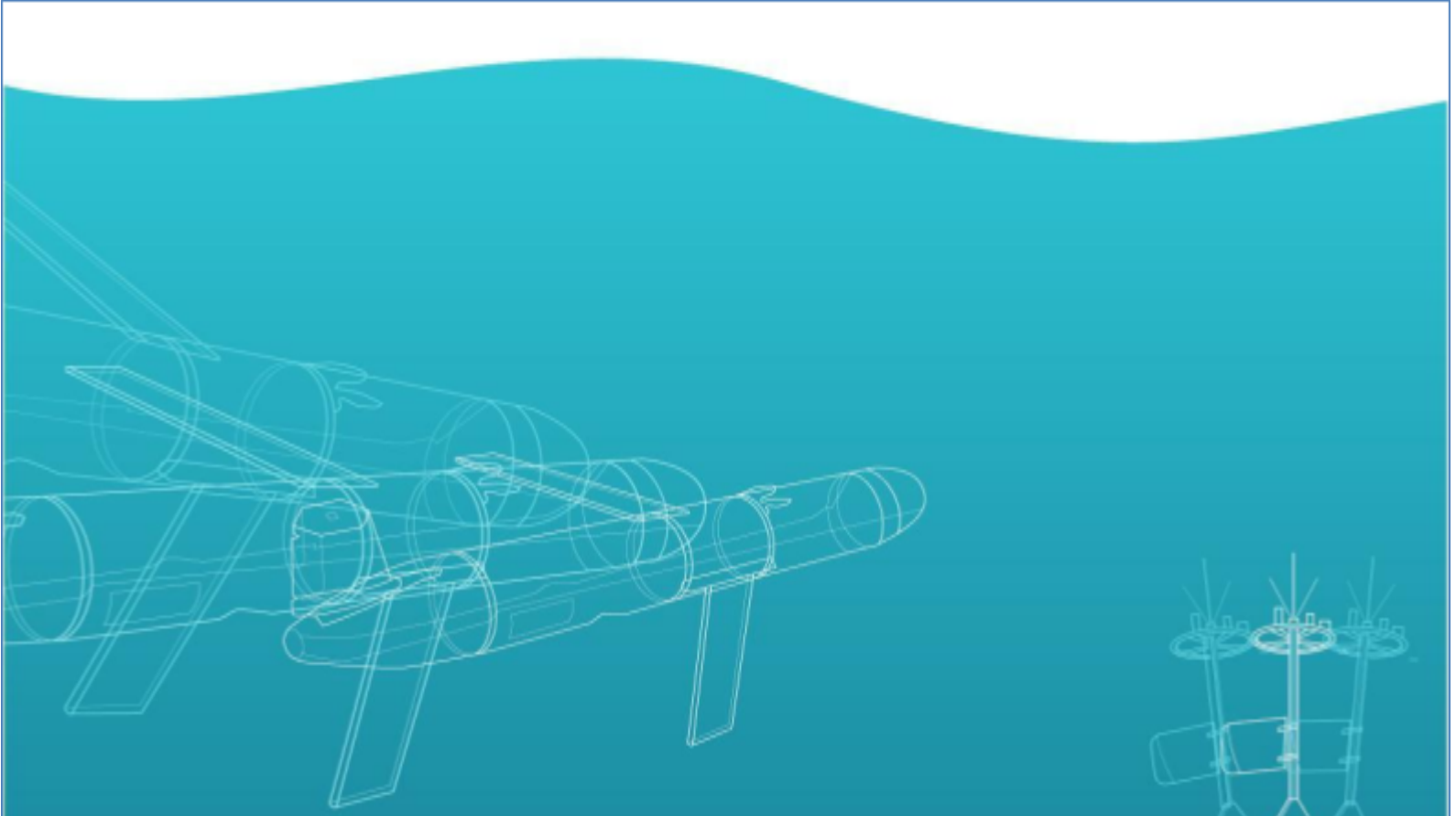


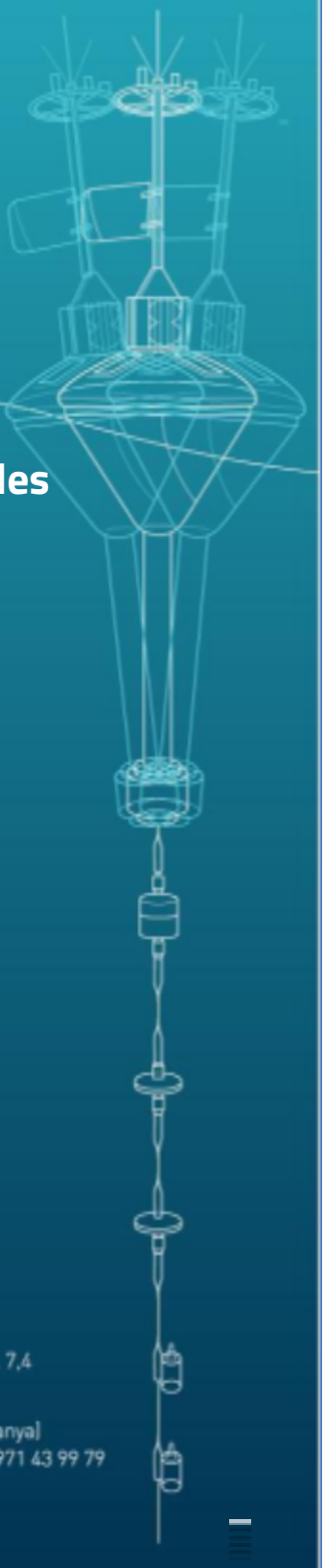
ONA Toolbox

Operational tool for climate chaNge impacts at locAl scales

USER'S MANUAL v1.0

Beach Monitoring Facility - ICTS SOCIB

May 2022



SOCIB Balearic Islands Coastal Observing and Forecasting System

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Creation Date (Last update)	**May 2022 (May 2022)**

Description	This document presents the user's manual of the software ONA toolbox available at help.onatoolbox.socib.es
Authors	Àngels Fernàndez-Mora
Supervision	Àngels Fernàndez-Mora
Involved Personnel	Àngels Fernàndez-Mora, Francisco Fabián Criado Sudau, Matias Bonet (OceanDrivers), Joaquim Tintoré
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1. INTRODUCTION

This document is a hard copy of the online user's manual of the ONA toolbox (Operational tool for climate chaNge impacts at locAl scales) developed by SOCIB within the framework of the Addenda of the PIMA ADAPTA COSTAS IB.

