landslide Monitoring). More than 350 satellite images were combined with ground information to assess slope instability and risk across 8 830 km^2. 27 000 landslides were identified and 10 000 of them were classified as active.
Since the end of the project, satellite data has been used to update the IFFI and to implement the Plan of the Arno Basin.



Distribution of average soil subsidence rate in the period 2003-2010 ©Autorità di Bacino del Fiume Arno

> *"To reach a common understanding (...) of soil degradation processes, it is important to ensure data comparability"*
> **EU SOIL THEMATIC STRATEGY COM (2006) 231**

The result

Information collected through satellite imagery allows the Basin Authority to have a uniform overview of the entire area, to monitor subsidence, landslides and building stability and to plan interventions in the areas exposed to major risk.
As part of the Plan's implementation, satellite imagery has been employed to assess the soil deformation between 1992 and 2007 with millimetre-accuracy. The deformation maps produced are also used to verify the correlation between subsidence and human activities. For example, in the Prato alluvial plain, an area historically affected by subsidence, it has been possible to verify that the decrease in the demand of industrial water has caused a lift of the soil and a rise of the water table.

> *"Satellite imagery helps us monitor changes of hydro-geological phenomena spatially and throughout time, and to concentrate the restoration effort where it is more needed."*
>
> **Giovanni Montini**, Arno River Basin Authority

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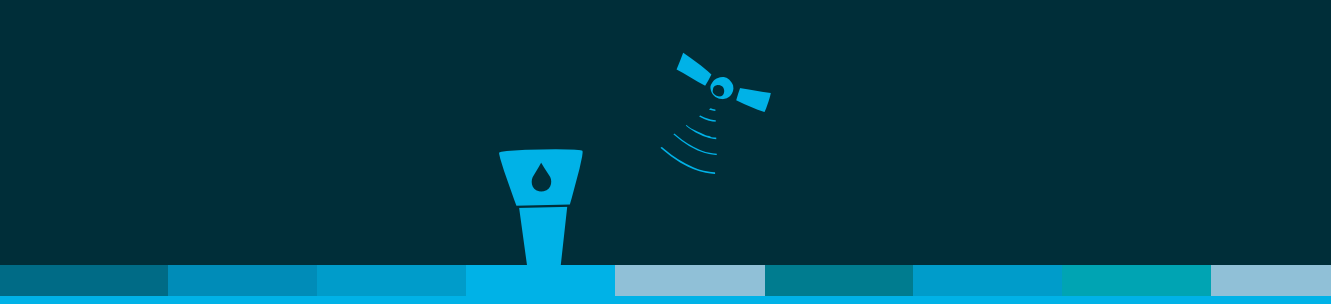

WATER SUPPLY & MANAGEMENT

THE JOANNEUM RESEARCH INSTITUTE USES SATELLITE COMMUNICATION TO MONITOR SPRING WATER QUALITY

Satcom ensures a reliable and continuous data flow on the status of spring water for potable use

© Joanneum Research

The company

The Joanneum Research Institute for Water, Energy and Sustainability is an Austrian private research facility based in Graz, Austria. The Department of Water Resources carries out applied research on all components of the water cycle and associated solute transport processes, including interactions with the climate, land cover and human activities. Joanneum Research provides such information to water suppliers and governmental institutions dealing with water resources.

The challenge

Joanneum Research is contracted by users such as Vienna Waterworks and the Environment Agency Austria to provide water quality information on Alpine underground water resources. Alpine karst waters are an important source of drinking water, as well as highly sensitive to contamination with *E. coli* bacteria from faecal material from the surface, especially in case of heavy rains. Therefore, hydrogeological and hydrometeorological investigations, as well as event monitoring and sampling, are indispensable to get appropriate information for optimised water management. Joanneum Research was hence looking for a solution to collect water quality data remotely, in near real time, and despite the lack of terrestrial telecommunication networks (GSM/GPRS) in these mountainous regions.

The satellite solution

Joanneum Research uses ORBCOMM, a satellite telecommunication system that ensures the connection between portable hydrometeorological measuring stations installed in water reserves, and web servers at their Central Monitoring Station (CMS). This enables Joanneum to collect remotely and in near real time data on gauge-height, electrical conductivity, temperature, different quality parameters, precipitations or humidity, as well as during fully automated event-sampling campaigns. By linking the CMS to a web-server, such information can be transferred to the customers of Joanneum Research.

