



MOHID Land in Action


Frank Braunschweig, Luís Fernandes, David Brito, Rodrigo Fernandes & Susana Braunschweig
MOHID Meeting @ IST – 7-8 June 2018



Content

- Reference Projects
- Software for MOHID Land
- The Future of MOHID Land @ Bentley

Reference Project - SAFER



Project Information

PROJECT
System for Advanced Field and Emergency Response

COUNTRY
Portugal

CLIENT
Tecmic SA
Av. Prof. Doutor Cavaco Silva 13
2740-120 Porto Salvo
Portugal

PARTNERS
Technical University of Lisbon
INESC


DATES
November 2010 - October 2012

MAIN TASK
Software development, including database integration and all map visualization. Numerical model integration and user training.

SOFTWARE & SUPPORT
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System for Advanced Field and Emergency Response



Tagus River
Flood with 10000m³/s

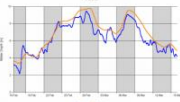
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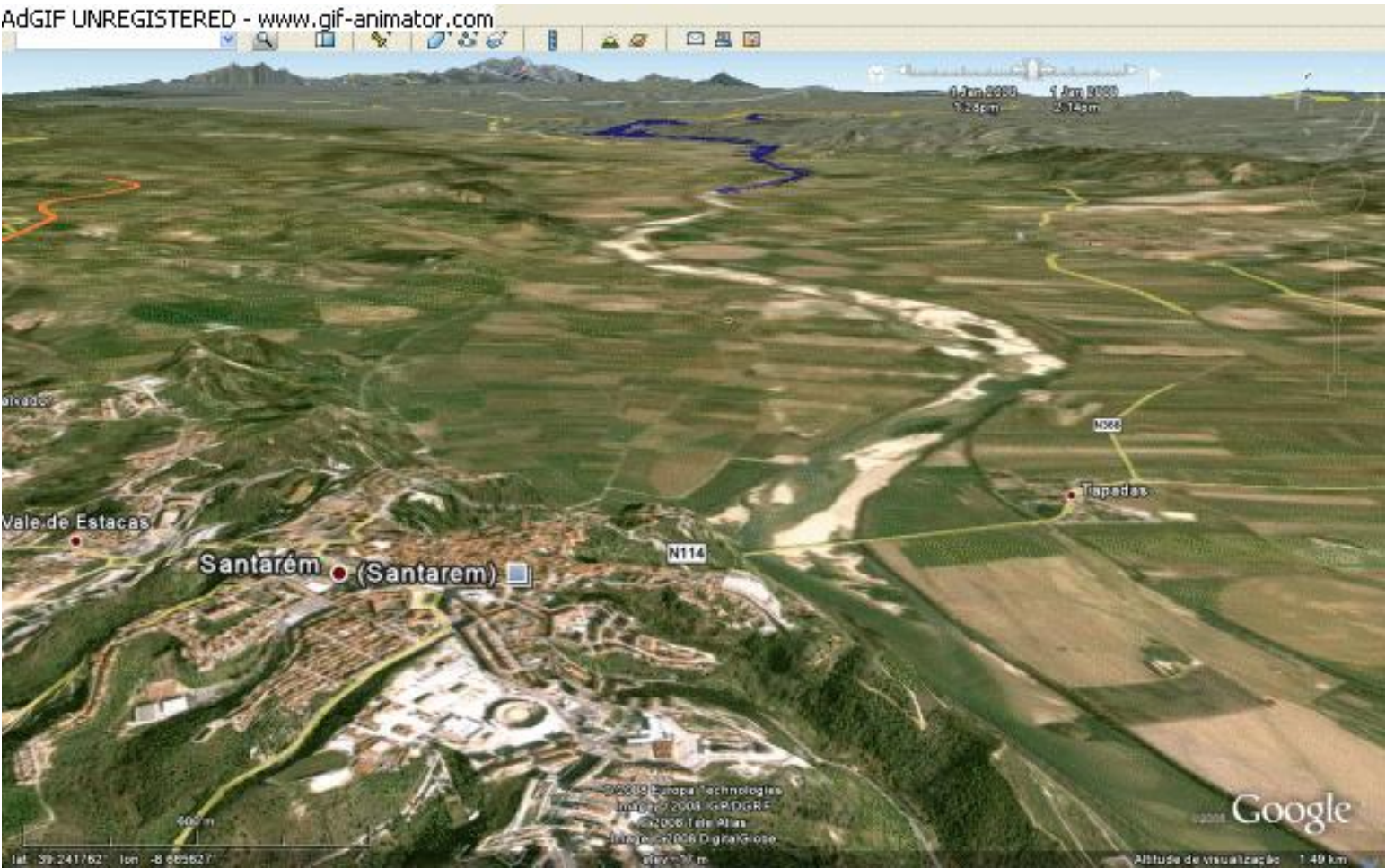
The SAFER project, co-funded by the Portuguese National Research Foundation, had the objective to develop an integrated platform for the management of operating theaters, incorporating the following components:

- Hardware and software for (emergency) vehicle tracking;
- Video surveillance cameras, remotely controlled by the platform;
- Detailed numerical weather predictions and near real time observations;
- Software for logistics management for all means;
- Numerical models for the simulation of forest fires, floods, oil spills, toxic discharges and location of dead bodies drifting in coastal waters.

ACTION MODULERS has been involved in the project and has been responsible for several tasks, including:

- The development of the software architecture of the entire system;
- Integration of all numerical models;
- Implementation of numerical models for riverine floods and urban floods (MOHID Land), oil spill simulations and dead body tracking (MOHID Water);
- Downloading, conversation and visualization of radar images;
- Development of the virtual emergencies and the logistics module;
- Training sessions.






Key Innovations:

MOHID Land in an External Platform
MOHID Land as tool for Civil Protection

Reference Project – SIMTEJO (1/2)



Project Information

PROJECT
Mathematical Modelling of the Trancão watershed in context of the EnviTejo

LOCATION & COUNTRY
Trancão Watershed, Portugal

CLIENT
SimTejo SA
Avenida de Ceuta
1300-254 Lisboa
Portugal

PARTNER


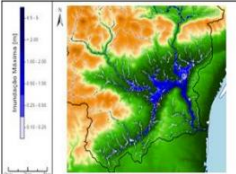
DATES
September 2011 - June 2013

ACTION MODULERS' MAIN TASKS
Implementation, calibration and validation of the MOHID Land in the Trancão watershed.
MOHID Land and MOHID Water integration.

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Mathematical Modelling of the Trancão watershed



Bacia Hidrográfica do Trancão (Sul)
Inundação Máxima (T = 50 anos)

The EnviTejo project, co-financed by the FEDER through the POR Lisboa program, aims to integrate knowledge, information and tools relevant to the management and monitoring of the Tagus Estuary, as well as optimize the logistics of monitoring carried out by the project partners. SIMTEJO, responsible for managing waste water in large part of the Lisbon area, partner of the EnviTejo project, subcontracted Action Modulers for modelling the Trancão watershed, in order to address the following objectives:

- Analyze the flood risk of SIMTEJO's infrastructures located in the Trancão watershed;
- Analyze the effect of several discharges on water quality (nutrients and microbiology) in the Rio Trancão;
- Study the interaction between the Trancão River and the Tagus Estuary.



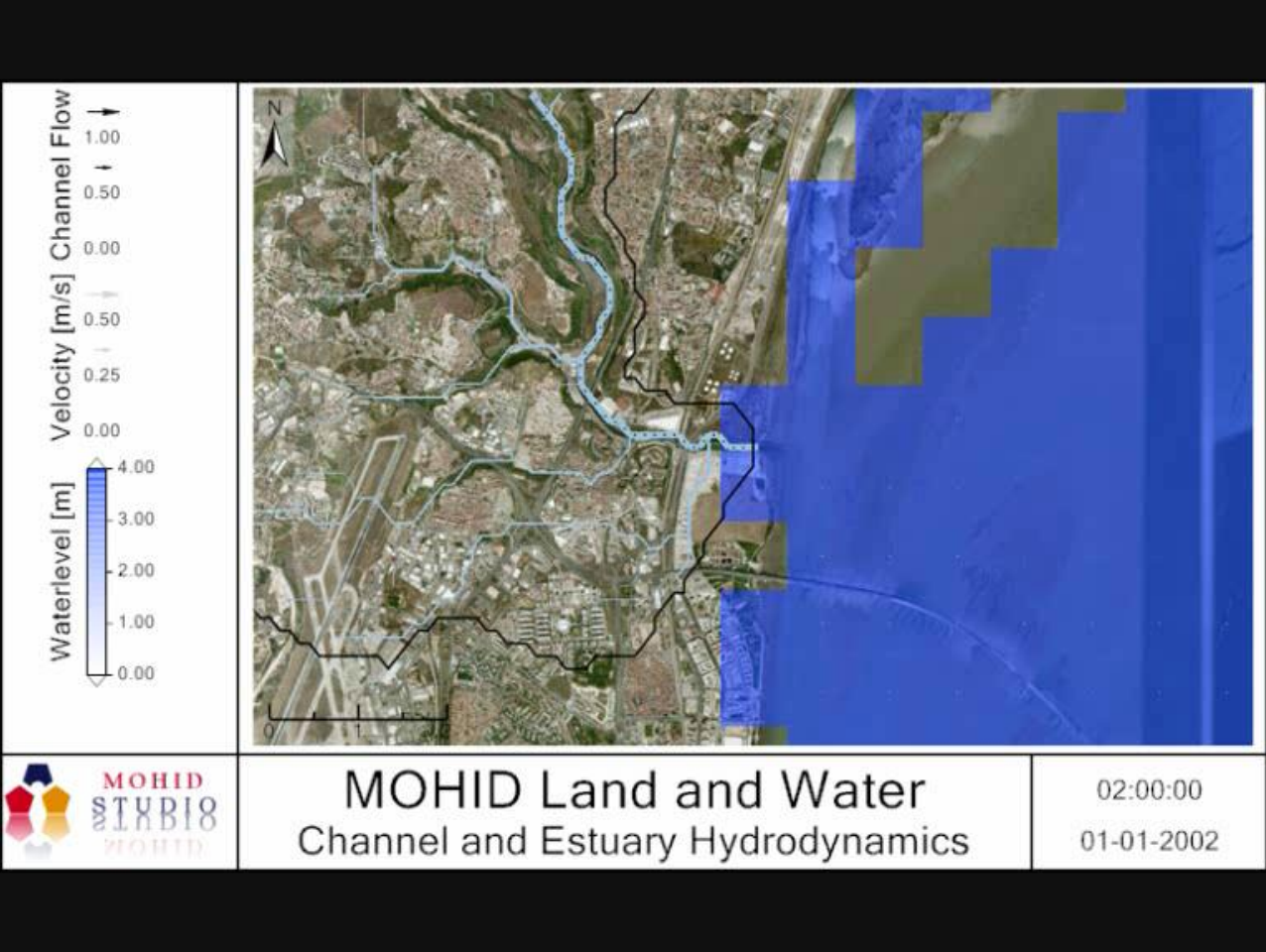
Bacia Hidrográfica do Trancão
Localização na ETARIS

