Development of an assesSment tOol for predicting the dynamic riSk of drowning on bEAcheS
- *SOSeas* -

User Requirements
15th November 2020

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List of Acronyms

API	Application Programming Interface
ANN	Artificial Neural Networks
C3S	Copernicus Climate Change Service
CMEMS	Copernicus Marine Environment Monitoring Service
DIAS	Data Information Access Service
DSS	Decision Support System
ETL	Extract, Transform & Load
GFS	Global Forecast System
M2M	Machine to machine communication
NOAA	National Oceanic and Atmospheric Administration
OGC	Open Geospatial Consortium
PWA	Progressive Web App
SDGs	Sustainable Development Goals
SOBRASA	The Brazilian Life-Saving Society
TDS	THREDDS Data server
UX	User Experience
UI	User Interface
WEkEO	We knowledge Earth Observation
WCS	Web Coverage Service
WMS	Web Map Service

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1 INTRODUCTION

The SOSeas Service is a user driven Service. The design of the Service was adapted regarding requirements and functionality, including an interactive method to explore needs and requirements from final end users. The following lines describe the methodology undertaken for the development of the SOSeas Service.

The SOSeas project focuses on the development of an operational service based on the CMEMS products to prevent one of the major public health problem worldwide, ***drowning***. According to the World Health Organization (WHO), drowning is among the ten leading causes of death for children and young people in every region of the world. It is estimated that there are 360,000 annual deaths from drowning all around the world, although, global estimates may significantly underestimate the real problem of public health related to drowning.

The seventeen UN **Sustainable Development Goals** (SDGs) were proposed at the United Nations Conference on Sustainable Development in Rio de Janeiro in 2012 to meet the urgent environmental, political and economic challenges facing the world. Goal 3 of the SDGs focuses on “ensuring healthy lives and promoting the well-being at all ages”. The downstream service proposed helps to reduce the third leading cause of unintentional injury death worldwide; designing, developing and implementing an operational assessment tool that provides electronic flags based on the dynamic risk of drowning on beaches using CMEMS data and Artificial Intelligence (AI).

The SOSeas CMEMS downstream Service is summarized in Figure 1.