> *"Member States shall take the measures necessary to ensure that water intended for human consumption is wholesome and clean"* **EU NEW DRINKING WATER DIRECTIVE (CONSOLIDATED) 98/83/EC**

The result

This satcom system offers a reliable way to collect information from remote locations efficiently, and in near real time, helping Joanneum Research to provide its customers with solid information on the quality of spring water, according to European safety standards.

"Satellite communication is a precious and valuable tool in alpine remote regions, enabling us to provide essential data to our clients."

Hermann Stadler, Joanneum Research

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THE TENSIFT HYDRAULIC BASIN AGENCY USES SATELLITE INFORMATION TO IMPROVE MANAGEMENT OF WATER RESOURCES

A partnership among Moroccan and foreign water managers and researchers allowed the Agency to acquire daily satellite imagery to implement an integrated water resources management system in the Haouz Plain near Marrakech

The Tensift Hydraulic Basin Agency

The Tensift Hydraulic Basin Agency federates the interests of water stakeholders in the Tensift-Ksob-Igouzoulen hydraulic basin. The area extends on 24 800 km² and is home to some 2 800 000 inhabitants in six administrative districts.
The Agency is mandated to plan, develop and manage the water resource in the region in an integrated, decentralised and concerted manner, with the aim of better exploiting it in the interest of the local economy, while ensuring its sustainability.

The challenge

In the Haouz Plain near Marrakech, irrigated agriculture accounts for about 85 % of the total water demand. Since 1990, a series of droughts and an increasing number of groundwater pumping sites for irrigation have caused a drop in the level of the Haouz aquifer (the main aquifer in the region) of up to two metres per year. To ensure a more efficient water use in the region, the Agency needed, on the one hand, to predict snow melting feeding into streams and reservoirs upstream. On the other hand, it needed to have a better overview on water demand from agriculture and its spatial distribution, in order to improve water use downstream.

© Agence du Bassin Hydraulique du Tensift

The satellite solution

Since 2010, the Tensift Hydraulic Basin Agency has used remote sensing to estimate the availability of water resources and irrigation water demand, so as to adapt groundwater abstraction to such demand.
The agency receives daily satellite imagery with data on the snow cover and its water equivalent, which allow for estimations on water availability upstream. Downstream, land cover maps and data from satellite imagery, hydrometeorological ground stations and piezometric sensors, are combined to estimate evapotranspiration and assess water demand for agriculture. The system is the result of a collaboration among several local and foreign water management entities and research institutes.

> *"The Ministers responsible for Water (...) agree to (...) make best possible use of surface and ground water resources (...) by developing economies in all different uses"*
> **MEDITERRANEAN CHARTER FOR WATER, 1992**

The result

The integrated model, combining geographic information and satellite imagery, enables the Basin Agency to have a permanent, long-term and accurate overview of land use, of the evolution of irrigated areas and of irrigation water demand in the area, and to plan measures to balance out availability and demand. This is especially important in the southern Mediterranean regions, where weather stations are scarce, especially in mountain areas.

"Satellite imagery allows us to better estimate water availability and demand from agriculture, and to ensure an efficient and effective use of this resource in the long term."

Brahim Berjamy, Head of the Information Systems, Communication & Cooperation department, Tensift Hydraulic Basin Agency

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SARDINIA REGION: MONITORING THE WATER TRANSPORT AND DISTRIBUTION NETWORK REMOTELY WITH SATCOM

The Water Authority of Sardinia uses a remote control system of the infrastructure for distributing raw water between various users, saving time and money

The Water Authority of Sardinia

ENAS (Ente Acque della Sardegna) is in charge of developing, operating and maintaining the water infrastructure and facilities for the Italian Sardinia Region. The Sardinia raw water reserve is stored in 32 large dams spread over the territory, from which the resource is transported for the subsequent supply of the industrial, agricultural and civil sectors. Moreover, ENAS designs, builds and operates renewable energy plants in the region.

The challenge

From its decentralised headquarters, ENAS manages installations spread over a large area of 24 090 km², characterised by a varied orography and a low population density. In addition to the time and workforce needed to visit the water installations, the region's landscape features mean that terrestrial telecommunications infrastructure is unavailable or unreliable outside urban and industrial areas. Therefore, it was difficult to connect to the installations remotely and receive data about their functioning. ENAS was hence looking for solutions to control the infrastructure from its headquarters, through adequate IT systems that could be used both for routine activities and emergencies.