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2. MAIN PAGE

The lateral panel can be open through the upper left menu icon. The panel shows the contents of the online manual.

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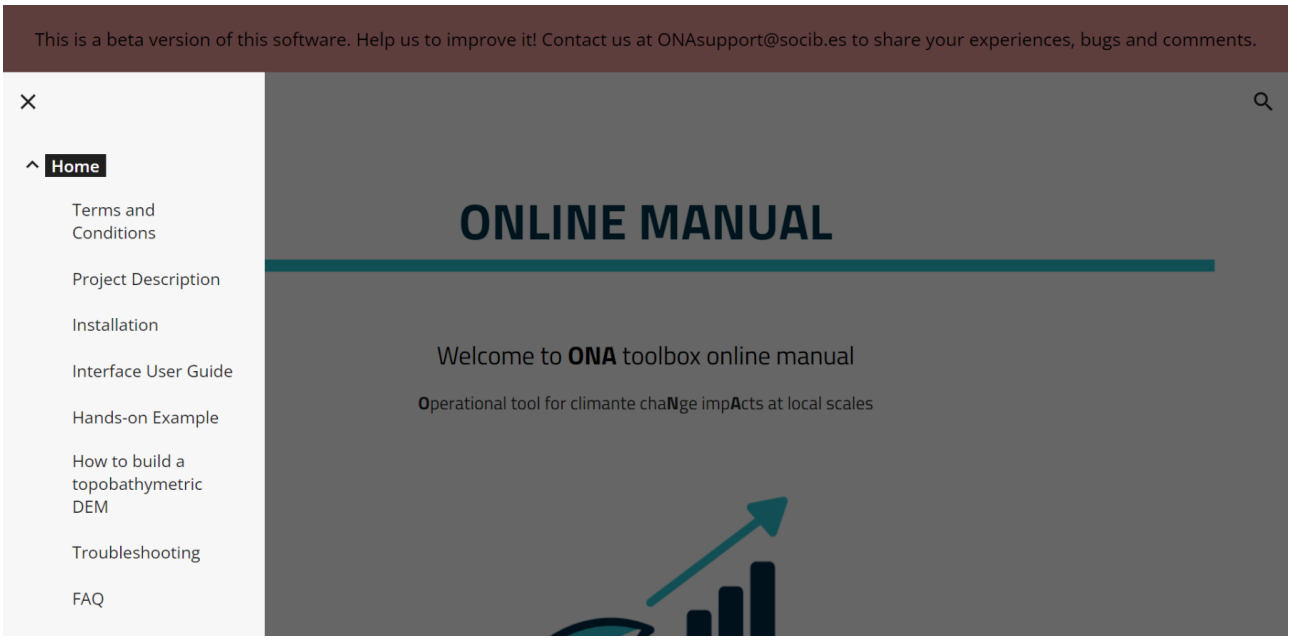

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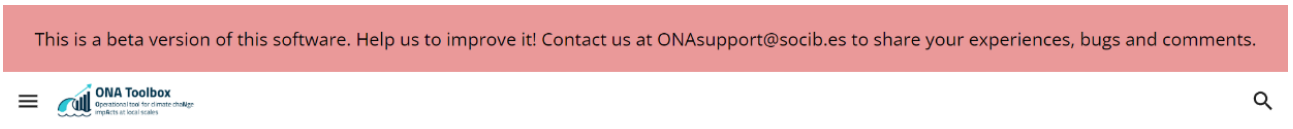
3. TERMS AND CONDITIONS



TERMS AND CONDITIONS

LICENSE

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Note about SITIBSA background images used within the ONA toolbox: as stated in the service 'The use of the map service is free and free of charge under license CC BY 4.0 mentioning the origin of the data: SITIBSA-scne.es'.

VERSION HISTORY

First public release version: ONA-Toolbox v.2.9 (May 2022)

TERMS OF USE

The Balearic Islands Coastal Observing and Forecasting System (SOCIB) upholds the Open Science (OS), therefore users can use the ONA-toolbox under the GNU General Public License v3. All content provided by this software is freely available for each user or institution. Users are allowed to view, download, copy, distribute or use the ONA toolbox for any lawful purpose (commercial and non-commercial), without requesting prior permission. The intended use of this software is the support for local plans related sea-level rise coastal adaptation, and it is not suitable for any other purpose. ICTS SOCIB is exempted of any responsibility regarding its usage.

The use of this code or any derivation must be properly referenced as stated in the following section **'HOW TO CITE'**. Any changes made to the original code need to be noticed and the original code has to be properly referenced. SOCIB has no responsibility for user-generated content.

DISCLAIMER

Before using the ONA-Toolbox software (hereafter "the Software") please read carefully the following terms for use. DOwnloading and/or installing files of ON-Toolbox on to your computer indicates you accept the following terms.

1. The Balearic Islands Coastal Observing and Forecasting System (hereafter "the Developers") do not warrant that the software will meet your requirements or that the operation of the software will be uninterrupted or error-free or that all errors in the Software can be corrected.

2. You install and use the Software at your own risk and in no event will the Developers be liable for any loss or damage of any kind including lost profits or any indirect incidental or other consequential loss arising from the use or inability to use the Software or from errors or deficiencies in it whether caused by negligence or otherwise.

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4. Users are not in reliance on any statements warranties or representations which may have been made by the Developers or by anyone acting or purporting to act on their behalf.

HOW TO CITE

If you are using this model or any derivation thereof for your work or research, please cite these references:

Fernández-Mora, À., & Tintoré, J. (2022). *ONA Toolbox User's Manual* (Version 1.0). Balearic Islands Coastal Observing and Forecasting System, SOCIB. https://doi.org/10.25704/TPA5-4Y84

Hoch, J. M., Eilander, D., Ikeuchi, H., Baart, F., and Winsemius, H. C.: Evaluating the impact of model complexity on flood wave propagation and inundation extent with a hydrologic–hydrodynamic model coupling framework, *Nat. Hazards Earth Syst. Sci.*, 19, 1723–1735, https://doi.org/10.5194/nhess-19-1723-2019, 2019.

