

# Decision Support System, Based on a Set of Information, Data and Indicators, for Integrated Management of the Coastal-marine Environment. Final Outcomes of the Caribbean EBM-DSS Pilot Project of Dominican Republic

## Sistema de Soporte a la Toma de Decisiones, Basado sobre un Conjunto de Información, Datos e Indicadores, para el Manejo Integrado del Ambiente Costero-marino. Resultados Finales del Proyecto Piloto EBM-DSS del Caribe en la República Dominicana

## Système d'Aide à la Décision, Basé sur un Ensemble d'Informations, de données et d'Indicateurs, pour la Gestion Intégrée de l'Environnement Marin et Côtier. Résultats Finaux du Projet Pilote EBM-DSS dans les Caraïbes en la République dominicaine

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### ABSTRACT

A pilot project based on the Ecosystem Based Management (EBM) concept was promoted and performed in the provinces of Montecristi and Puerto Plata, Dominican Republic, as part of the “Biodiversity for Sustainable Development in the Caribbean through EBM” project. The main outcome of first phase, implemented in 2016 - 2017, was the creation of an interinstitutional multidisciplinary working group and its training in the use of the Decision Support System (DSS) Software. These two essential results were achieved through the application of the PROGES EBM-DSS methodology in a stage of four specific workshops. A relevant difficulty of the first phase was related to the data availability, accessibility and format. In the second phase of the project (January - September 2019) the Ministry of Environment and Natural Resources (MARENA) has created synergies and actions between different projects and institutions in order (i) to improve and update the database of the DSS, tackling the data collection issue occurred in the first phase, (ii) to strengthen the sustainability of the DSS and (iii) to enhance the effectiveness of the institution in the coastal-marine area management. MARENA has established interinstitutional agreements with the key-actors in order to ensure a periodic and continuative update of the data to be entered in the EBM-DSS. The monitoring of the key parameters and the specific management actions have been developed by the interactions among experts and institutional stakeholders in the process of the ecosystem cause-effect analysis based on the DSS methodology. The results of the data collection task, the field monitoring practices, and the above mentioned management activities will be finalised within September 2019. The scientific, technical and the institutional final outcomes will be identified and described.

KEYWORDS: EBM-DSS, coastal marine PAs, sustainability

### INTRODUCTION

The Ecosystem Based Management (EBM) strategies require an interdisciplinary approach that balances ecological, social and governance principles, incorporating data analysis of various interactions at appropriate temporal and spatial scales in a distinct geographical area (Arkema et al. 2006, Long et al. 2015).

One of the challenges for the implementation of an ecosystem approach includes the development of tools and methods that incorporate operational processes, help in the decision making process and support the transference of knowledge to all levels of the system (Curtin and Prellezo 2010). In the EBM context the tools include repeatable process and analytical support tools such as software, information and data (Smith et al. 2010, Paul et al. 2012, Peedell et al. 2017), all developed to facilitate practitioners to better understand the ecosystem context of their management decisions.

The EBM takes in consideration a holistic management perspective, where the presence of the stakeholders is involved “in an integrated and adaptive management process where decisions reflect societal choice” (Long et al. 2015). Stakeholder participation is a fundamental component, not only because implies having access to local ecological knowledge, values needs, social interactions, but also because involving stakeholders is expected to increase the legitimacy and acceptance of the management. EBM is a complex concept that requires a considerable investment in communication of the general principles and an accurate description of the concept and the implementations of the EBM (UNEP 2011, Schwermer et al. 2020).