The satellite solution

In 2005, ENAS deployed a satellite communication network to monitor water quality of the Sardinian reservoirs located in valleys not easily accessible. In 2008, it was decided to further develop such network also to monitor the operation of the whole water distribution network. Thanks to the satcom receivers installed near dams, hydroelectric power stations, pumping stations and aqueducts, ENAS is able to receive information about and to control flow rates, volumes, levels and status of pumps in real time and remotely.

Nuraghe-Arrubiu ©ENAS Sardegna

> *"The supply of water is a service of general interest as defined in the Commission communication on services of general interest in Europe"*
>
> **EU WATER FRAMEWORK DIRECTIVE 2000/60/EC**

The result

In the last few years the network was extended from 10 to 62 nodes, to which were also added nodes with a peer-to-peer connection, enabling better communication between the staff in the outskirts and the central offices. The choice of using a scalable, simple and easily manageable system has proved successful, allowing ENAS to have an overview of the whole water distribution system, irrespective of the distance of the employees scattered on the territory. The current network for communication and data transmission between the periphery and the central office ensures the continuity and quality of the service, while reducing the costs and efforts necessary for monitoring the water infrastructure.

"The satcom system enables us to control the entire distribution system in real time and remotely, saving us time and money we can invest in making the service better for our users."

Maurizio Bonetti, Ente Acque della Sardegna

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THE WESTERN SLOVAKIA WATER COMPANY USES GNSS TO MAP WATER INFRASTRUCTURE WITH CENTIMETRE ACCURACY

Satellite positioning enables precise geolocalisation of water pipes and infrastructure, guaranteeing efficient and secure maintenance of the water supply to 507 municipalities

The Western Slovakia Water Company

Západoslovenská vodárenská spoloÐnosÐ a.s. (ZsVS) is a joint-stock company funded in 2002. It operates in an area in West Slovakia including 11 districts, 507 municipalities, and 950 000 inhabitants. Through seven regional offices, ZsVS is responsible for ensuring water supply for urban, industrial and agriculture needs, building and maintaining water mains, treating sewage waters and for protecting water sources in the area.

The challenge

In managing water infrastructure, ZsVS needs to know the position of water pipes as well as other infrastructure (gas pipes, fibre) with centimetre accuracy. Traditionally, the company's surveyors mapped this infrastructure by distance measurements on the field and filling in paperwork. Then, once back in the office, they had to document their observations. This was both costly and time consuming, and left room for errors when filling in the data.

The satellite solution

Since 2008, ZsVS benefits from SmartNet, a network of permanent GNSS receivers, which improves the

© GEOTECH

accuracy of GPS positioning compared to what is available to the general public. ZsVS surveyors now go on field to map the infrastructure equipped with mobile devices which capture a GNSS-improved positioning signal.
Using a field computer linked to headquarter systems, surveyors send this information on location, condition, material and state of the infrastructure directly to the office in near real time. These maps are also made available to maintenance workers, allowing them to quickly find objects or damages in the field, or to perform underground works without threats to existing infrastructure.

> *"Member States shall ensure that metadata are created for the spatial data sets and services (...) and that those metadata are kept up to date"*
>
> **EU INSPIRE DIRECTIVE 2007/2/EC**

The result

The Water Company is able to map water infrastructure much more precisely than it was previously possible, saving time on paperwork and limiting errors. The improved maps enable maintenance workers to avoid damaging existing infrastructure when intervening on buried infrastructure. Finally, the company provides a more competitive and reliable service to its clients.

"The use of satnav in combination with SmartNet to collect field data makes ZsVS a more competitive company, since it enables savings both in terms of time and money, while enhancing the quality of our services."

Alexander Budai, Western Slovakia Water Company

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PRIMARY SECTOR

THE SCAEL COOPERATIVE USES SATELLITE INFORMATION FOR A MORE EFFICIENT USE OF FERTILIZERS

Subscribers receive a satellite-based map showing fertilizer and water needs of the crops. The GPS-guided machinery then distributes fertilizers only where and in the quantity needed

The SCAEL group

The SCAEL group is an association of 1 700 farmers, created in 1886. Its members are associates, as well as clients, to the group for their supplies (seeds, fertilizers). Moreover, the association supports its members in selling crops nationally and internationally. The cooperative produces mainly wheat (358 000t/year), rapeseed (90 000t/year), barley (87 000t/year), corn (85 000t/year), and durum wheat (74 000t/year). Other activities include the production of seeds, laboratory studies and benchmarking new technologies of interest to members.