Bates, P. D., de Roo, A. P. J.: A simple raster-based model for flood inundation simulation, *Journal of Hydrology*, 236, 54-77, https://doi.org/10.1016/S0022-1694(00)00278-X, 2000.

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4. PROJECT DESCRIPTION

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ONA Toolbox

PROJECT DESCRIPTION

PIMA ADAPTA: KNOWLEDGE AND ACTION IN FRONT OF CLIMATE CHANGE EFFECTS

The Environmental Encouraging Plan for Climate Change Adaptation (PIMA ADAPTA from the spanish acronym Plan de Impulso al Medio Ambiente para la ADAPTAción al cambio climático) has been an operational tool since 2015 to support the achievement of the objectives of the National Plan for Adaptation to Climate Change. It uses economic resources from emission rights auctions, carried out within the framework of the emission rights trading regime, channeling them towards adaptation projects. The PIMAs projects have become an important instrument to develop the complete cycle of adaptation in Spain, contributing in all phases (generation of knowledge, governance, sectoral integration, actions on the ground, monitoring, etc.) and promoting action at all levels (administrative, academic, private and NGO). The PIMA ADAPTA, coordinated by the Spanish Office of Climate Change (OECC), is managed by various public entities: D.G. Water and D.G. Coasts, National Parks Autonomous Organism, Biodiversity Foundation (public call for projects) and autonomous communities.

The current work is developed within the framework of the PIMA ADAPTA COSTAS IB (Balearic Islands Coastal Adaptation), coordinated by the Main Office of Energy and Climate Change of the Balearic Islands Government.

Further information at https://www.miteco.gob.es/es/cambio-climatico/planes-y-estrategias/PIMA-Adapta.aspx (Spanish).

COASTS FOR CHANGES PROJECT (COSTES PEL CANVI)

The PIMA ADAPTA COSTAS IB project, developed between 2018 and 2020 by IMEDEA-CSIC, UIB and SOCIB, aimed to provide the scientific basis for the development of the Balearic Islands Strategies for Adaptation of coastal areas in front of climate change effects, particularly, sea-level ris e ad extreme wave conditions.

During the project, and following the recommendations of the IPCC, an ad-hoc methodology was developed to evaluate the hazards and impacts in the coastal area based in three modules: numerical modelling of coastal inundation, spatial impacts of inundation over inhabitants, critical infrastructures, natural areas and the socio-economic system, and, response of the subsystems and economic loss (Luque et al., 2021).

Potential risk events are related to two time frames, 2050 and 2100, considering two climate change scenarios of the IPCC, the RCP-4.5 and RCP-8.5, that represent a low reduction of green-house gas emissions pathway and a current emission pathway respectively. Modeling the impacts of the sea-level rise projections in these RCP nd time fremes wave developed in a regional framework, by means f numerical models and unidimensional approximation of wave propagation processes. The results of the regional approach are accessible at https://apps.caib.es/sites/costespelcanvi/ca/informe_de_/ (Catalan) and through a map viewer at https://www.caib.es/sites/costespelcanvi/ca/mapes/ (Catalan).

The development of the ONA toolbox is framed by the Addenda of the agreement between the Balearic Islands Energy Transition, Productive Sectors and Democracy Memory Council and the Balearic Islands Coastal Observing and Forecasting System (ICTS SOCIB). The Addenda aims to provide to local authorities a tool as a support system to develop local strategies of adaptation in front of climate change effects in the coastal area.

Link to COAST for CHANGES project w...

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PhD. Àngels Fernàndez-Mora – SOCIB
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PhD. Aina García – SOCIB
PhD in Environmental Hydraulics.

PhD. Lluís Gómez-Pujol – UIB
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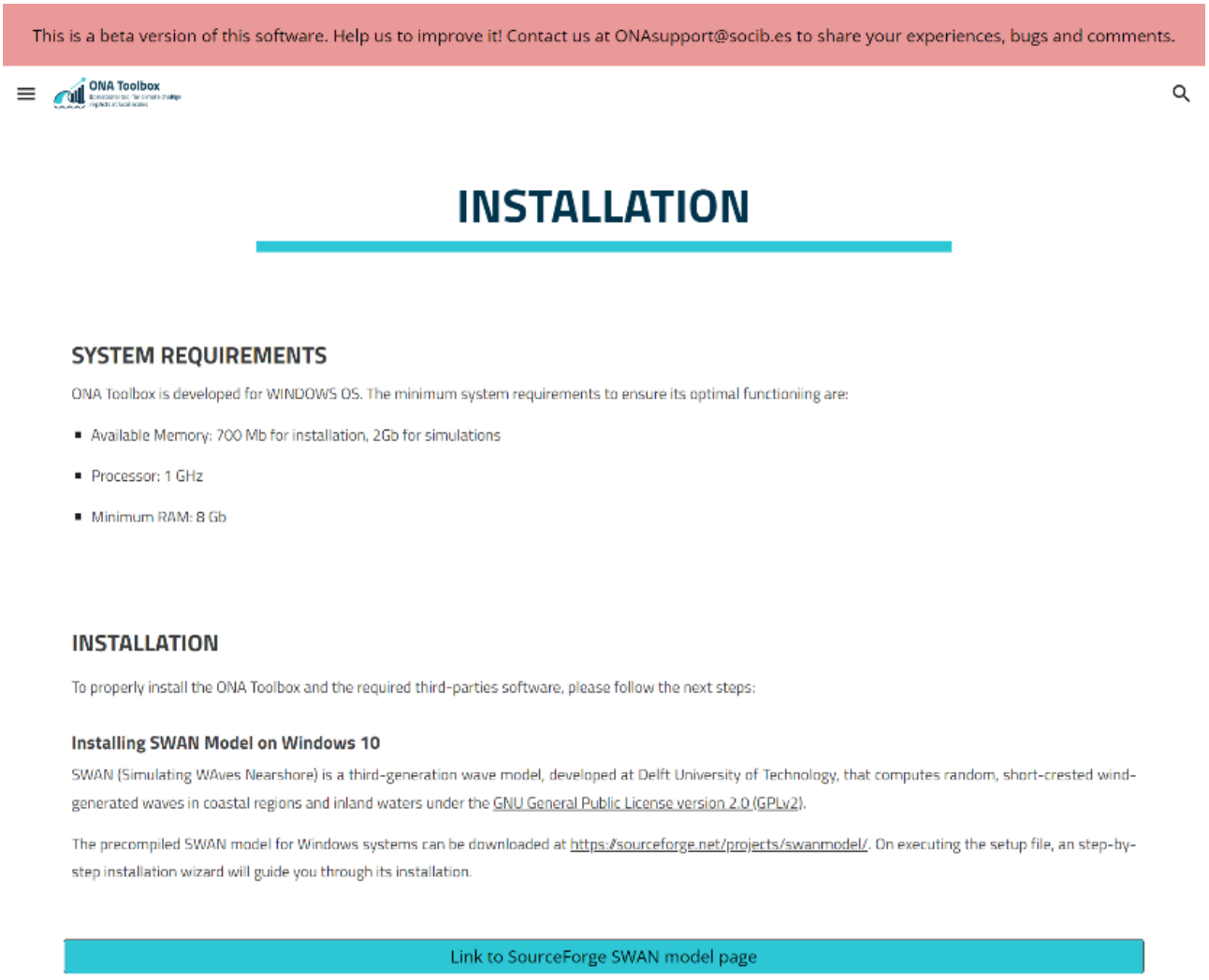
PhD. Marta Marcos – UIB
PhD in Physics.