The main results of the services provided include:

- Implementation of the MOHID Land model in the Trancão river basin, using different spatial scales;
- Simulation of flood events, microbiological contamination and nutrient loading;
- Integration, via OpenMI, of MOHID Water and MOHID Land for simulating the interaction between rivers and coastal zones.

Mathematical Modelling of the Trancão watershed


© Action Modulers 2015



Key Innovations:

MOHID Land & OpenMI
MOHID Land & Water Quality

Reference Project – SIMTEJO (2/2)



Consulting & Technology

Project Information

PROJECT

Mathematical Modelling of the Trancão watershed in context of the EnviTejo

LOCATION & COUNTRY

Trancão Watershed, Portugal

CLIENT

SimTejo SA
Avenida de Ceuta
1300-254 Lisboa
Portugal

PARTNER

DATES

September 2011 - June 2013

ACTION MODULERS' MAIN TASKS

implementation, calibration and validation of the MOHID Land in the Trancão watershed.
MOHID Land and MOHID Water integration.


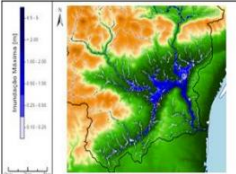
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Mathematical Modelling of the Trancão watershed



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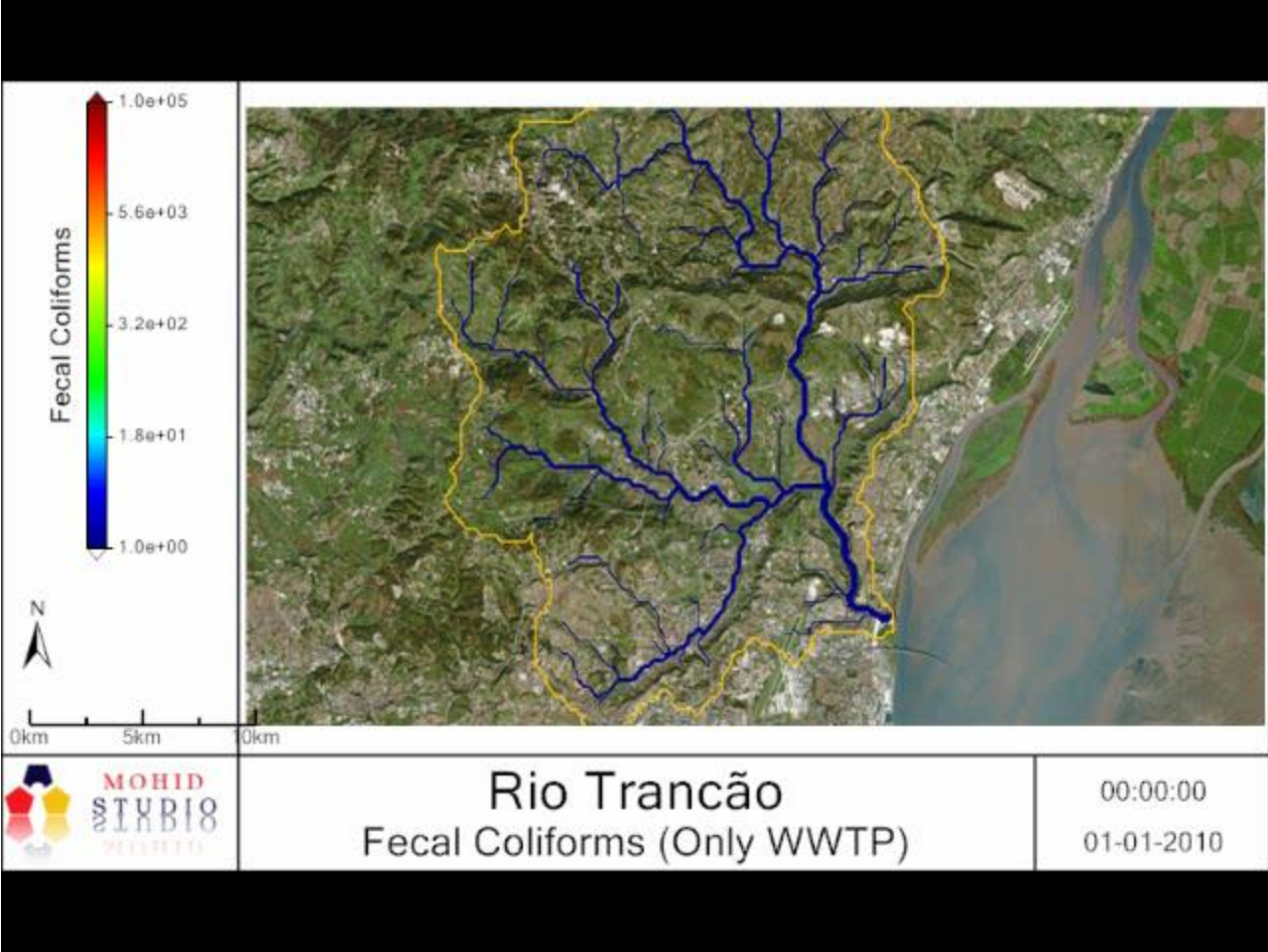
- Analyze the flood risk of SIMTEJO's infrastructures located in the Trancão watershed;
- Analyze the effect of several discharges on water quality (nutrients and microbiology) in the Rio Trancão;



Bacia Hidrográfica do Trancão
Localização: Rio ETAR

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- Simulation of flood events, microbiological contamination and nutrient loading;
- Integration, via OpenMI, of MOHID Water and MOHID Land for simulating the interaction between rivers and coastal zones.



The figure is a map of the Rio Trancão watershed showing Fecal Coliforms concentration. The map includes a color scale for Fecal Coliforms ranging from 1.0e+00 to 1.0e+05. The map shows the river network and coastal zones. The title is 'Rio Trancão Fecal Coliforms (Only WWTP)'. The date is 01-01-2010.


Key Innovations:

MOHID Land & OpenMI
MOHID Land & Water Quality

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Reference Project – CIRAC



Consulting & Technology

Project Information

PROJECT
Floods and Flood Risk Maps in Climate Change Scenarios

LOCATION & COUNTRY
Urban Areas & Portugal

FINAL CLIENT
Associação Portuguesa dos Seguros
Rua Rodrigo de Fonseca 41,
1250 – 190 Lisboa
Portugal

PARTNER
University of Lisbon

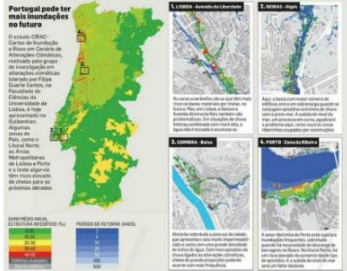
DATES
March 2011 - August 2013

ACTION MODULERS' MAIN TASKS
Development and implementation of the integrated model in several areas.
Training and support.

SOFTWARE & SUPPORT
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Floods and Flood Risk Maps in Climate Change Scenarios (CIRAC)




Being risk defined as product of probability of occurrence by caused damage, urban floods have particularly high risk due to the damage they cause. Taking into considerations climate change scenarios, the risk can even be higher, since the probability of occurrence of heavy rainfall events is expected to increase. Being aware about this the Portuguese Assurance Association ordered a study to assess urban flood risk in context of climate change scenarios with the following objectives:

- Setup of several climate change scenarios, including rainfall events for different return periods;
- Modelling of urban floods;
- Elaboration of flood risk maps for the entire national territory.