The challenge

Nitrite pollution affecting both water and crop quality for exports has been an issue of concern for many years. As early as 1992 the cooperative used an advice service which produced nitrogen nutrition indicators based on an analysis of samples of the juice in the plants' stem. However, sampling in the field four times a year over an area of 8 000 hectares was complicated in terms of logistics. The service was also only available for wheat crops.

The satellite solution

Since 2004, the SCAEL cooperative started using Farmstar – a precision agriculture advice service developed by Astrium, a satellite data provider, and Arvalis Institut du végétal, a research institute on applied agriculture. Farmstar combines both

©SCAEL

satellite and in-the-field information collected by SCAEL's technicians to advice farmers on the quantity of fertilizers to use, according to the real needs of crops, so as to avoid excesses. It also gives lodging and likelihood of crop disease. Subscribing farmers receive a map with advice by email, at a cost ranging from €6.5/ha to €10/ha, depending on the area covered. They can load this map on their GPS-guided machinery for optimal distribution of fertilizers or growth regulators.

> *"With the aim of providing for all waters a general level of protection against pollution, Member States shall (...) establish codes of good agricultural practice, to be implemented by farmers on a voluntary basis, which should (...) (reduce) pollution by nitrates (...) in so far as they are relevant (to) periods when the land application of fertilizer is inappropriate".*
>
> **EU NITRATES DIRECTIVE 91/676/EEC**

The result

Service adoption has increased continuously, especially among young farmers, since its introduction in 2004. Today 525 farmers have subscribed to the service, covering an area of about 30 000 hectares. In addition to improving product quality, the service allows farmers to prepare for what the cooperative anticipates to be ever more demanding regulations on water pollution in the near future. In the coming years, the cooperative aims at extending the advice service to cover other crops, as well to be able to identify rapeseed diseases, weeds coverage and soil sulphur content.

"It is a useful service for us, especially in view of increasingly demanding regulations on water pollution."

Mathilde Lejards, SCAEL Group

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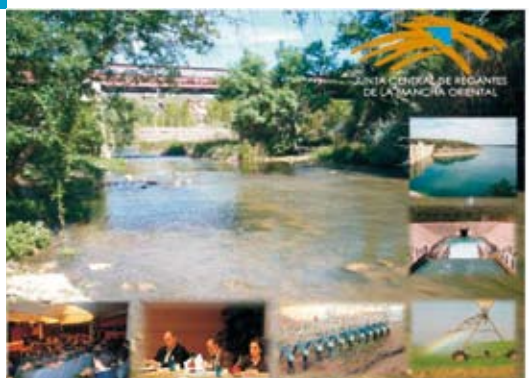
THE CENTRAL IRRIGATION BOARD OF LA MANCHA ORIENTAL USES SATELLITE IMAGERY TO MONITOR IRRIGATION WATER CONSUMPTION



©JCRMO

A GIS integrating satellite information allows the Board to enforce the Annual Exploitation Plan and to optimise water use in the irrigated fields of La Mancha Oriental, Spain

The Central Irrigation Board of La Mancha Oriental

The Júcar river flows through the territory of the autonomous communities of Castilla-La Mancha and Valencia, in the east of Spain.
In Eastern-La Mancha, the Central Irrigation Board of La Mancha Oriental (JCRMO) is mandated by the Júcar River Basin Authority to represent the interests of irrigators in the large aquifer «Mancha Oriental», covering around 10.000 km^2. The JCRMO ensures the sustainable management of the water resources -including groundwater- for irrigation and other purposes.

The challenge

Like the majority of semi-arid Mediterranean basins, the Júcar River Basin is often subject to drought and floods, making the balance between water supply and demand very fragile. In Eastern-La Mancha, 40 years of increasing water demand for irrigation caused a drop in groundwater levels, threatening the conservation of the water resource of the aquifer. The JCRMO and the River Basin Authority were hence looking for cooperative solutions to regulate and to monitor water use sustainably.

The solution

In order to facilitate efficient water monitoring, since 1998, the JCRMO, the Júcar River Basin Authority, the regional Government and the University of Castilla La Mancha, agreed to use information derived from satellite imagery to map the spatial distribution of land covers and uses in order to build a Geographic Information System. Moreover, since 2010, the JCRMO has been using time series of satellite images (12-14 images per year) provided by the EU GMES-funded project SIRIUS, to map and estimate irrigation water needs of cultivated plots according to precipitations, atmospheric demand and irrigation methods.