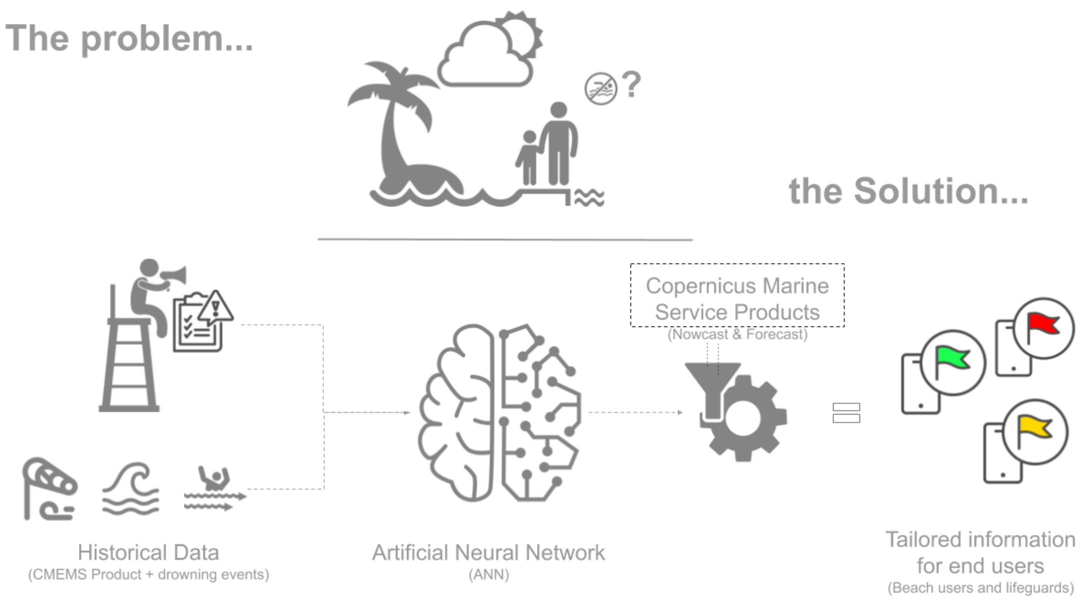

Figure 1. Conceptual scheme of the SOSeas Service

2 USER REQUIREMENTS

A common problem that take place globally is showed, one of the main causes of significant number of accidents and deaths worldwide is the lack of knowledge about the possible risks that take place at aquatic spaces. Against this backdrop, the main requirement of the SOSeas Service arises:

<< inform end users about the risks at any attended or unattended beaches >>

The expected result is a Service that could be easily implemented at any beach worldwide, with low costs of maintenance and possible high impacts in terms of reduction of deaths by drowning and rate of accidents in aquatic areas.

The design of the Service has been adapted regarding requirements and functionality, including an interactive method to explore needs and requirements from final end users. The following lines describe the methodology undertaken for the development of the SOSeas Service.

The SOSeas Service has been implemented under an iterative and incremental development ensuring a greater ability to incorporate changes during the development cycle, see Figure 2. Software development has been divided into four phases: (1) Requirement Analysis, (2) Software specifications, (3) Software development and (4) User Feedback. The following lines provide a brief description, reasons why it was necessary, expected results and possible constraints, assumptions or solutions for each of the development phases:

- *Requirement Analysis* or product line analysis has focused on the relationships between the different spatial information provided by metocean data providers (CMEMS, NOAA, etc.) and end user needs. This stage has braked down functional and non-functional requirements to a basic design view to provide a clear software development framework.
- *Software specifications* phase has described the essential features that the SOSeas Service provides to end users. The software requirements fully describe what the software does and how it is expected to perform. Specifications has helped avoid duplication and inconsistencies and act as a reference for software development. Functional Specifications provide the consensus on what the Service is going to achieve. Software requirements have permitted a rigorous assessment of requirements before design began and has reduced later redesign. It has also provided a realistic basis for estimating product costs, risks, and versioning schedules. This Action took into account the results obtained from the Requirement Analysis phase.

Software specifications have been created every iterative loop for the software development phase.

- *Software development* phase has been based on Software specifications. The SOSeas Architecture design has been described, which has provided the definition of the architecture, components and modules to satisfy all the specifications stated at the Requirement analysis phase.
- Testing and *user feedback* has provided significant inputs for the improvement of the final user experiences. Feedback and bugs have been included at every iterative loop in order to adapt the SOSeas Service according to user requirements.