The main results of the services provided by ACTION MODULERS include:

- Integration of the MOHID Land model with the SWMM model in order to simulate urban floods in an integrated approach;
- Implementation of this integrated model in different urban areas;
- Implementation of the MOHID Water model in the coastal areas;

The integrated model (MOHID Land + SWMM) has been included into MOHID Studio.



Floods and Flood Risk Maps in Climate Change Scenarios


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Key Innovations:

MOHID Land coupled with SWMM (OpenMI)
MOHID Land in urban environment

Reference Project – CM Coimbra



Project Information

PROJECT
Emergency Response Plan for Inundations and Flooding

LOCATION & COUNTRY
Coimbra, Portugal

CLIENT
Coimbra Municipality
Praça 8 de Maio
3000-300 Coimbra
Portugal

PARTNER
Tetraplano

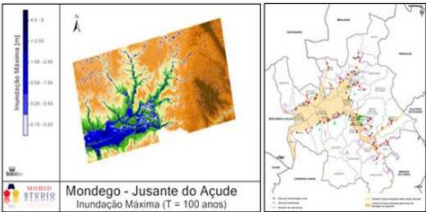
DATES
February 2012 – August 2012

ACTION MODULERS' MAIN TASKS
Project coordination, numerical modeling and implementation of the operational flood warning system.

SOFTWARE & SUPPORT
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Emergency Response Plan for Inundations and Flooding




Mondego - Jusante do Açude
Inundação Máxima (T = 100 anos)

The elaboration of the *Emergency Response Plan for Inundations and Flooding* included the following main objectives:

- Determination of flood zones, taking into consideration historical records and numerical modelling;
- Risk analysis in the identified flood zones;
- Elaboration of cartographic maps of the flood zones and all relevant information about flood risk emergency response;
- Integration of all relevant information into the Geographic Information System of the municipality;
- Installation of an operational flood warning system which, based on observed and modelled data, allows anticipating the occurrence of floods.

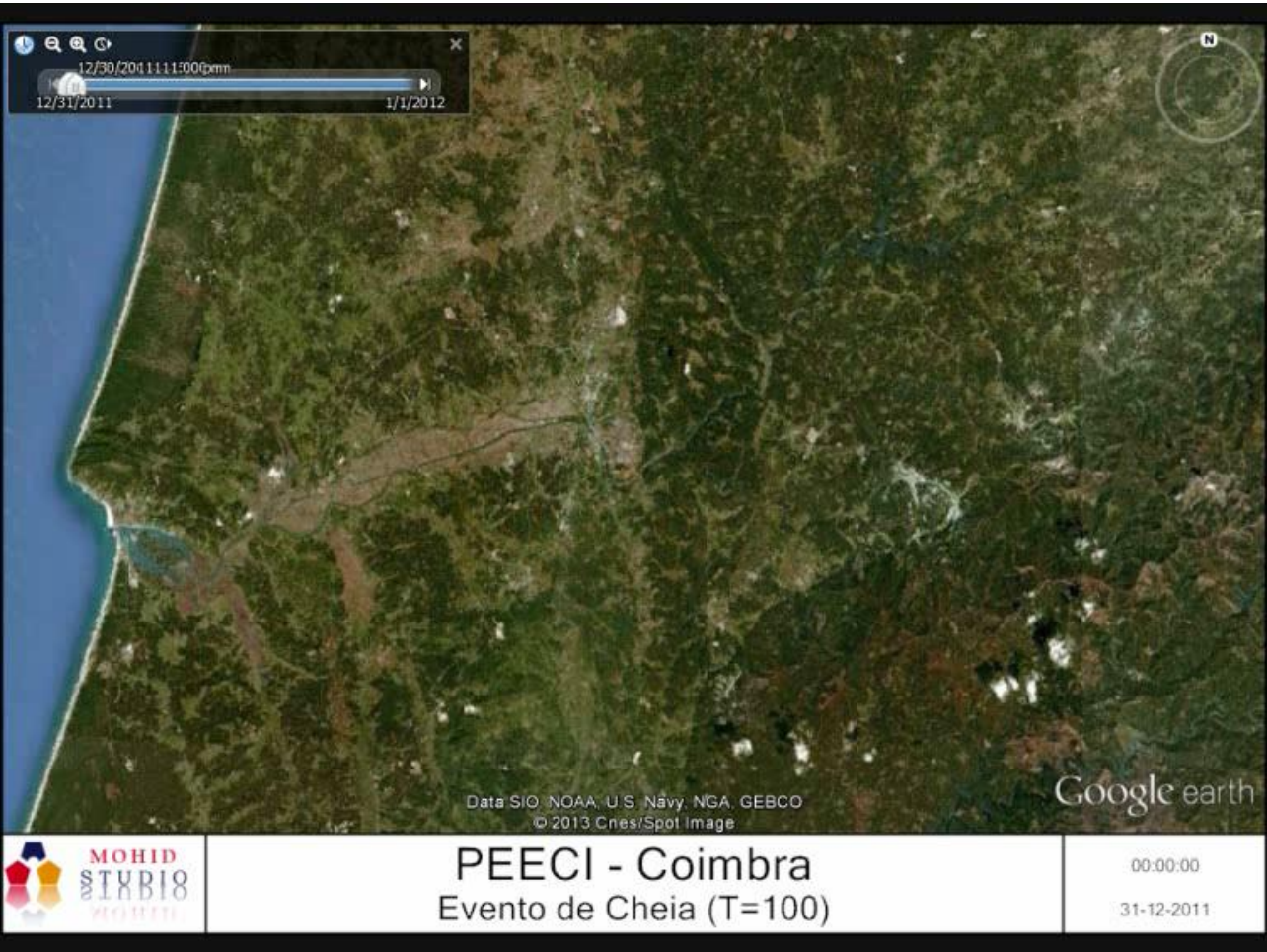
The main results of the services provided include:

- Implementation of the MOHID Land model in different areas of the municipality, using a 2D high resolution approach. Specific models have been implemented in small watersheds (e.g. "Rio Ceira") and along the main river (Rio Mondego);
- Elaboration of the emergency plan, following the recommendations of the National Civil Protection;
- Public discussion of achieve results;
- Implementation of the flood warning system *Action Flood*.




Emergency Response Plan for Inundations and Flooding

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Key Innovations: Implementation of ACTION Flood MOHID Land for Mun. Planning



ACTION Modulers
Consulting & Technology

Project
Information

PROJECT

Flood Risk Assessment in the
Portuguese Territory

LOCATION & COUNTRY

Portugal

CLIENT

Portuguese Agency for
Environment

Rua da Murgueira, 9/9A -
Zambujal Ap. 7585

2611-865 Amadora

Portugal

PARTNER

Aqualogus

DATES

September 2014- December 2014

ACTION MODULERS' MAIN TASKS

Responsible for the numerical
modelling in all of the 24 places.

SOFTWARE & SUPPORT

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Flood Risk Assessment for the Portuguese Territory




Maximum Depth



Maximum Velocity



Portugalidade - 6.0-8.5	
8.75	Insufficient
8.25 - 8.75	Baixo
7.75 - 8.25	Médio
7.25 - 7.75	Alto
6.75 - 7.25	Muito Alto



Danger Map

In order to respond to the European Directive 2007/60/CE, of the 23 of October, the Portuguese Environmental Ministry conducted a public tender to perform elaborate flood inundation and flood risk maps for the Portuguese territory. This tender has been won by the consortium ACTION MODULERS / AQUALOGUS.

During the project detail flood risk assessment has been performed for 24 previously identified places, considering different return periods.

The work performed by Action Modulers included the **data collection**, **numerical modelling** and the **production of maps**.