> *"Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water (...)"*
>
> **EU WATER FRAMEWORK DIRECTIVE 2000/60/EC**

The result

Satellite information is used to assign water abstraction rights to farmers, according to crops and fields' extension, and to monitor the enforcement of the Exploitation Plan of the Aquifer. Enforcement of the AEP is indeed key to ensure sustainability. Moreover, a web-GIS provides farmers with routine reports on irrigation needs. Thanks to these results, historical water rights were assigned on 95% of the territory, discouraging new non-authorised cultivations and allowing a recovery of groundwater levels in the last three humid years.

The classification process to identify irrigated areas based on satellite imagery has been recognised as evidence by the Spanish Supreme Court in 2012.

"The system based on satellite data allows for a more efficient use of this important resource, while enhancing transparency and participation."

Francisco Belmonte, President of the JCRMO

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THE REGIONAL COMMITTEE OF MARINE FISHING OF BASSE-NORMANDIE ENSURES SUSTAINABILITY OF WILD MUSSEL FISHERIES THANKS TO SATELLITE DATA

©Franck Maheux - IFREMER

The Regional Committee uses satellite positioning and communication to improve the understanding of the reproduction cycle of wild mussels

The Regional Fisheries Committee of Basse-Normandie

Basse-Normandie is the third largest shellfish producer in France, with 80 000 tons of oysters and mussels per year, mussels representing over 35 % of the total production. Blue mussels are cultivated on marine pilings, while an important part of the production also comes from wild mussels growing naturally in deep waters. The Regional Committee of Marine Fishing (CRPM-BN) manages shellfish exploitation and represents the general interests of professional shellfish producers in Basse-Normandie.

The challenge

Shellfish yield and supply strongly vary depending on wind, water temperature and sea currents, all of which influence where mussels settle and grow along the coast. Such variations have increased recently, which makes it harder for fishermen to predict yield and manage the stock. The traditional method for obtaining this information involves sampling on site, and is limited to mussel stock assessment. In addition to being costly and time-consuming, this method does not take into account the interaction between the species and its ecosystem.

The satellite solution

To study the dynamics of mussel beds in relation with environmental parameters and to better understand larval dispersal, the Regional Committee partnered with the French Research Institute for the Exploitation of the Sea–IFREMER. Six drifting buoys were released three times, in October 2012, February 2013 and March 2013, to simulate larval drift in the Baie de Seine. They provided information on their position every ten minutes, thanks to both GPS satellites and to Iridium, a global, full ocean coverage satellite communication network.

> *"The Common Fisheries Policy should be improved to ensure the long-term viability of the fisheries sector through sustainable exploitation of living aquatic resources based on sound scientific advice (...)"*
> **EU COUNCIL REGULATION (EC) N. 2371/2002 ON THE CONSERVATION AND SUSTAINABLE EXPLOITATION OF FISHERIES RESOURCES UNDER THE CFP**

This information, combined with other data, helped estimate the influence of water circulation on mussel larval dispersal. The DILEMES project was supported, among others, by the European Fisheries Fund.

The result

The study has allowed the Regional Committee to better understand how mussels respond to environmental factors. It will also help to understand the dynamics of mussel beds in the Baie de Seine, including their connectivity, and thus to inform measures for ensuring sustainable exploitation. The process may also be used for the conservation and the management of other natural resources such as crustacean and other bivalves.

"The information obtained could allow us to understand and manage mussel stocks from one year to the next."

Béatrice Harmel, Regional Committee of Marine Fishery of Basse-Normandie

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ENERGY

STATKRAFT: USING SATELLITE IMAGES TO MANAGE HYDROPOWER PRODUCTION

During the snow-melt period Statkraft receives daily satellite-derived information on snow cover and its water equivalent to plan hydropower production and provide flood alerts in case of water reservoir overflows

© Serg Zastavkin - Fotolia.com

Statkraft

Statkraft, Norway's state-owned electricity company is Europe's largest generator of renewable energy and is the leading power company nationally. The company owns, produces and develops hydropower, wind power, gas power and district heating. Renewable energy production makes up to 91 % of its total annual power production of 60 TWh.

The challenge

The availability and quantity of water supplies for hydropower production is crucial to support the production and trading of electricity. Most of Statkraft's reservoirs in Norway are located in high mountains, which are covered in snow half of the year. 50 % of the water used for hydropower production comes from snow.

Statkraft needs to have reliable information on snow coverage, melting and water-equivalent, so as to manage water resources and production planning, but also environmental risks affecting water reservoirs (e.g. soil movements and erosion).