PhD. Alejandro Orfila - IMEDEA (CSIC-UIB)
PhD in Physics.

ACKNOWLEDGEMENTS: The working team want to acknowledge the collaboration and facilities for the development of the current toolbox to Pau Luque (UIB), Elena Jiménar Tomas (DG Canvi Climàtic, GOIB) and José Carlos Cerro (DG Canvi Climàtic, GOIB).

5. INSTALLATION



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ONA Toolbox

INSTALLATION

SYSTEM REQUIREMENTS

ONA Toolbox is developed for WINDOWS OS. The minimum system requirements to ensure its optimal functioning are:

- Available Memory: 700 Mb for installation, 2Gb for simulations
- Processor: 1 GHz
- Minimum RAM: 8 Gb

INSTALLATION

To properly install the ONA Toolbox and the required third-parties software, please follow the next steps:

Installing SWAN Model on Windows 10

SWAN (Simulating WAves Nearshore) is a third-generation wave model, developed at Delft University of Technology, that computes random, short-crested wind-generated waves in coastal regions and inland waters under the GNU General Public License version 2.0 (GPLv2).

The precompiled SWAN model for Windows systems can be downloaded at https://sourceforge.net/projects/swanmodel/. On executing the setup file, an step-by-step installation wizard will guide you through its installation.

Link to SourceForge SWAN model page

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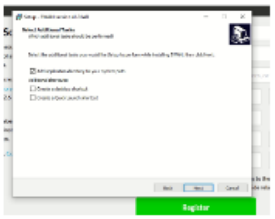
Important steps during SWAN installation

1. A security warning message may appear on running the executable file of SWAN installation setup. Execute anyway the application.

2. At the '**Select Additional Tasks**' step during SWAN installation, tick the **'Add application directory to your system path'.**

1. Security Warning Message



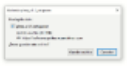
2. Add application to your system path

Installing ONA Toolbox on Windows 10

The ONA Toolbox is available at https://softwareupdates.oceandrivers.com/api/ona_toolbox/download_latest/.

ONA Toolbox downloading link

Please, follow next steps for its installation:



1. Save the setup

Download the setup file and double click on the file to start the installation process

2. Windows warning messages

If Windows warning message prompts, please select 'More information' and then click on 'Execute anyway'

3. Security message

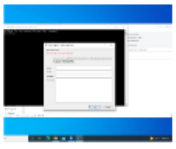
Agree on the security message

4. Follow the installation wizard

Follow the steps on the wizard to install the program

5. Start the program

Tick the "Execute ONA toolbox" to start the program



6. Register your copy

The first time you run ONA Toolbox you will be asked to intriduce your name, institution, and an email.

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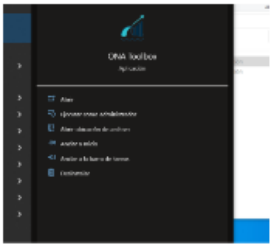

READY TO WORK!

Now the program should be ready and installed in your computer. You can find it at your Desktop as well as in your Windows applications.

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6. INTERFACE USER GUIDE

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ONA Toolbox

INTERFACE USER GUIDE

1. INTRODUCTION

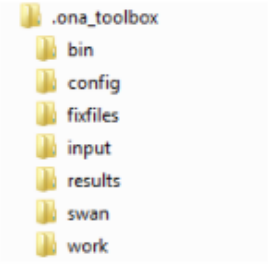
This section describes the file system and the main interfaces and capabilities of ONA Toolbox.

2. FILE SYSTEM

On installing ONA Toolbox on your computer a working folder is created in C:/Users/UserName/.ona_toolbox. This folder contains the main working subfolders and files of the toolbox.

Special interest folders are:

- 'work' folder, which contains the modelling files of simulations. Each simulation subfolder will contain the inputs and raw results of the models.
- 'fixfiles' folder, containing the templates of the parameter input files of the models, the database of wave storms, storm surges, their position and the sea levels corresponding to the RCP projections and time horizons.
- 'results' folder, that contains all the graphical results and the corresponding DEMs for their further use.



ONA Toolbox file system

3. USER INTERFACES

3.1 Main Interface

The main interface allows users to access to the two main sections of the toolbox: the DEM/Bathymetries Manager and the Projects Manager sections. The user can also access to this sections as well to other sections at the expandible menu located at the upper left corner of the window.

Fig 3.1. Main interface (click image to enlarge)

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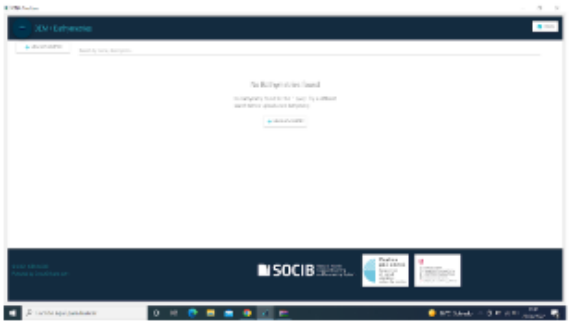
3.2 Digital Elevation Models (DEM)/Bathymetries Interface

The section Digital Elevation Models / Bathymetries allows user to upload, visualize and manage the topobathymetry of the study area. Topobathymetries are saved in the computer and can be accessed, modified and/or deleted through this section.