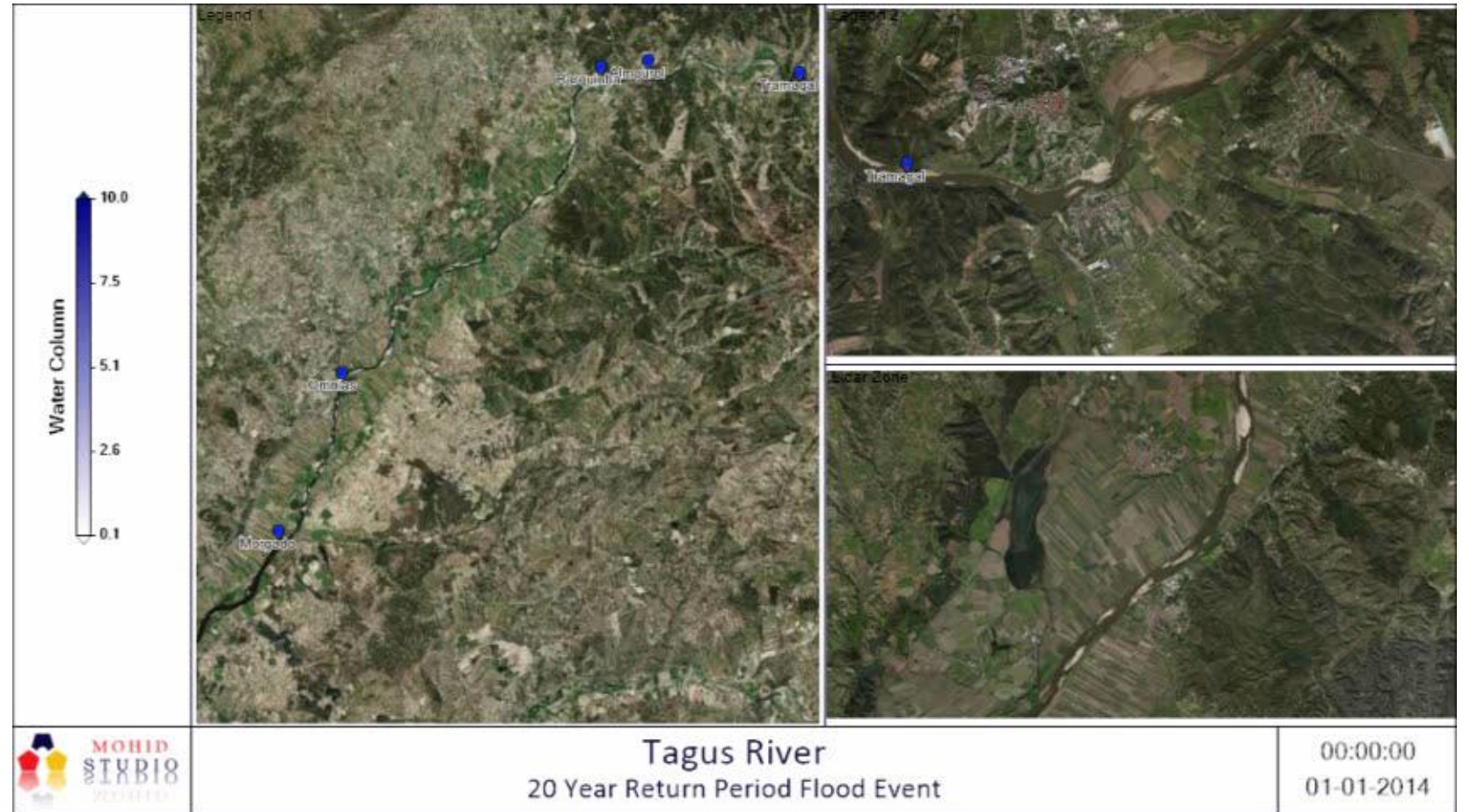
The initial data collection allowed gathering a wide range of data sets for the Portuguese Territory.

These data sets have been processed with Action Modulers' core product, MOHID Studio, in order to generate input data for the numerical models. In the context of this project, 2D high resolution models have been implemented. MOHID Land and MOHID Water models have been used for inland and coastal areas, respectively.

Models have been run for historic events (for calibration and validation) and afterwards for a 3 different return periods (20, 100 and 1000 years). Inundation maps and flood risk maps have been produced for all these places and are now public on the Environmental Agencies website: <http://snimportal.apambiente.pt/dir/ativa60ce2007/>. Contact us for further information.


Flood Risk Assessment for the Portuguese Territory

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Reference Project – APA (2/5)



Consulting & Technology

Project Information

PROJECT
Flood Risk Assessment in the Portuguese Territory

LOCATION & COUNTRY
Portugal

CLIENT
Portuguese Agency for Environment
Rua da Murgueira, 9/9A - Zambujal Ap. 7585
2611-865 Amadora
Portugal

PARTNER
Aqualogus

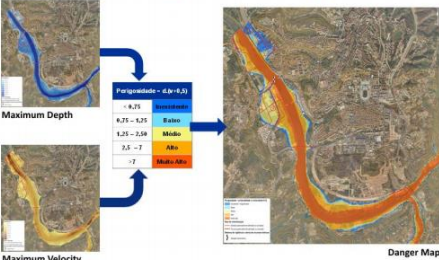
DATES
September 2014- December 2014

ACTION MODULERS' MAIN TASKS
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Flood Risk Assessment for the Portuguese Territory



Maximum Depth

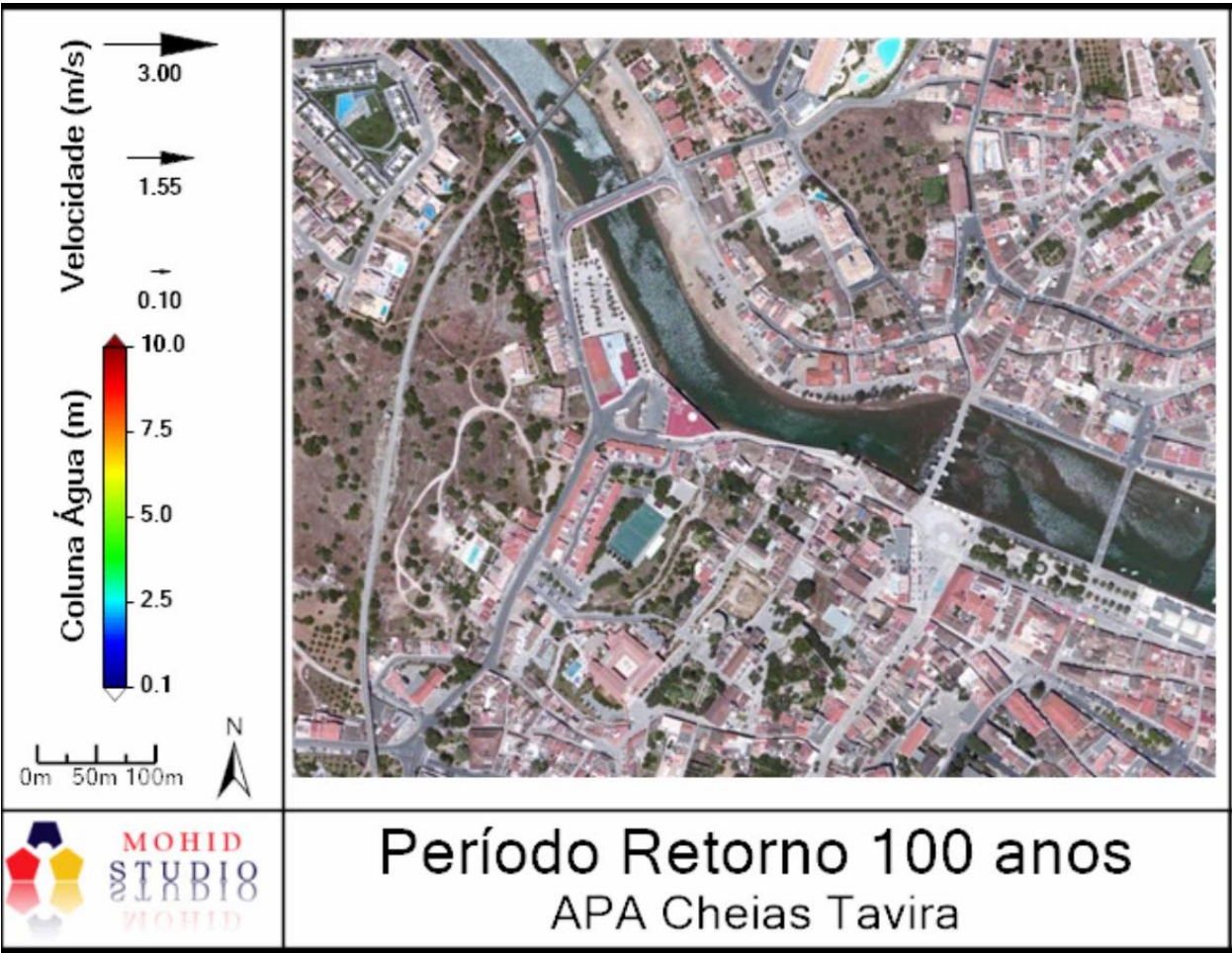
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Flood Risk Assessment for the Portuguese Territory

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Key Innovations: Automatic Flood Hazard calculation
22 sites -> No MOHID Land crash...

Reference Project – APA (3/5)



Consulting & Technology

Project Information

PROJECT
Flood Risk Assessment in the Portuguese Territory

LOCATION & COUNTRY
Portugal

CLIENT
Portuguese Agency for Environment
Rua da Murgueira, 9/9A - Zambujal Ap. 7585
2611-865 Amadora
Portugal

PARTNER
Aqualogus

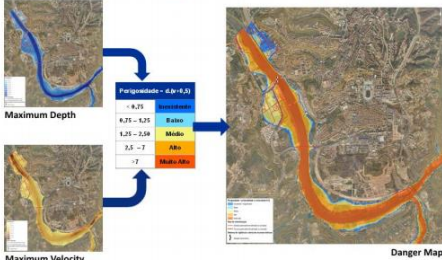
DATES
September 2014- December 2014

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Flood Risk Assessment for the Portuguese Territory



In order to respond to the European Directive 2007/60/CE, of the 23 of October, the Portuguese Environmental Ministry conducted a public tender to perform elaborate flood inundation and flood risk maps for the Portuguese territory. This tender has been won by the consortium ACTION MODULERS / AQUALOGUS.