This paper summarises the outcomes, the challenges and the lessons learnt and discusses how the use of a Decision Support System (DSS) tool, called Integrated Spatial Planning (ISP 5.0) facilitates the application of EBM, building at the same time a better level of communication within the relevant stakeholders. The EBM-DSS experience described in this paper was just applied in a coastal-marine ecological system north-west of the Dominican Republic as a pilot for the

Caribbean region; this initiative took place in the framework of a project implemented by United Nations Environment Programme - Caribbean Environment Programme (UN Environment/CEP) funded by Italian Agency for Development Cooperation (AICS), under the coordination and supervision of the Ministry of Environment and Natural Resources (*Ministerio de Medio Ambiente y Recursos Naturales* – MARENA). The EBM process was proposed and coordinated by a team of consultants of Proges, a consulting firm that provide services, tools and methods for the implementation of sustainable development projects. The company developed the EBM-DSS tool as well, now uploaded and managed – as a milestone of the EBM-DSS process - by a Dominican database expert. He is contracted by another project, called “Coastal Biodiversity and Tourism” (Biodiversidad Costera y Turismo, BCyT). The synergy between the BCyT and EBM-DSS projects was an initiative aimed to optimise the achievement of their overlapped targets such as the creation of the inter-institutional technical coordination mechanism between the Ministry of Tourism and Ministry of Environment and Natural Resources and the necessity to update of the Geographic Information System BCyT database.

#### PILOT AREAS

A pilot project based on the EBM concept was promoted and performed in the provinces of Montecristi and Puerto Plata, Dominican Republic, as part of the “Biodiversity for Sustainable Development in the Caribbean through EBM” project (Figure 1).

The entire area was divided following the provincial borders, the decision was based on the profound differences in terms of natural resources and economic aspects, number and participation of the local compound of stakeholders. Moreover, a group composed by stakeholders working in the Environment Minister found a technical consensus for the delimitation of the area to be managed by EBM within a buffer of 5 km inland from the coastal edge and the marine space up to 200 m isobath. The pilot areas of the provinces of Montecristi and Puerto Plata included a buffer with watersheds, mangroves, coastal lagoons on the land side, and the coral reefs on the seaside.

#### METHODS

##### Workshops

In October 2016, the first cycle of workshops was organised in Puerto Plata and Montecristi. The outcomes were the matrices, tables where the stakeholders identified and listed the components and sub-components of the pilot areas. The second cycle of workshops followed shortly later (November - December 2016), in Santo Domingo. The diagrams were drawn with the stakeholders in the EBM-DSS software, called Integrated Spatial Planning (ISP). The activities of the third cycle of workshops, organised again in the capital, provided the lists of the indicators, that were written inside the EBM-DSS suite (for all the details of the outcomes of the first three workshops, included the introduction to the EBM-DSS tool, see Attorre et al. 2016).



**Figure 1.** Pilot areas of the DR EBM-DSS project: provinces of Montecristi and Puerto Plata and delimitation of the area to be managed by EBM (sea buffer highlighted in yellow, land buffer in green colour).

The fourth cycle of workshops was carried out in November-December 2017. All the participants carried out an analysis called “cause-effect”, in order to explicit and to explain the relations between the components and to evaluate the nature of them. Moreover, the stakeholders reviewed the status of the knowledge of each component, writing the data available and lack of information. The final step was the suggestion of management initiatives, that included both practical actions and monitoring or/and new collection campaigns of data.

### Action plans

In July 2019, once that the second phase of the project was approved, Proges selected a set of the action plans coming for the cause-effect analyses and proposed a document with detailed explanations of the proposals coming from the stakeholders during the fourth workshop. Linked with this file there was a new action plan focused on filling the gap of information regarding the presence of pollutants in the fresh water of streams and canals and in the brackish ones in the area of the mangroves of Estero Balsa.

The water and sediment samples were collected in August 2019, all the field work was carried out in collaboration with technical professionals of MARENA and Proges, while the analyses of the samples were performed by an external laboratory. The outcomes of the action plan were entered in the EBM-DSS software.

### Data Collection

During the workshops (2016-2017) the stakeholders were informed about the necessity to collect material about all the components and the indicators that they listed in the EBM-DSS suite. The campaign of collating data started in June and temporarily stopped in September 2017, and the material was entered in the DSS tool by a Dominican database expert employed to accomplish this task and trained by Proges. During the fourth workshop the coordinators, the data expert and the stakeholders discussed about the difficulties faced and some limits experienced to get all the files. When the second part of the project started in July 2019, MARENA approached the data request sending in advance an “institutional letter” to the other ministries and institutions, in order to improve the communication between institutions and the efficiency in obtaining the data. Official requests were signed by the Environment Minister Mr Estevez Bourdierd himself.