The format of input topobathymetries and how to build them is detailed in the section **'How to build a topobathmetric DEM'** of this manual.

The interface accounts for a search bar to find uploaded DEMs by name or description.



3.3 Projects Interface

At the Project Manager section, user can create, access and modify working projects. The **'CREATE NEW PROJECT'** button allows users to add working projects. The saved project will appear listed in the Projects Manager interface, from which they can be accessed, modified and deleted.

The interface accounts for a search bar to find projects by name or description.

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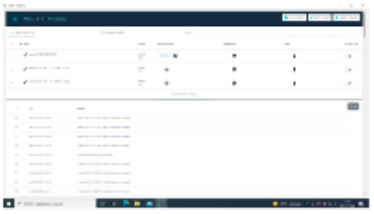
3.4 Simulations Interface

On clicking to a existing project, the Simulations interface will appear. In this interface, user can create, modify and delete simulations that will be listed in the main screen. Each project can contain as many simulations as user needs, considering different RCP scenarios and time horizons as well as topobathymetries or study areas for the same topobathymetry.



This interface also controls simulations. By clicking the '**EXECUTE SIMULATION**' button, full simulations start. User can control the simulations steps and performance in the debugging windows that appears at the lower half of the screen.

The interface accounts for a search bar to find saved simulations by name or description.

3.5 Results Interface

The Results interface contains all the information of the project, the computational area, boundary conditions, as well as the results of each model: wave propagation, coastal flooding and beach erosion. The upper banner accounts for different buttons that guide user through the different sections of the Results interface.

From this interface user can also retrieve an automatic report that summarizes the main results, models results in ASCII format (to be used with GIS platforms) and the raw model results for further analysis.

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7. HANDS-ON EXAMPLE

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ONA Toolbox

HANDS-ON EXAMPLE

1. IMPORTING A DIGITAL ELEVATION MODEL

From the main interface or the drop-down menu, access to the '**DEM/Bathymetries section**'. Previously saved bathymetries will be shown in the window.

To import a new bathymetry, click in the button '**+ ADD NEW BATHYMETRY**'. A pop-up dialog will appear asking: 1) File, the location of the DEM file, 2) Name, a name for the bathymetry and 3) Description, a brief description (optional).

On clicking to '**File**', a file browser dialog will appear to search the DEM file to be added in your file system. DEM file must be a regular DEM ASCII file with the structure defined at section '**HOW TO BUILT A TOPOBATHYMETRIC FILE**' of this manual.
Once DEM file, Name and Description are filled, click in the '**UPLOAD**' button to add the bathymetry. At the 'DEM/Bathymetries Section', the DEM will appear listed as well as the visualization of the area.

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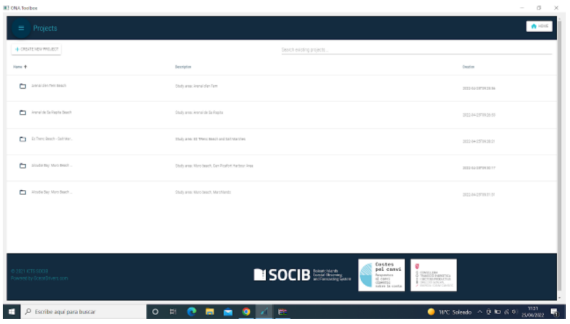
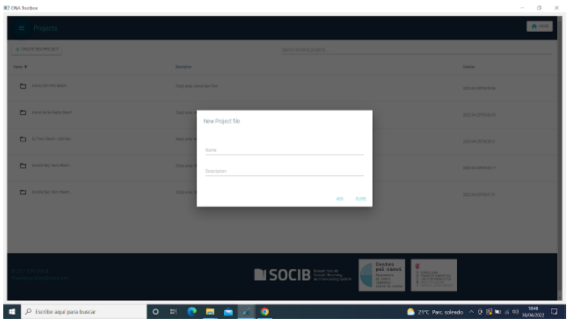
2. CREATING A NEW PROJECT

From the 'Projects' section, accessible from the main interface or the lateral drop-down menu, user can access to saved projects or create new projects.

On clicking the '**CREATE NEW PROJECT**' button, a pop-up dialog will appear asking for the project name and a brief description of the project. Once created by pushing on the '**CREATE**' button, it will appear listed at the '**Projects**' section interface.

By clicking over the name of any of the saved projects, user can access, visualize, modify simulations within the projects.





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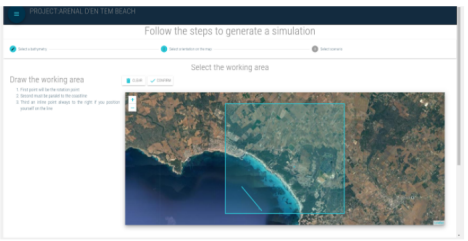
3. CREATING A NEW SIMULATION

By clicking over the name of any of the saved projects, users can access, visualize and modify simulations within the projects. Each project can contain as many simulations as user requires.

To create a new simulation, first enter a project by clicking over its name. The 'Simulation' interface will appear. Through the button '**CREATE NEW SIMULATION**', the user will access to the 'Simulation' step-by-step wizard. The first step is to select the bathymetry to be used for the simulation. Saved bathymetries are listed in the screen.

On selecting the corresponding bathymetry, user must define the computational area for the SWAN model (further details at the Scientific Report Section of this manual). The wizard assistant will guide user to the steps to follow to define the computational area.

First of all, user must draw a line parallel to the shoreline of the study area, and approximately situated at least at 15 m depth of the bathymetry (off-shore). It is recommended to read the instructions in the screen to properly define the computational area. User can remove the selection by the button '**CLEAN**'.



Second, user must define a point inland that will define the onshore boundary of the computational area.