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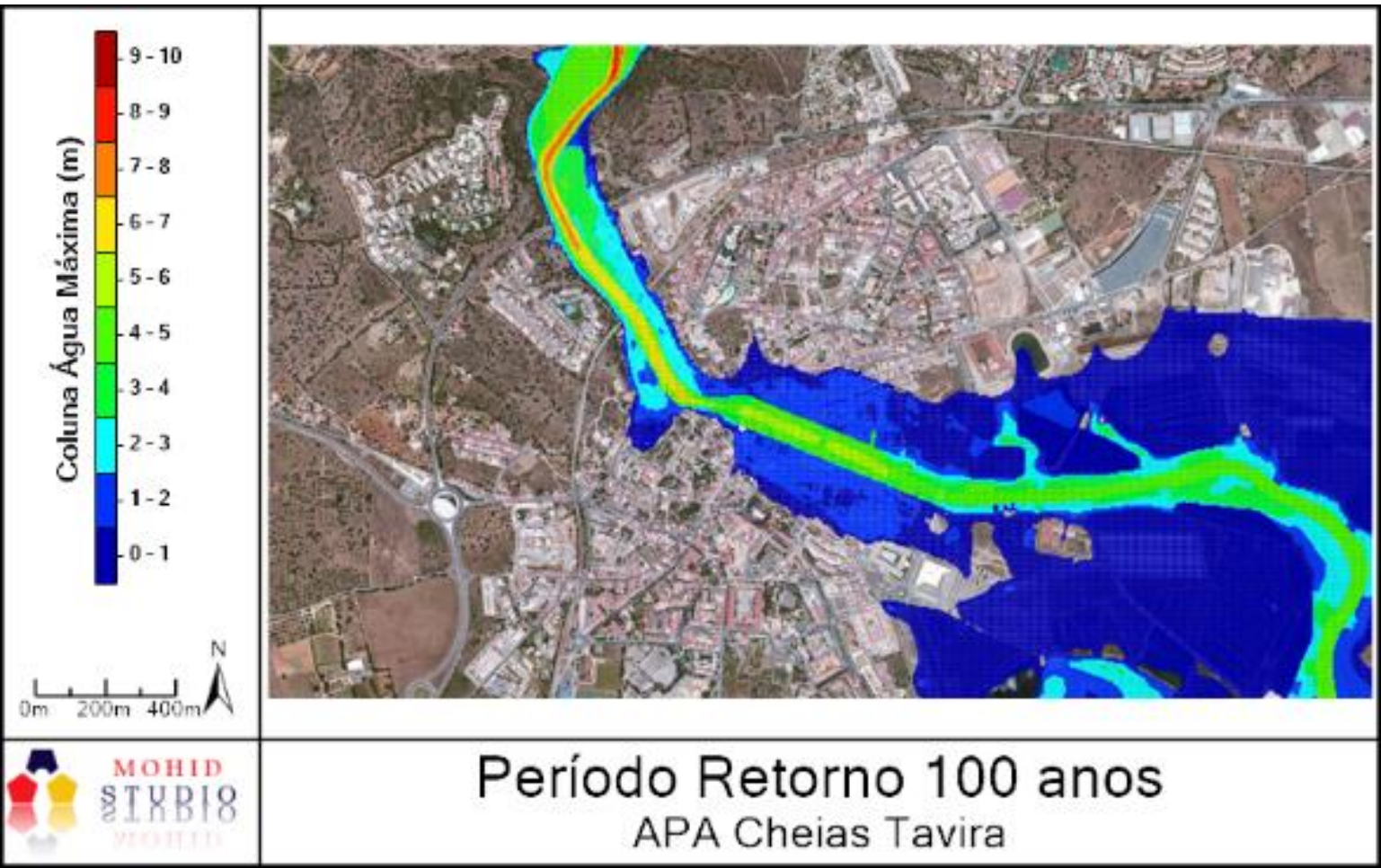
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Flood Risk Assessment for the Portuguese Territory

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Key Innovations: Automatic Flood Hazard calculation
22 sites -> No MOHID Land crash...

Reference Project – APA (4/5)



Consulting & Technology

Project Information

PROJECT
Flood Risk Assessment in the Portuguese Territory

LOCATION & COUNTRY
Portugal

CLIENT
Portuguese Agency for Environment
Rua da Murgueira, 9/9A - Zambujal Ap. 7585
2611-865 Amadora
Portugal

PARTNER
Aqualogus

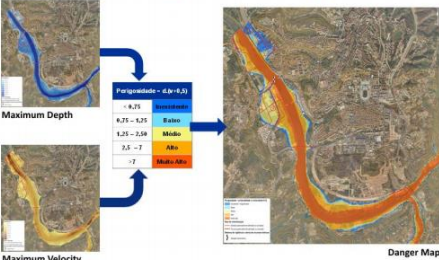
DATES
September 2014- December 2014

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Flood Risk Assessment for the Portuguese Territory



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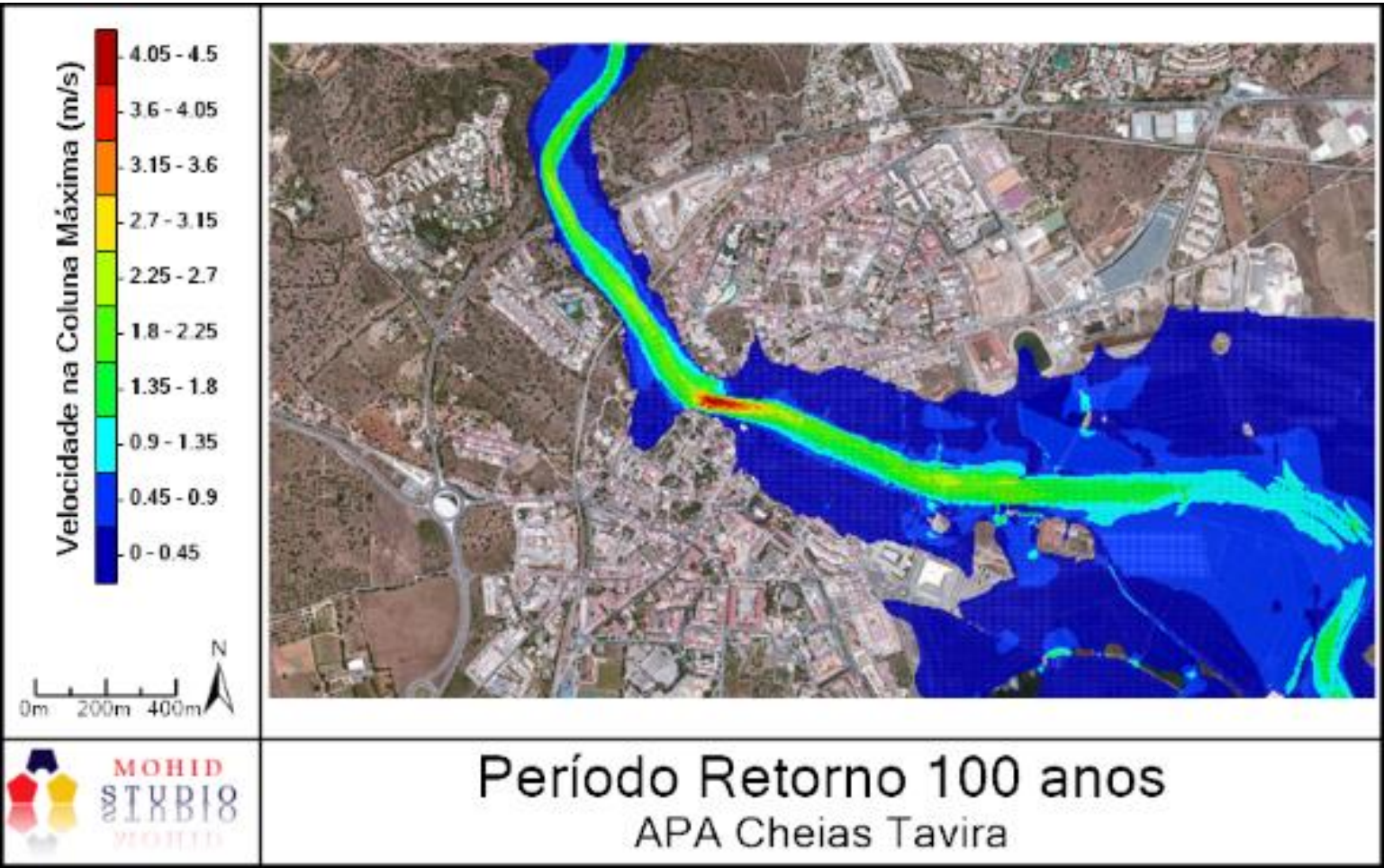
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Flood Risk Assessment for the Portuguese Territory

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Key Innovations: Automatic Flood Hazard calculation
22 sites -> No MOHID Land crash...