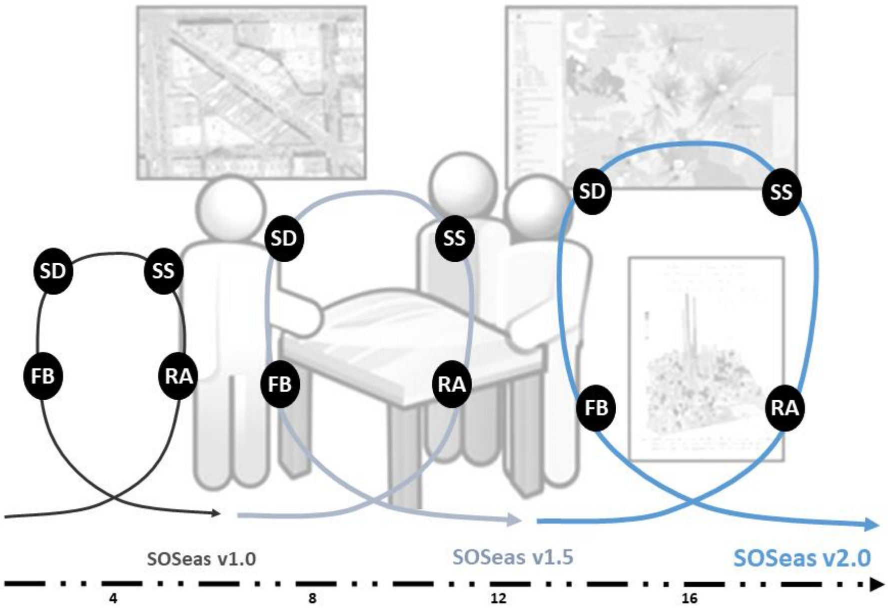

Figure 2. SOSeas Service - Iterative and incremental development. [RA- Requirement Analysis, SS-Software Specifications, SD-Software Development, FB- Feedback]

In order to accomplish the previously listed milestones, the SOSeas design and development have been undertaken through three main tasks:

1. Cross cutting analysis of the beach characterization, catalogue of drowning events and metocean conditions
2. Design and development of an expert system, based on the implementation of ANN to obtain electronic flags.
3. Design, development and implementation of the System Architecture, based on two sections:
   - the back-end, which integrates the operational workflow of metocean data, perform ANN analysis and obtain the results from the Operational electronic flags, and
   - the front-end for interaction with end users.

Subsequently, under a user driven approach, through iterative and incremental cycles, the SOSeas Service has being designed and developed. Iterations have being undertaken, firstly, among the SOSeas Team, see Figure 3, in which the Lifesaving & Prevention Team has provided end user needs and requirements, and secondly, with members from the Brazilian Life-Saving Society (SOBRASA - https://www.sobrasa.org/) and the Fire Department of Santa Catarina Military Police.

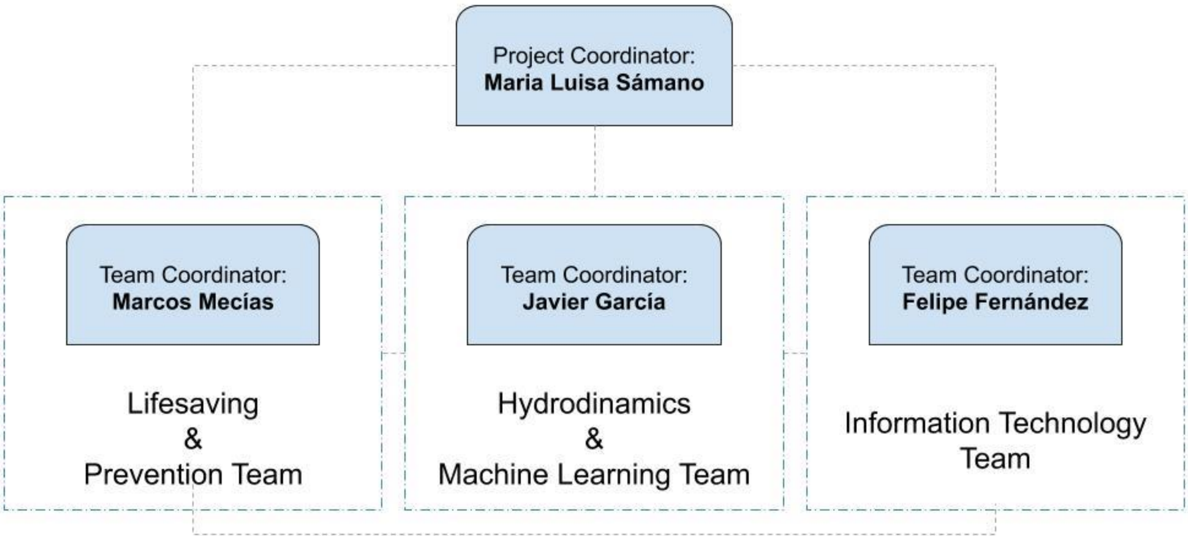

Figure 3. SOSeas Team

In a user driven software development, end users and their needs are the central pillar. Depending on the type of users, their needs and requirements may be different. Subsequently, targeted users were identified and classified:

- ***Beach users***: Through the SOSeas app, each user will be able to have detailed and real-time information of all risks and their variability throughout the day. It should be mentioned that lack of knowledge of bathing areas is one of the risk factors that contributes to the increase cases on drownings and accidents on beaches. Providing information in a predictive manner would therefore help to minimize this risk factor, enabling the selection of the safest spaces at every moment.