Once the area is confirmed, a new pop-up dialog will appear asking for:

i) the name of the simulation,

ii) a brief description,

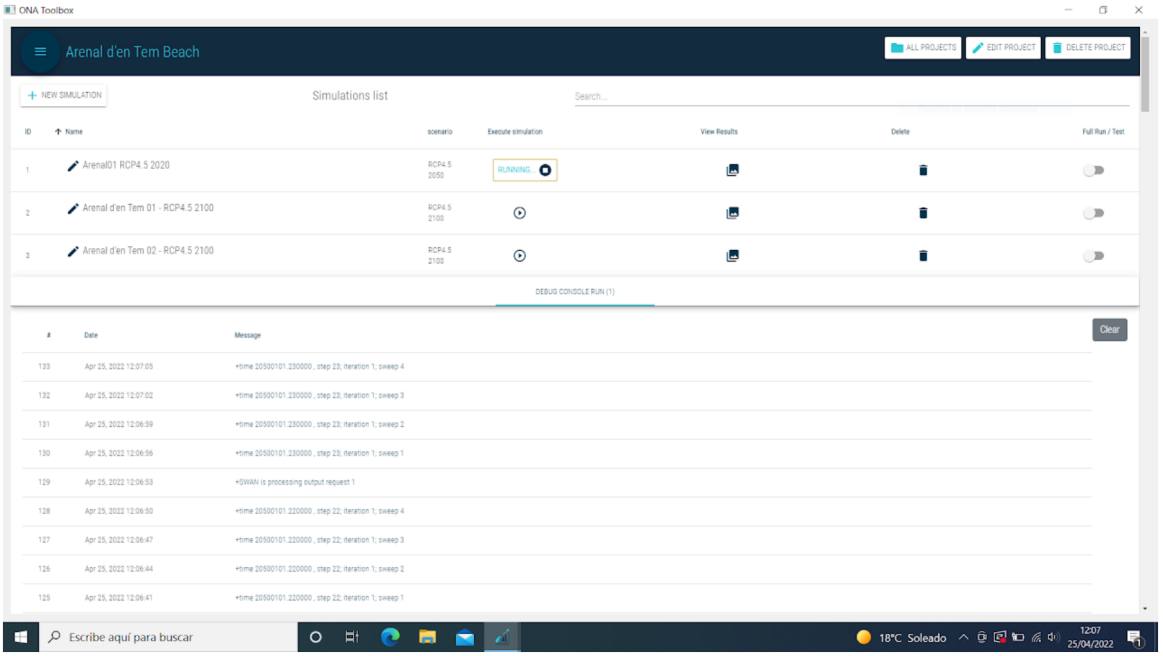
iii) the RCP scenario, the time horizon to be simulated by means of a drop-down menu, and

iv) the median grain size D50.

On clicking the button '**CREATE NEW**', the simulation will be properly created, listed at the 'Simulation' interface, and ready to be computed.

4. RUNNING A NEW SIMULATION

To run a simulation, first enter in the Simulation interface by selecting the project from the '**Projects**' page. The simulations of the corresponding project will be listed in the main screen. To start the simulation, user can click the '**Execute Simulation**' button. Once the simulation starts, the debug console activates at the lower half of the screen. The console provides details of the steps being performed.



During the simulations, the user can continue preparing new projects, simulations or see the results of previous runs inside the tool. The current ongoing simulation will be running in batch mode.

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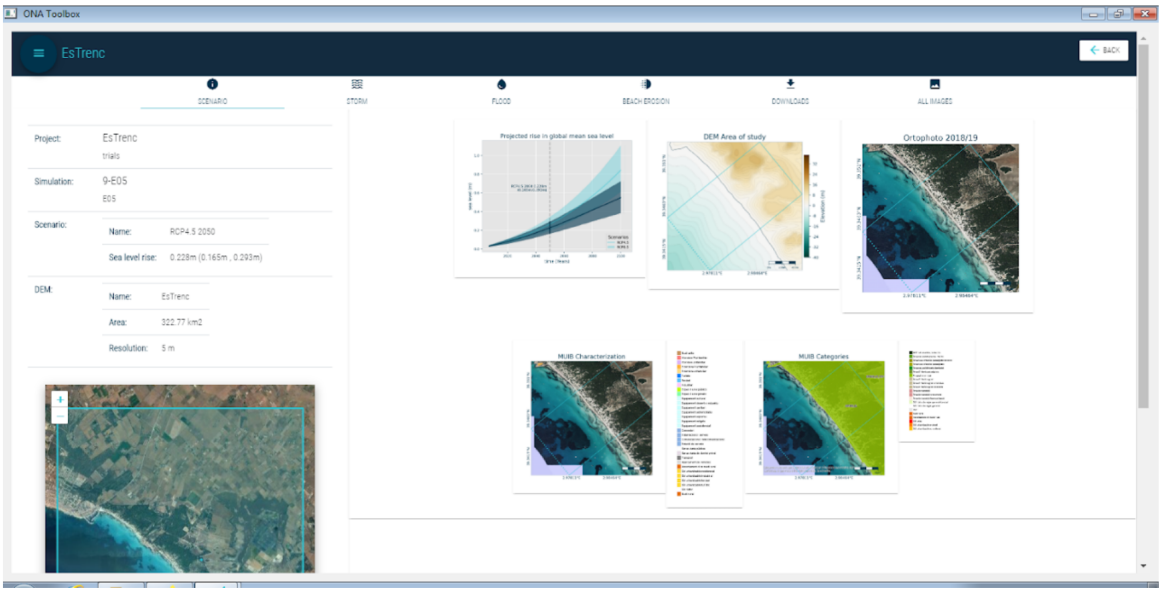
5. VIEWING RESULTS

Once the simulation has finished, the user can access to the results section through the '**VIEW RESULTS**' button. The 'Results' interface is divided in 6 sections:

1. Scenario: where user can fins the main data of the simulation: RCP scenario, study area, topobathymetry,...
2. Storm: results of the simulations of storm wave propagation.
3. Flood: results of the permanent and punctual inundation.
4. Erosion: results of the erosion approximation.
5. Download: see Section 6.
6. All images: Visualization of all results plots.