Reference Project – APA (5/5)



Consulting & Technology

Project Information

PROJECT
Flood Risk Assessment in the Portuguese Territory

LOCATION & COUNTRY
Portugal

CLIENT
Portuguese Agency for Environment
Rua da Murgueira, 9/9A - Zambujal Ap. 75B5
2611-865 Amadora
Portugal

PARTNER
Aqualogus

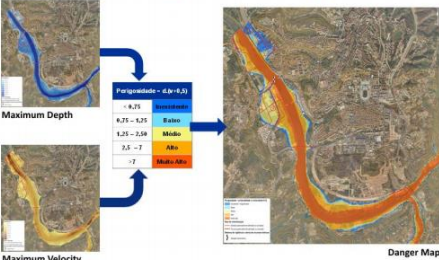
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Flood Risk Assessment for the Portuguese Territory



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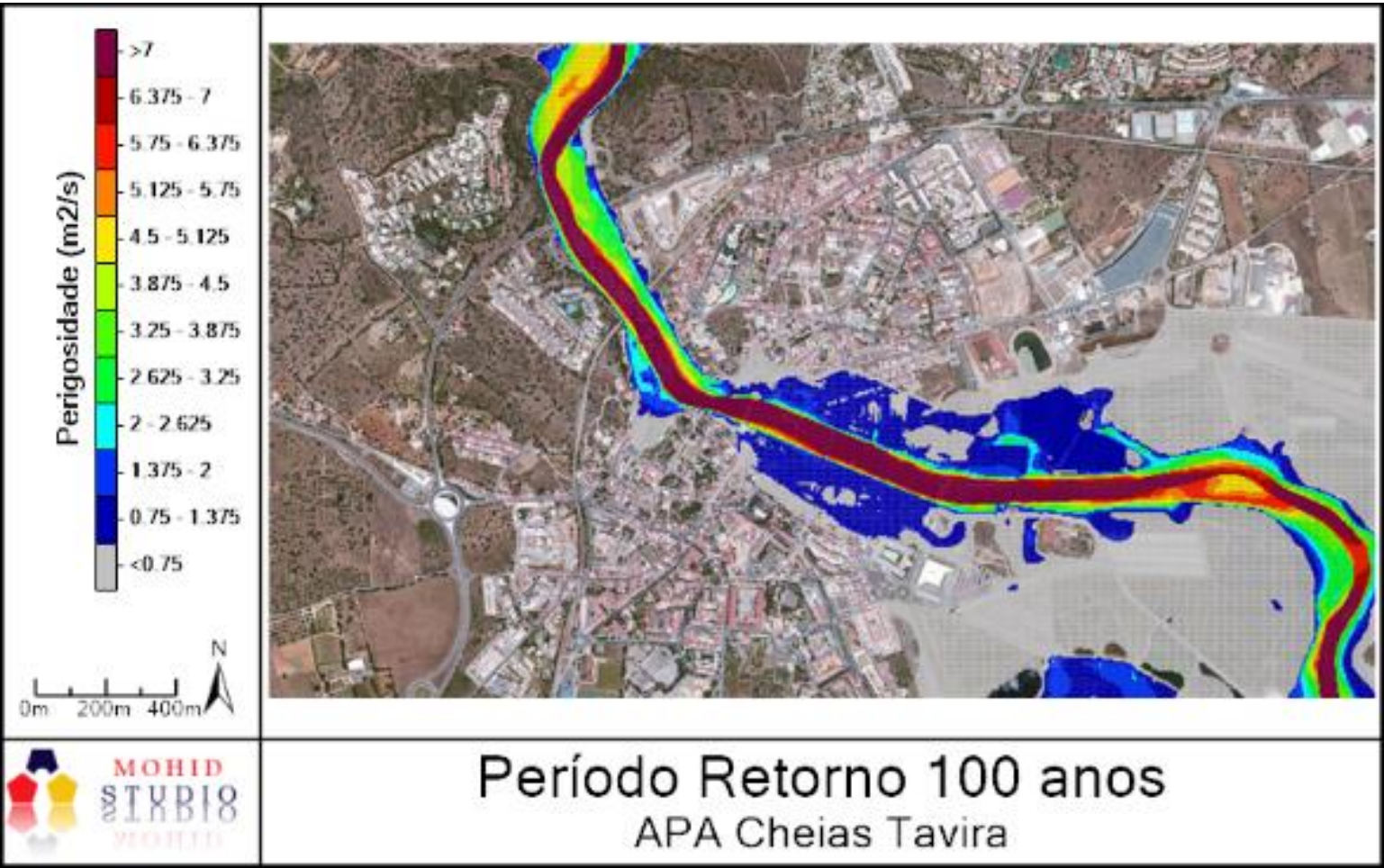
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Flood Risk Assessment for the Portuguese Territory

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Key Innovations: Automatic Flood Hazard calculation
22 sites -> No MOHID Land crash...

Reference Project – Lisbon Drenagem Plan (1/3)



Consulting & Technology

Project Information

PROJECT
New Drainage Master Plan for Lisbon Municipality

LOCATION & COUNTRY
Lisbon, Portugal

FINAL CLIENT
Câmara Municipal de Lisboa
Praça do Município
1149-014 Lisboa
Portugal

PARTNER
Hidra, Hidráulica e Ambiente

DATES
August 2015

ACTION MODULERS' MAIN TASKS
Simulation of different scenarios using the integrated urban flood modelling software MOHID Land-SWMM.

SOFTWARE & SUPPORT
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New Drainage Master Plan for Lisbon Municipality



Lisbon Downtown - 10 Year Return Period
Current Situation (Left - Water Depth, Right Top - Volume Ration, Right Bottom - Rain)

Being risk defined as product of probability of occurrence by caused damage, urban floods have particularly high risk due to the damage they cause. Taking into considerations climate change scenarios, the risk can even be higher, since the probability of occurrence of heavy rainfall events is expected to increase. Lisbon urban areas are frequently affected by intense flush floods. With the objective to mitigate the impact caused by those floods, the Municipality decided to invest about 190M Euros in the redesign of the urban drainage network. The most complex alternatives have been simulated using the integrated urban flood simulator developed by ACTION MODULERS.

The main results of the services provided by ACTION MODULERS include:

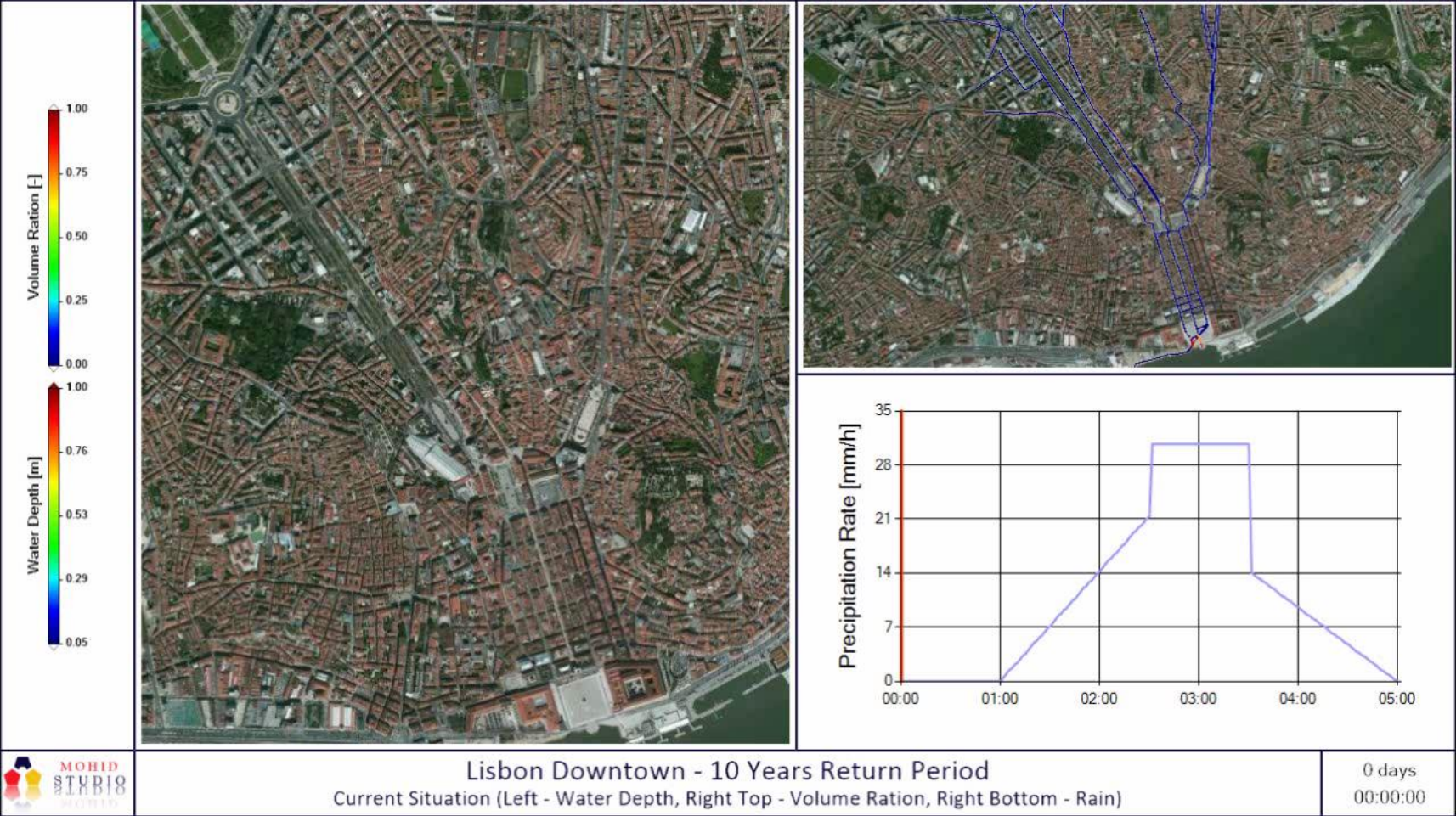
- Integration of the MOHID Land model with the SWMM model in order to simulate urban floods in an integrated approach;
- Implementation of this integrated model in the main problematic zone;
- Simulation of different alternatives to access the impact of construction works;



For further information, please contact ACTION MODULERS;

New Drainage Master Plan for Lisbon Municipality

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Key Innovations: -

Reference Project – Lisbon Drenagem Plan (2/3)



Consulting & Technology

Project Information

PROJECT
New Drainage Master Plan for Lisbon Municipality

LOCATION & COUNTRY
Lisbon, Portugal

FINAL CLIENT
Câmara Municipal de Lisboa
Praça do Município
1149-014 Lisboa
Portugal

PARTNER
Hídra, Hidráulica e Ambiente

DATES
August 2015

ACTION MODULERS' MAIN TASKS
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SOFTWARE & SUPPORT
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sales@actionmodulators.com
www.actionmodulators.com

New Drainage Master Plan for Lisbon Municipality



Lisbon Downtown - 10 Year Return Period
Current Situation vs. Future Situation (Heavy Storm Water Event) - Water Depth

Being risk defined as product of probability of occurrence by caused damage, urban floods have particularly high risk due to the damage they cause. Taking into considerations climate change scenarios, the risk can even be higher, since the probability of occurrence of heavy rainfall events is expected to increase. Lisbon urban areas are frequently affected by intense flush floods. With the objective to mitigate the impact caused by those floods, the Municipality decided to invest about 190M Euros in the redesign of the urban drainage network. The most complex alternatives have been simulated using the integrated urban flood simulator developed by ACTION MODULERS.