### Interinstitutional Network

Between February and March 2017 four meetings of the Ministerial Internal Group were carried out, with the targets of:

- i) Reviewing the matrices in order to specify the participation and responsibilities, and
- ii) Strengthening the inter-institutional working group, through the definition of the assignments of the representative staff for each entity as a function of the actor key of this working group according to the thematic participation.

The ministry's thematic entities are: Vice Ministry of Coastal and Marine Resources, Vice Ministry of Forest Resources, Vice Ministry of Soils and Water, Directorate of Biodiversity, Areas Directorate Protected, Directorate of Environmental Protection, Directorate of Environmental Information, Directorate of Environmental Education, Directorate of Planning, Coastal Biodiversity and Tourism Project (GEF-MIMARENA). In order to continue to use the EBM-DSS approach and to guarantee the updating and use of the software suite for management purposes of the two pilot areas, short-term and long-term strategies were adopted. The first included the involvement of a professional consultants in August 2019 with the task to collect the data from the other institutions and ministers outside MARENA. In the same period Proges, with the director of the marine resources and her collaborator and in synergy with the BCyT project, collected the information from the different departments and vice-ministers inside MARENA. This tandem collection speeded the collating activity of the data that the EBM-DSS software showed still lacking. On the other side, the long-term strategy strengthened the sustainability of the EBM-DSS approach:

- i) Contracting a data expert that guarantee that all the information needed will be entered and managed using the ISP 5.0 software suite. This professional figure works inside the public institution and has been involved in entering the data stored by the professional consultants and Proges. Because he is employed by BCyT, a project still ongoing, he will continue to work with the EBM-DSS tool and to ensure the uploading of new information,
- ii) Creating a unit inside MARENA that is and will be responsible of the planning and the implementation of the action plans and the data collection, included new monitoring initiatives, and
- iii) Building an EBM-DSS technical Unit inside MARENA; Proges ensured that the software, once online, was accessible from all the users of the ministry and all the related institutions.

## RESULTS

### Stakeholders

Considering all the four cycles of workshops, 24 different institutions, ministries, NGOs were present and 67 stakeholders. Seven people attended all of them, 11 stakeholders participated 75% of the occasions, 30 people attended half of the workshops (50%), and 19 were present only once.

### EBM-DSS Software Suite: IPS 5.0

Several components were linked with data and indicators. The data received in August-September are still in the entry phase, and for this reason the total number of the indicators in the IPS is not defined yet. All the data will be visualised like the example shown in Figure 2. The main window of the software has the system diagram of one of the pilot areas (A in the Figure 2, expanded in Figure 3), maps (corresponding to B), the list of the indicators with the temporal and spatial options (C, expanded in Figure 4),

tables or charts (D, expanded in Figure 4) (Figure 2). Moreover there are commands to open a Reporting tool in order to facilitate to write reports; the tool gives the opportunity to write notes, comments and paste pertinent figures.

**Using the ISP during the Workshop “Cause-effect Analysis”**

Two main topics for each pilot area were identified and analysed. For Montecristi the mangroves and the coral reefs were selected and discussed, for Puerto Plata the