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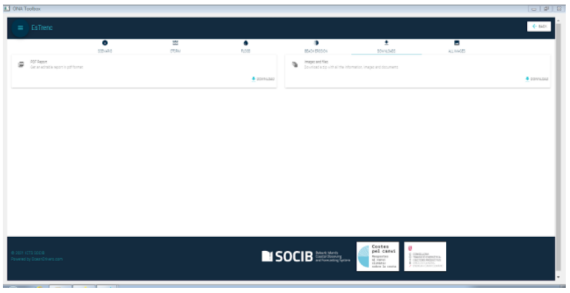
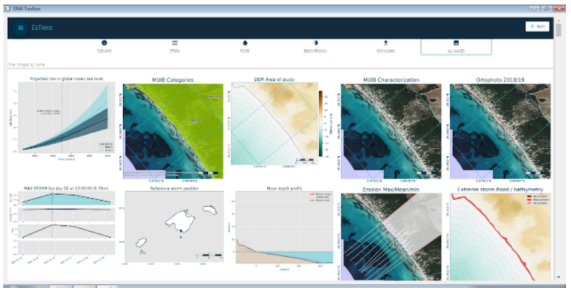
6. DOWNLOADING RESULTS

The 'Download' section allows user to generate an automatic report (pdf) containing the basic information of the project and the simulation as well as the most relevant results, as well as to download a zip file containing models raw results, plots, reports and the DEM of inundation and erosion areas.





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8. HOW TO BUILD A TOPOBATHYMETRIC DEM

This is a beta version of this software. Help us to improve it! Contact us at ONAsupport@socib.es to share your experiences, bugs and comments.

ONA Toolbox

HOW TO BUILT A TOPOBATHYMETRIC DEM

1. WHAT IS A TOPOBATHYMETRIC DEM?

A Digital Elevation Model (DEM) is a representation of the terrain surface elevation. A common and widely used format of DEM is the raster ASCII. This format allows an easy transfer between different GIS systems.

The ONA Toolbox needs a Digital Elevation Model (DEM) embracing both emerged land and submerged beach to simulate first the bi-dimensional storm wave propagation, second, the land flooding due to sea-level rise and storm waves, and third, estimate the potential beach erosion area.

For low-lying coastal areas, it is important that the DEM embraces enough area inland to properly estimate flooding processes.

The Raster ASCII format

Raster ASCII files have two different sections. The first section contains the information defining the rater properties: number of rows and columns, the origin coordinates of the raster and the cell size. The second section is the cell data representing the elevation model.

The basic structure of the ASCII raster for the ONA Toolbox must have the raster information at the beginning of the file followed by the cell data. The spatial location of the raster is specified by the location of the lower left cell corner.

The raster information is structured by keyword and their corresponding values, followed by cell value data in space-delimited format and each row separated by a carriage return, as follows:

```
nrows         XXXX
ncols         XXXX
xllcorner     XXXX
yllcorner     XXXX
cellsize      XXXX
NODATA_value  XXXX
row 1
row 2
...
row n
```

Table at the right panel describes the keywords in the raster information section.

Parameter	Description	Requirements
NROWS	Number of cell columns	Integer > 0
NCOLS	Number of cell rows	Integer > 0
XLLCORNER	X-coordinate of the origin	UTM Easting coordinate (m)
YLLCORNER	Y-coordinate of the origin	UTM Northing coordinate (m)
CELLSIZE	Cell size	> 0
NODATA_Value	The input values to be NoData in the raster	Default is -9999

The raster information keyword is followed by cell value information specified in space-delimited row-major order, with each row separated by a carriage return. The cell value data must follow the next requirements:

- Cell values should be delimited by spaces.
- No carriage returns are necessary at the end of each row in the raster. The number of columns in the header determines when a new row begins
- Row 1 of the data is at the top of the raster, row 2 is just under row 1, and so on.

2. HOW TO BUILT A DEM AS INPUT FOR ONA-TOOLBOX

While high-resolution LIDAR topography DEM are extended and easy world-wide available and free downloadable, high-resolution bathymetries are not so extended. ONA Toolbox need as input a single DEM file containing both types of data.

There are many ways to combine DEM rasters with bathymetric raster.

Here there is an example of how you can prepare the input raster ASCII for the ONA toolbox using the QGIS platform:

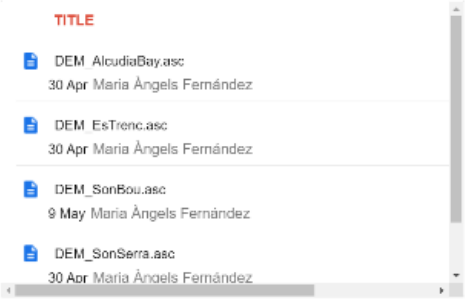
1. Get a high-resolution digital elevation model. For the Spanish territory, you can download for free the high resolution DEM by areas at the download center of IGN webpage (National Geographic Institute, https://centrodedescargas.cnig.es/CentroDescargas/index.jsp): Digital Elevation Models → Digital Terrain Model - MDT05 → By list → Select by municipality or by map sheet.
2. Import the DEM into QGIS in the corresponding coordinate system (Layer → Properties → Information → SRC (ETRS 1989 UTM Zone 31N).
3. Import the high-resolution bathymetry. Common formats of bathymetries are: the xyz ASCII files containing the x, y and z coordinates, GIS shapefiles (*.shp) or even raster ASCII.
4. Convert bathymetry layer to raster type: Raster → Conversion → Rasterise (vector to raster).
5. Both rater can be combined by: Raster→ Miscellaneous →Combine. Note that the resulting raster will have the resolution of the coarser resolution of the rasters to combine.
6. It is recommended to use the Terrain Profile tool or similar to check that the final combination of the rasters does not present discontinuities or unrealistic shapes.
7. To extract the final combined raster or a section: i) save the combined layer, ii) toggle layer edit, iii) add a polygon and draw the area of the raster corresponding to the study area, and iV) extract the raster zone by Toolbox → GDAL → Raster extraction→ Cut raster by mask layer. Save the resulting layer as raster ASCII file.

Note that the current version of ONA Toolbox works in ETRS89 UTM 31 N projection that is the corresponding to the Balearic Islands zone. This is necessary to obtain the background maps of the soil use and characterization catalogue and characterization from the Balearic Islands Territorial information Service (SITIBSA) and for its internal transformation to WGS84 projection. In a future, ONA will allow consider other projections.

3. TOPOBATHYMETRIC DEM EXAMPLES

Here you can download some examples of DEMs to be used as input for the ONA-Toolbox.