The main results of the services provided by ACTION MODULERS include:

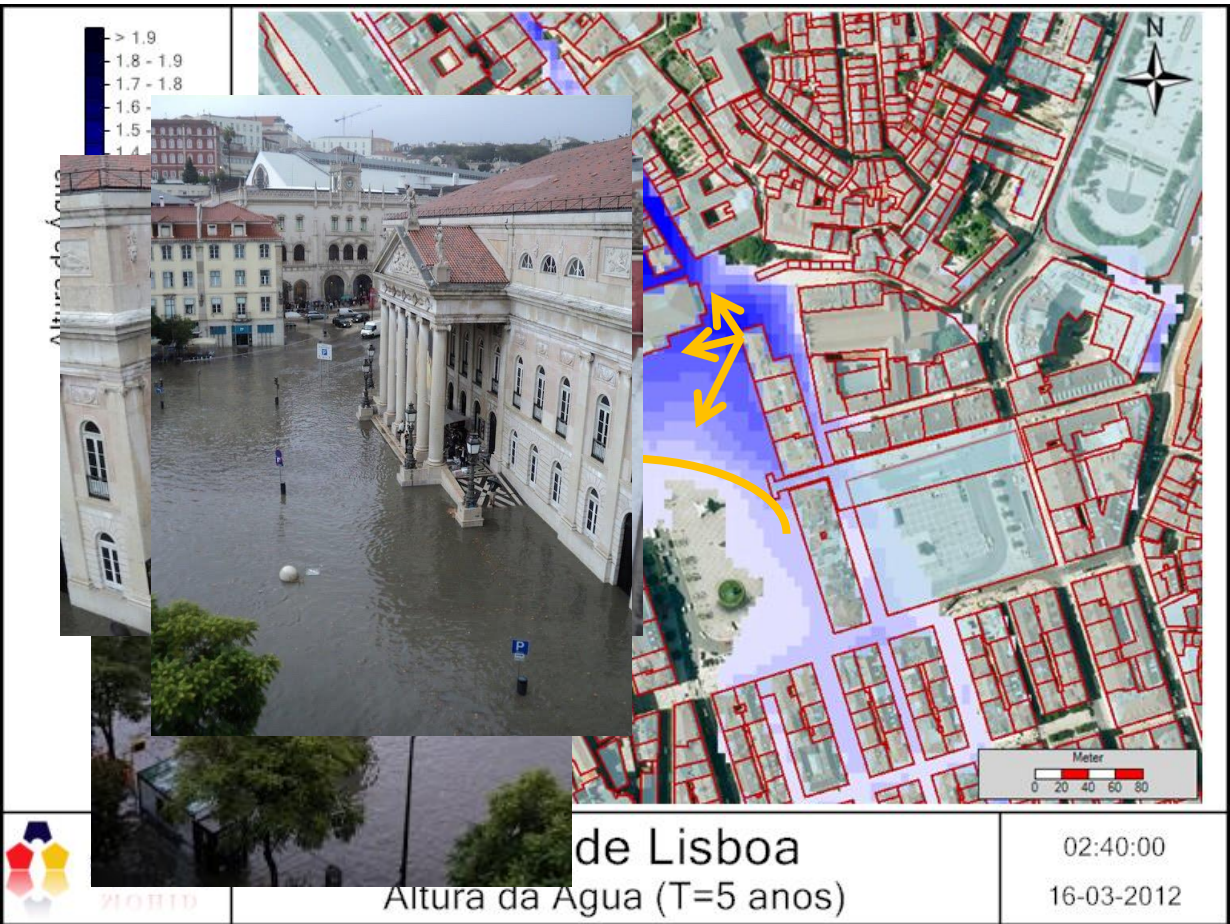
- Integration of the MOHID Land model with the SWMM model in order to simulate urban floods in an integrated approach;
- Implementation of this integrated model in the main problematic zone;
- Simulation of different alternatives to access the impact of construction works;



For further information, please contact ACTION MODULERS;

New Drainage Master Plan for Lisbon Municipality

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Key Innovations: -

Reference Project – Lisbon Drenagem Plan (3/3)



Consulting & Technology

PROJECT
New Drainage Master Plan for Lisbon Municipality

LOCATION & COUNTRY
Lisbon, Portugal

FINAL CLIENT
Câmara Municipal de Lisboa
Praça do Município
1149-014 Lisboa
Portugal

PARTNER
Hídra, Hidráulica e Ambiente

DATES
August 2015

ACTION MODULERS' MAIN TASKS
Simulation of different scenarios using the integrated urban flood modelling software MOHID Land-SWMM.

SOFTWARE & SUPPORT
Action Modulers offers a wide range of customisable software products. We also provide professional support to implement your projects.

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Project Information

New Drainage Master Plan for Lisbon Municipality



Lisbon Downtown - 10 Year Return Period
Current Situation vs. Future Situation (Grey - Storm Water Newtork, Color - Water Depth)

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Water Depth [m]

1.00
0.76
0.53
0.29
0.05

MOHID
LAND-SWMM

Lisbon Downtown - 10 Year Return Period
Current Situation vs. Future Situation (Grey - Storm Water Newtork, Color - Water Depth)

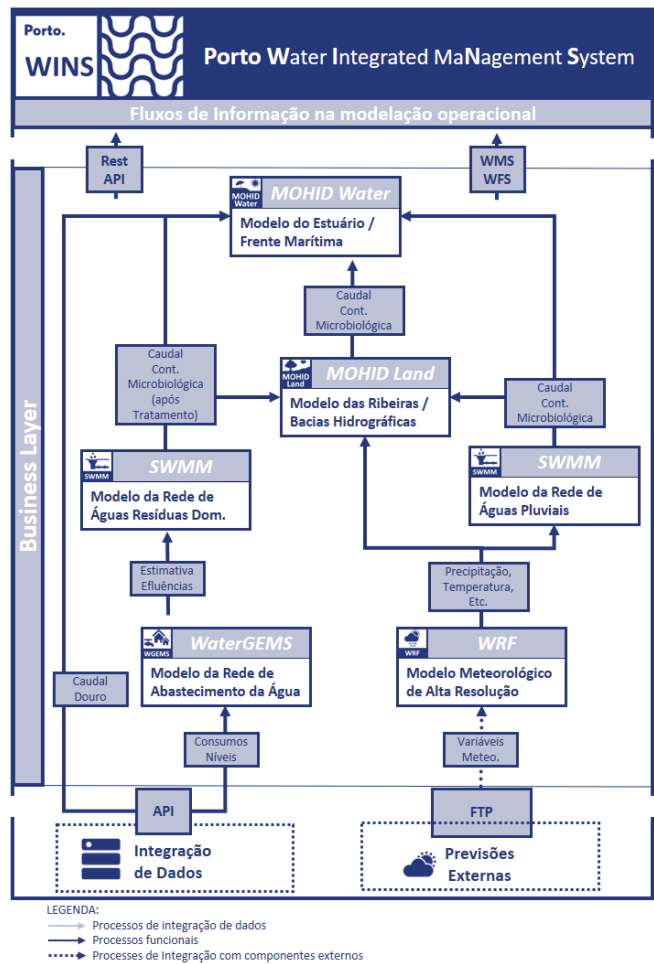
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Key Innovations: -

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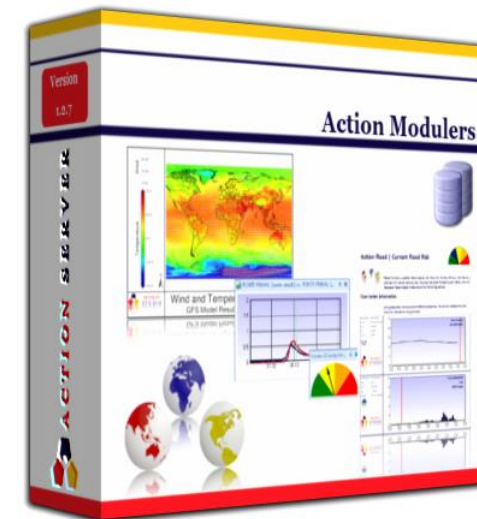
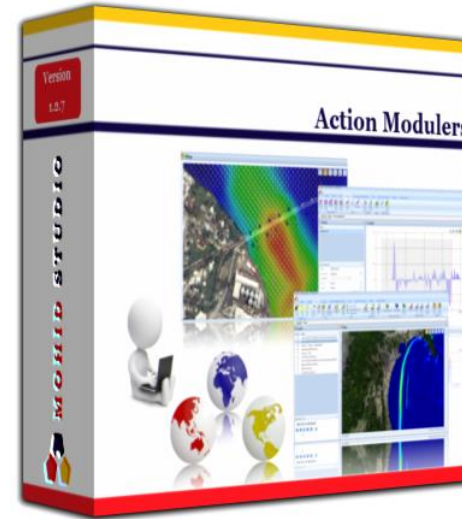
Reference Project – Águas do Porto