A. System diagram, detail

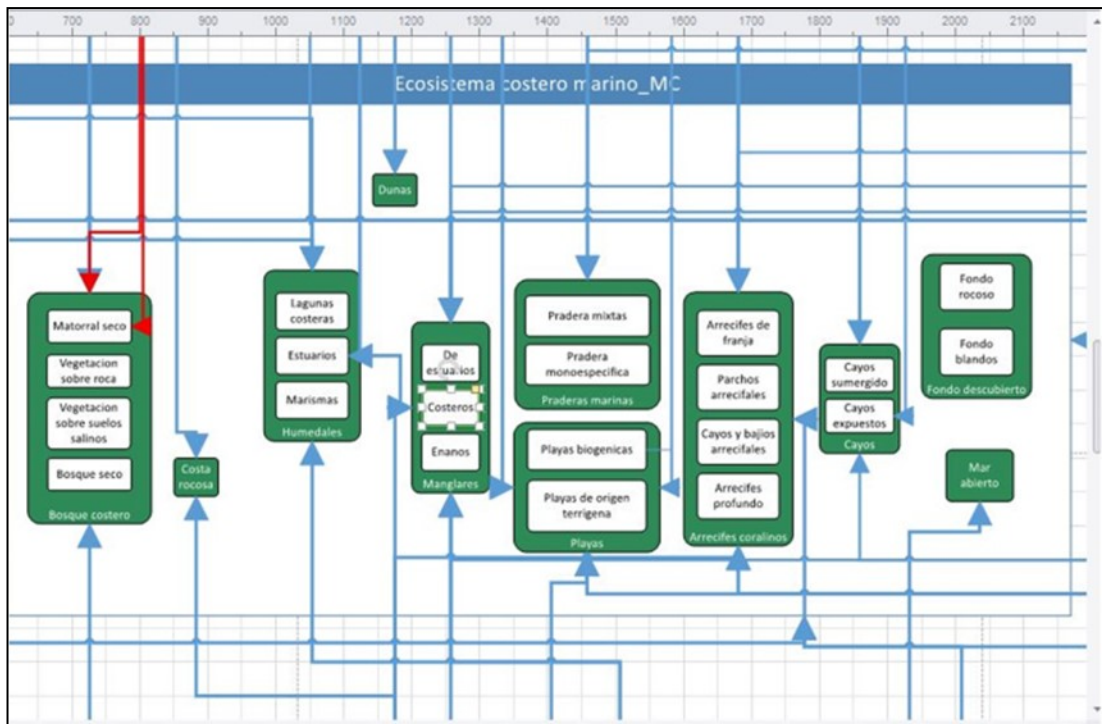


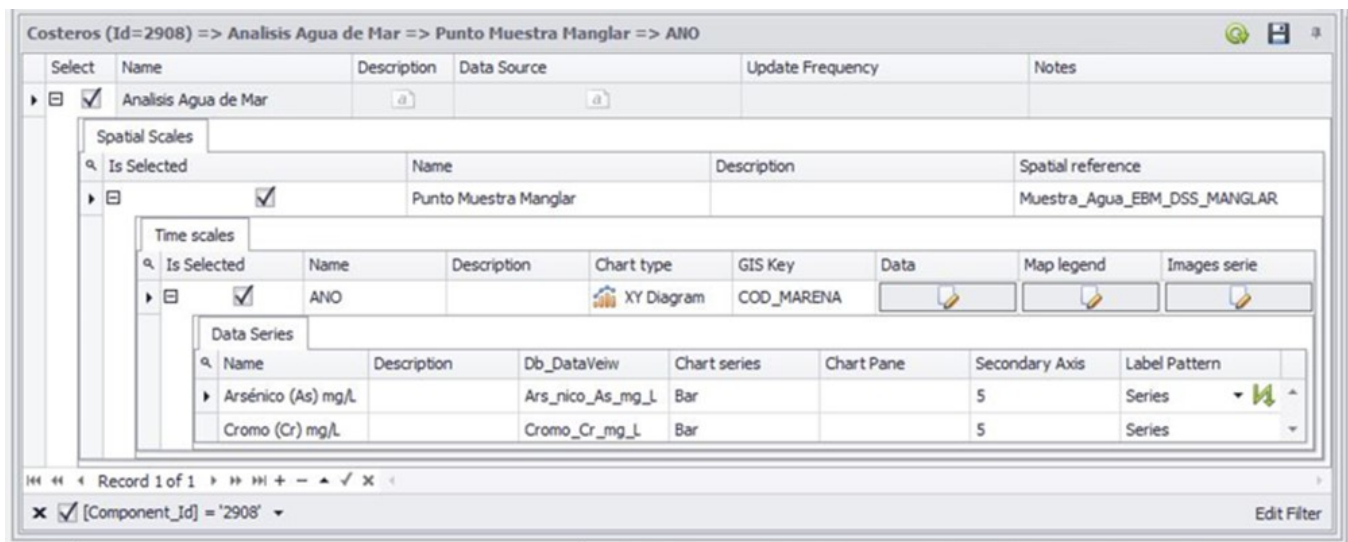
Figure 2. Main window of the software EBM-DSS Integrated Spatial Planning 5.0.