NOTE: Their intended use is as test examples for the software, not for official purposes. These DEMs have been developed by means of the Digital Terrain Model - DTM05 of Spain (CC-BY scne.es) and the Web Map service of SITIBSA (CC-BY SITIBSA).



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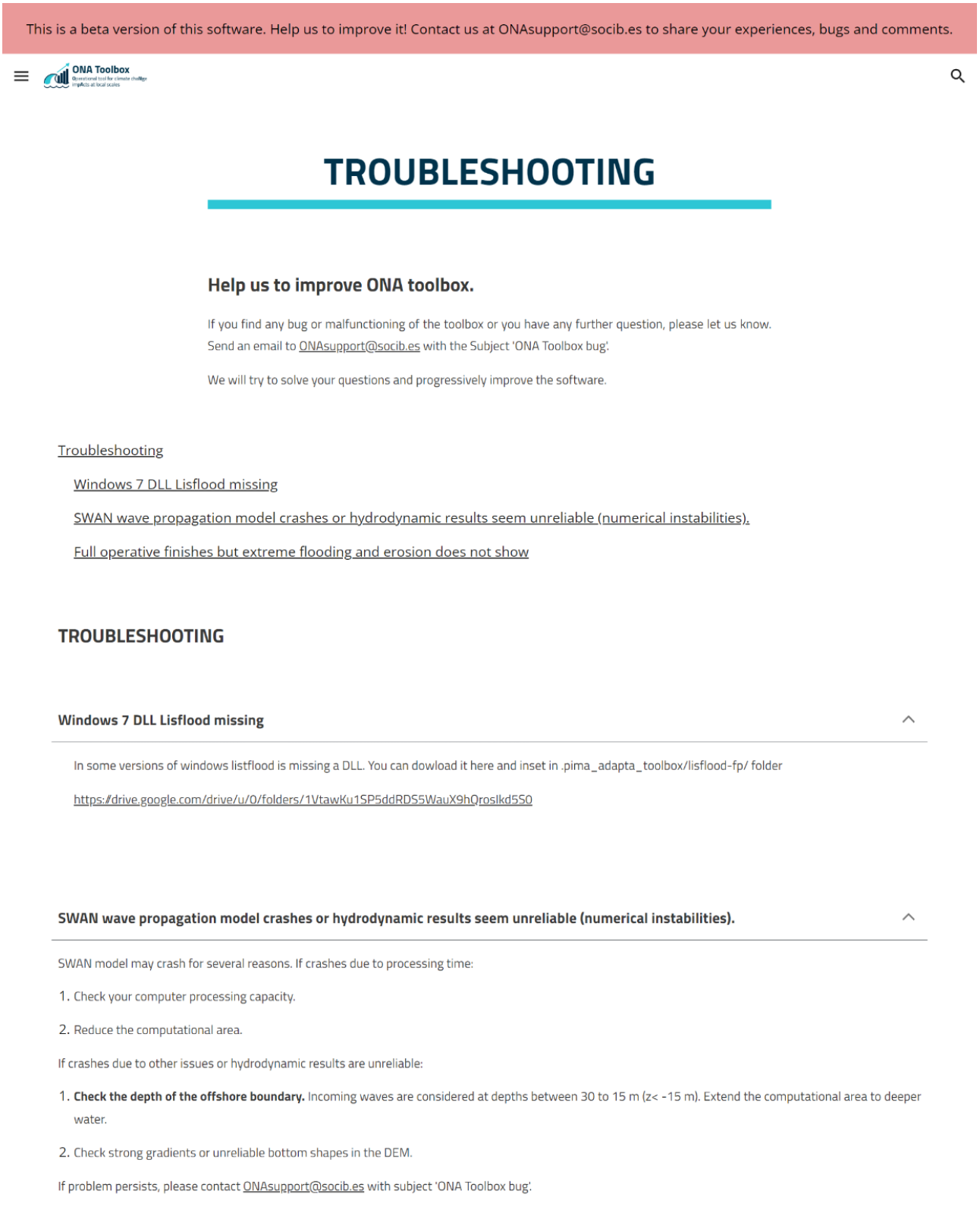
9. TROUBLESHOOTING



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ONA Toolbox

TROUBLESHOOTING

Help us to improve ONA toolbox.

If you find any bug or malfunctioning of the toolbox or you have any further question, please let us know. Send an email to ONAsupport@socib.es with the Subject 'ONA Toolbox bug'.

We will try to solve your questions and progressively improve the software.

Troubleshooting

- Windows 7 DLL Lisflood missing
- SWAN wave propagation model crashes or hydrodynamic results seem unreliable (numerical instabilities).
- Full operative finishes but extreme flooding and erosion does not show

TROUBLESHOOTING

Windows 7 DLL Lisflood missing

In some versions of windows listflood is missing a DLL. You can dowload it here and inset in .pima_adapta_toolbox/lisflood-fp/ folder

https://drive.google.com/drive/u/0/folders/1VtawKu1SP5ddRDS5WauX9hQroslkd5S0

SWAN wave propagation model crashes or hydrodynamic results seem unreliable (numerical instabilities).

SWAN model may crash for several reasons. If crashes due to processing time:

1. Check your computer processing capacity.
2. Reduce the computational area.

If crashes due to other issues or hydrodynamic results are unreliable:

1. **Check the depth of the offshore boundary.** Incoming waves are considered at depths between 30 to 15 m (z< -15 m). Extend the computational area to deeper water.
2. Check strong gradients or unreliable bottom shapes in the DEM.

If problem persists, please contact ONAsupport@socib.es with subject 'ONA Toolbox bug'.

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Full operative finishes but extreme flooding and erosion does not show

SWAN may have crashed. Check wheter the following statement appears at the terminat or the debugging console: 'XXXX'.

This may happen because the offshore boundary of the computational area is not deep enough.

Please, have a look to the previous question to try to solve the problem.

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10. FAQ

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FAQ

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FREQUENTLY ASKED QUESTIONS

Simulations take too long, is it normal?

Yes. ONA Toolbox couples two numerical models and, in addition, it runs 3 simulations per model. Computing time depends on the computer characteristics, the computational area and the simulation length.

Be patient!

The debugging console disappears after clearing

This is a bug we are aware and we will fix it as soon as possible.

You can continue controlling the model steps through the system terminal that is open simultaniusly with the toolbox.

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