Key Innovations: MOHID Land in an integrated platform to manage the urban water cycle

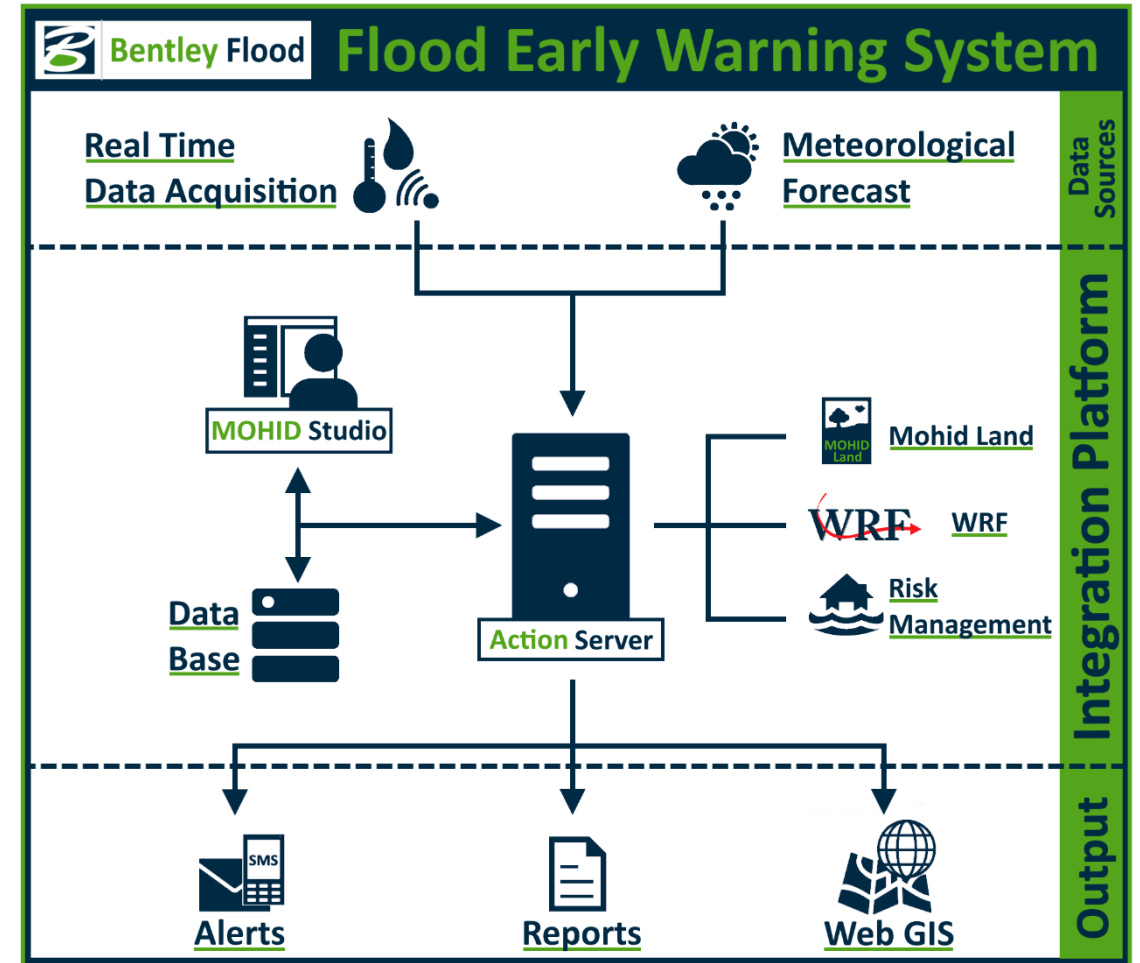
Software for MOHID Land - Core

- MOHID Studio
 - Graphical User Interface
 - Configure Models
 - Explore Scenarios
 - Manage Field Data
 - Configure Action System
 - Plugin Ready
- Action Server
 - Periodic Data Download
 - Periodic Model Execution
 - Risk Evaluation / Alert System
 - Plugin Ready





Software for MOHID Land – Action Flood

- Action Server
 - Download Data from Station & Online Models
 - Operational Modelling
 - Data Storage
 - Risk Analysis
 - Publish Results
- MOHID Studio Functions
 - Setup Model
 - Risk Management
 - Configure WMS Layers
 - Time Series
 - General Administration
- Numerical Models
 - MOHID Land & WRF



MOHID Land @ Bentley

- Integrate MOHID Land & MOHID Studio into Bentley's portfolio (High Priority)
- Integrate Action Flood into Bentley's portfolio
- Integrate MOHID Land with other Bentley Products



PRODUCT DATA SHEET

Flood Risk Assessment and Resilience

A complete Flood Modeling Software for Understanding and Mitigating Flood Risks in Urban, Riverine, and Coastal Systems

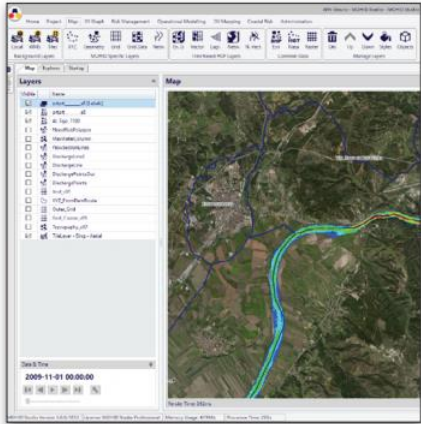
Flood risk management is critical to enhance flood resilience in urban and built-up areas. Growing population and urbanization in a context of climate change are increasing the need for comprehensive flood risk management to minimize impacts on human safety, economy, and environment. By accurately simulating extreme rainfall events, ruptured dams or levees, rapid ice/snow melting, coastal storms, and tsunamis, MOHID Studio can help deliver top infrastructure design and structural adaptive solutions as well as aid in emergency planning and design of green initiatives. With a complete multi-scale 1D/2D approach, MOHID Studio can also be used in the configuration of Flood Early Warning Systems (FEWS).

Urban Flooding
Urban flooding can be triggered by excessive local rainfall, overtopping of river defences and/or, insufficient flow capacity of drainage systems, posing risks for human safety, damaging property and infrastructure, and disrupting urban services.
MOHID Studio can produce detailed simulations of the extent of urban floods, helping identifying bottlenecks and hotspots that hinder the capacity of the stormwater drainage systems.

MOHID Studio is a complete Flood Modelling Software for understanding and mitigating flood risks in urban, riverine and coastal systems.

MOHID Studio scenario management can guide professional flood modelers to delineate efficient solutions to increase the resilience of urban drainage systems and prioritize the implementation of mitigation measures such as Low-Impact Development (LID) and green initiatives.

Riverine Flooding
Riverine flooding can cause property and infrastructure damage in built-up areas, loss of agricultural production, disruption of infrastructure operations (railways, roads), and hazards from large industrial facilities (e.g. oil or hazardous substances spills).





Screenshot of MOHID Studio Software during flood risk assessment.

MOHID Studio can efficiently address riverine flooding by producing inundation, flood risk, and hazard maps in relation to problems such as riverine conveyance, river defences capacity, and large-scale land use changes. It can help understand sediment transport and water quality in rivers, evaluate and optimize reservoirs operations, design and improve emergency structures, and outline flood resilient land use strategies, all within a climate change context.

Coastal Flooding
High tides and storm surges, sometimes in combination with insufficient urban drainage capacity or high upstream river flows, as well as tsunamis, can cause coastal flooding, posing risk to human safety, damaging property and infrastructure in low-lying areas including coastal defences.
MOHID Studio dynamically models the complex array of processes related with coastal flooding to assess the flood extent, including those originated by tsunami waves. The application provides accurate solutions for dimensioning and improving storm surge and tsunami protection schemes.

MOHID Land @ Bentley

- Consolidate MOHID Land
 - UK Benchmark
 - Other Benchmarks
- Improve MOHID Land Engine
 - New Features
 - Faster
- Improve User Interface
- Improve Training Material



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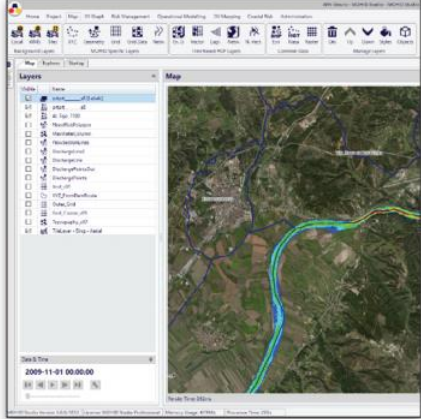
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