- ***Lifeguard Services***: SOSeas offers those in the lifeguard service to carry out a risk identification and evaluation of the aquatic space in which they are working. In addition, they will be able to predict future risks for their beaches, enabling them to make decisions that are more efficient on preventive strategies for their environment, helping to reduce accidents and deaths. The SOSeas Service has being implemented for the Santa Catarina beaches, where the lifeguard services are managed by the Fire Department of Santa Catarina Military Police, see Figure 4.

Figure 4. End users of the SOSeas Service - Fire Department of Santa Catarina Military Police

- ***Administrations***: SOSeas provides the administration, such as owners and managers of aquatic spaces, with the tools for the management and improvement of safety in sandy coastlines. It is necessary to remember that everyone who comes into contact with the inherent risks in these areas, are vulnerable to suffer an accident, by which reducing deaths and accidents grants the administration important savings in healthcare spending.

On the other hand, improving safety in these areas can also be a source of economic benefits for tourism. Beaches and bathing areas have become a point of interest for national and international tourism, in addition to the increased use made for recreational activities. The creation of safer aquatic spaces generates value as a sign of high quality tourism.

3 USE CASES

SOSeas use cases have been designed, a use case is a description of tasks that end users can perform on the System. The use case of the downstream service outline, from a user's point of view, the system's behaviour as a sequence of simple actions that they can undertake with the System. The following subsections describe the SOSeas use cases.

As a user driven software development, the analysis of type of end users was undertaken and three types of users were identified: beach users, lifeguard services and administrations. Subsequently, the requirement analysis, under an iterative and incremental approach, concluded with three use cases: operational processes, human interaction and machine interaction.

Firstly, see Figure 5, the system itself must independently obtain metocean information operationally. Outputs from Global numerical models, provided by external data sources, are collected: waves, currents, sea levels and winds. In the same way, metocean data from *in situ* sensors, buoys and tidal gauges, are collected operationally. The electronic flags are also calculated autonomously through the ANN algorithms.