The satellite solution

Statkraft receives daily satellite information on snow cover and water run-off estimations from PolarView, an international consortium of public and private organisations producing ice-related data. This information, combined with data from other sources, allows Statkraft to better quantify and forecast how much water could be available in the reservoir, or any dangers of overflows, floods or land displacement.

The result

Statkraft can schedule hydropower plant production and supply according to water availability estimations. It can forecast energy prices three years in advance, which gives it a significant competitive advantage.

While detailed reservoir water availability is a commercial information, Statkraft does share this information with National Water Authorities on reservoirs at risk of overflowing, in order to provide flood early warnings and take appropriate mitigation measures.

> *"Member States shall take appropriate steps to encourage greater consumption of electricity produced from renewable energy sources (...). These steps must be in proportion to the objective to be attained"*
>
> **EU DIRECTIVE ON THE PROMOTION OF ELECTRICITY FROM RENEWABLE ENERGY SOURCES IN THE INTERNAL ELECTRICITY MARKET 2001/77/EC**

"Statkraft's innovation strategy means we are using innovative technology analyses in hydro power, wind power and bio energy to gain a competitive advantage for today and the future."

Tom Andersen, Statkraft

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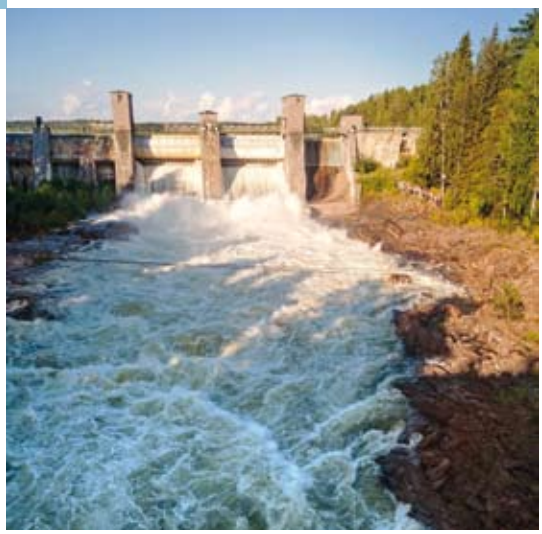
SERHY MANAGES A HYDROELECTRIC PLANT IN VIELLE GRANGE (HAUTES -ALPES) REMOTELY, USING SATELLITE COMMUNICATION

The French company SERHY controls the operating parameters of a hydro-electric site in a mountain area remotely and in real time, allowing it to intervene in case of malfunctioning



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SERHY

SERHY is a French company specialised in the development, construction, operation and maintenance of hydroelectric plants. The company, based in Sisteron, in the department of Alpes-de-Haute-Provence and the Provence-Alpes-Côte d'Azur region, operates hydroelectric power plants in France, with an annual production of more than 230 million KWh. SERHY provides services aiming at achieving the best balance between environmental protection and production optimisation.

The challenge

SERHY needs to monitor the smooth functioning of a micro hydro-electric site in Vielle Grange, in the Hautes-Alpes. Located in a mountainous area that is difficult to access, the plant is not reached by traditional means of communication such as telephone or GSM. Therefore, to control the site without sending people in the field, SERHY needed to find an innovative solution to monitor energy production, and to perform maintenance of the site.

The satellite solution

To ensure reliable and continuous communication between the hydro-electric site and the teleprocessing centre, SERHY decided to develop, in partnership with SATMOS®, a system relying on bidirectional satellite communication to control and manage remotely the regulating equipment of the plant, as well as the electromechanical equipment of the water crane. The satellite link permits to optimise the operation of the two Pelton turbines according to the water level at the dam, and to monitor the electrical parameters of the two alternators. In addition, in case of alarm or malfunctioning, an e-mail is automatically sent to the control centre.

> *"Member States shall ensure that transmission system operators and distribution system operators in their territory guarantee the transmission and distribution of electricity produced from renewable energy sources"*
>
> **EU DIRECTIVE ON THE PROMOTION OF THE USE OF ENERGY FROM RENEWABLE SOURCES 2009/28/EC**

The result

SATMOS' solution enables SERHY's staff not only to monitor parameters and alarms in real time, but also to regulate the equipment remotely. Operators in the teleprocessing centre receive the operating parameters of the plant twice a day, and can intervene at any time in case of malfunctioning. In addition, the solution allows SERHY to remotely monitor environmental parameters related to energy production.

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About Eurisy

Eurisy is a non-profit association of space agencies and government offices dealing with space affairs in Europe.

It is mandated and financed by its members to increase the access of society to the benefits of innovative satellite information and services.

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