watersheds and the fishery business. As mentioned before, for Montecristi one of the cause-effect analyses was focused on the relations between mangroves and wetlands, seaports, canal infrastructures, agriculture, road network, threatened species and marine piers. The participants described the mangroves of Montecristi using the data available and shown in the EBM-DSS tool. In this context they realised that one of the three mangroves of the province had a negative trend of the index Normalized Difference Vegetation Index (NDVI) recorded in 2010 and 2013. In a second moment, they started to consider one by one the other components mentioned before, and they check the information available in the software useful for its description and they reported the nature of the relation between the two components. When they analysed the relation between the mangroves and the wetlands, for example, the direct experience and the information shown in the EBM-DSS software brought to hypothesize a pollution impact on the mangroves from the fresh water coming from the areas intensively cultivated. Because it became evident that the level of knowledge in the nature

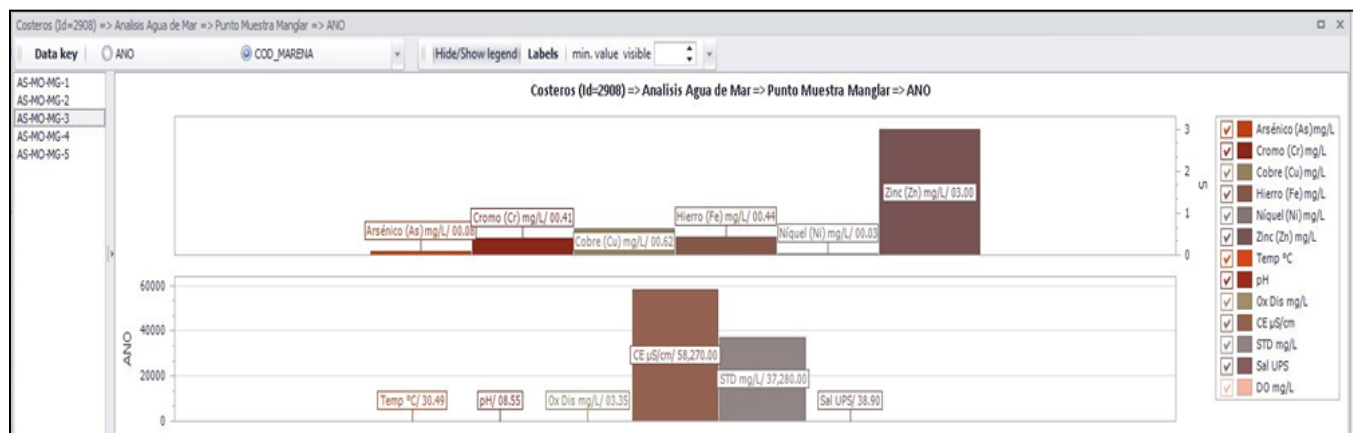
and concentrations of contaminants was not enough to establish a clear relation between the conservation status of the mangroves and the pollutants of the waters of canals and streams, the stakeholders suggested a specific action of contaminant monitoring.

### Action Plans

*Data collection procedures* —At the end of July 2019 MARENA revised the document, written by Proges, that contextualised the action plans proposed by the stakeholders. The coordinators of the EBM-DSS project in MARENA suggested to extend and include the action plans regarding the data collection to all the components and their relations listed during the cause-effect analysis, for both the pilot areas. This initiative implied the involvement of two teams, one responsible for the data collection outside MARENA, the other for all the material inside the ministry of environment and natural resources. Moreover, 11 technical sheets were written, one for each institution



**Figure 3.** Indicators of a component (here “Análisis Agua de mar”), with the spatial (“Spatial scales”), the temporal (“Time scales”) and “Data Series” options.