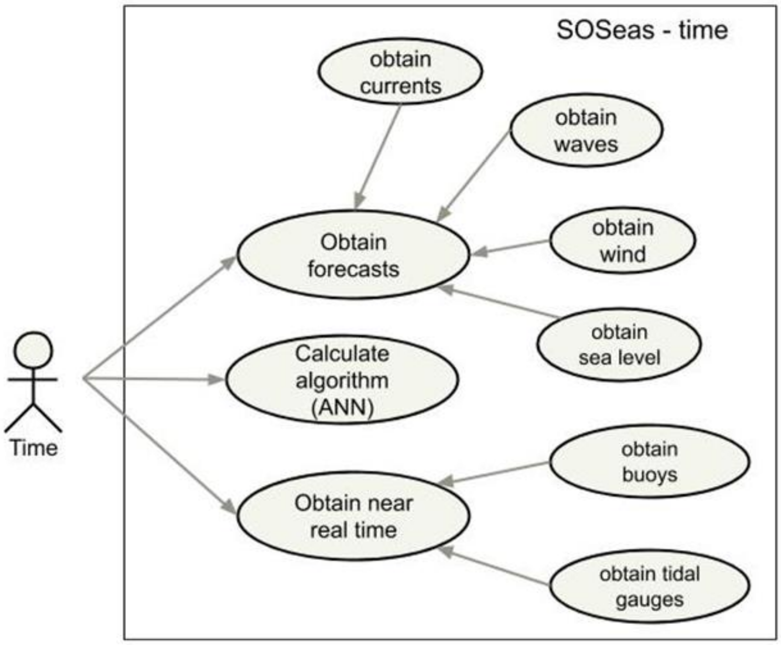

Figure 5. SOSeas Service - Operational and autonomous processes

Secondly, see Figure 6, end users must be able to access the information generated by the System in a clear and friendly way. In this sense, Web technologies, and specifically Progressive Web App (PWA), offers an effective communication channel to communicate risks to end users.

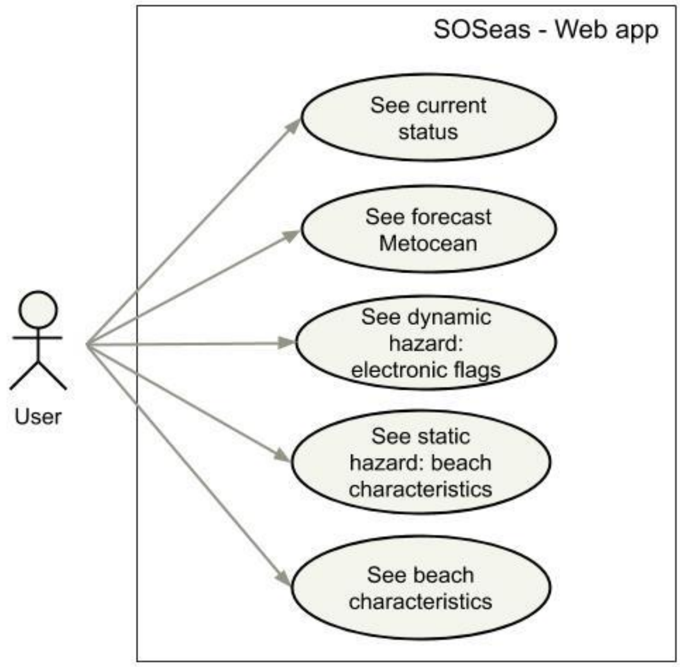

Figure 6. SOSeas Service - User interaction

Thirdly, see Figure 7, users with programming capabilities, such as technicians from administration or companies, must be able to develop software by establishing a machine-machine (M2M) communication with the SOSeas Service. The interoperability of the SOSeas Service allows access to the short-term metocean forecasting, near real time metocean data, hindcast metocean and the electronic flags obtained from the machine learning analysis.

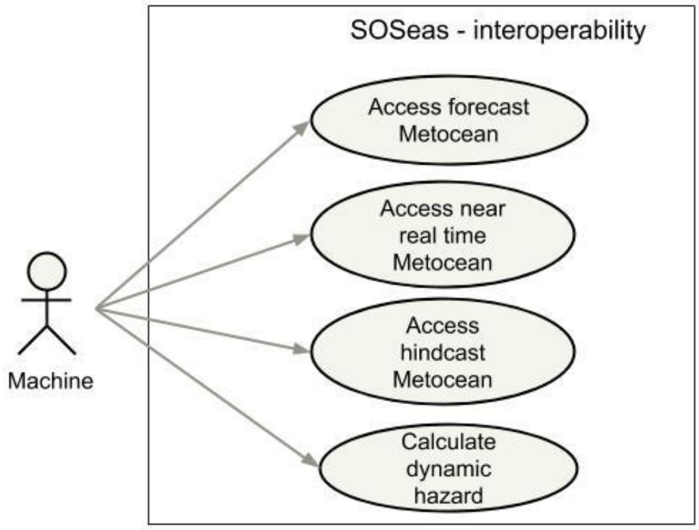

Figure 7. SOSeas - Machine interaction

The SOSeas requirement analysis, showed as use cases, allowed having a consensus about functional specifications and what the SOSeas Service provides to end users.