**Figure 4.** Tables or charts (here the details of the values of the heavy metals in the mangrove of Estero Balsa).

involved in the providing the data. These should help and guide the EBM-DSS data analyst and other users in the upload and management data processes. The technical sheets contain the names of the diagram in the EBM-DSS, all the indicators that the contacted institutions possess, the description of the indicators, the suggested frequency of actualization of the information, the target area (sometimes the data are needed for Montecristi and Puerto Plata, some other indicators are requested only for one of the two) and other notes useful to optimise the works.

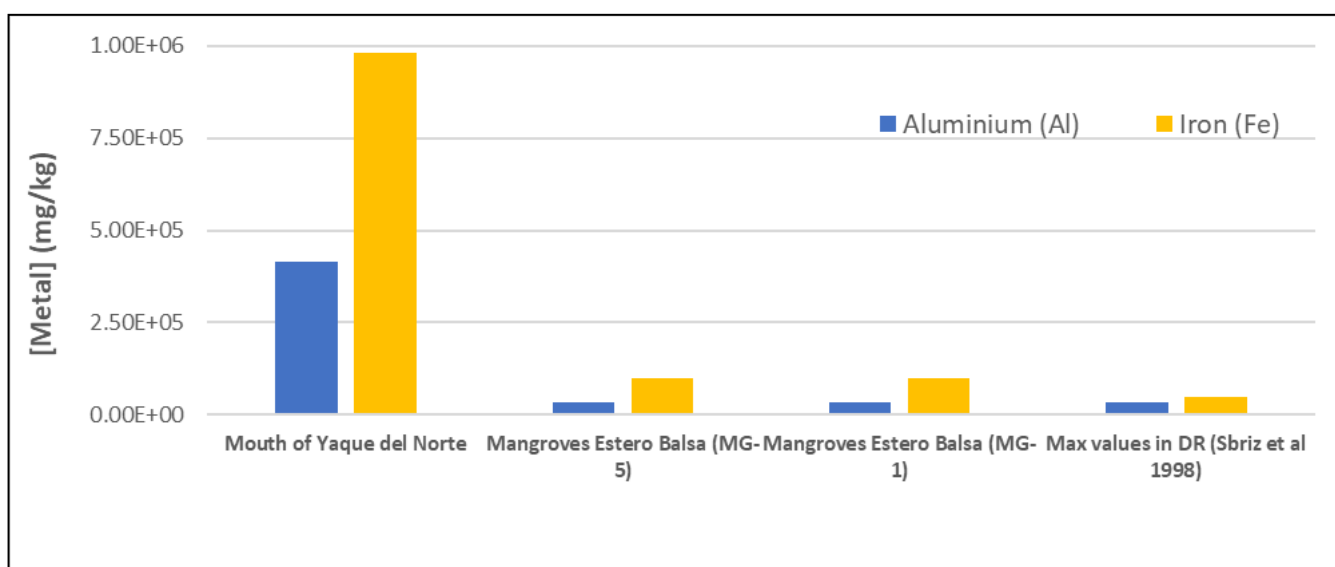
*Mangroves action plan: results of the action plan applied in Montecristi project* — Of the three mangroves of the Montecristi province, called El Morro, Punta Rucia and Estero Balsa, the last one was selected to apply a protocol for the action plan, titled “Manual of collection of data and monitoring: water and sediments”. It has the description of the target area and the reasons why it was selected by the stakeholders with the use of the EBM-DSS tool. The frequency of monitoring is suggested, followed by a detailed introduction of the components and by the aims of the action plan. The technical parts include the list and the descriptions of the experiments, the list of the indicators that will be updated in the EBM-DSS software suite once the results are analysed, the explanations of the procedures in the field and in the laboratory, the equipment required, the personnel and the protocols that they should be applied, and finally the references.

*Outcomes from the field work* — Fifteen samples were taken at 15 different points. Six samples of seawater, nine of surface water. Three sediment samples were taken, all in saline water. Data were collected on following water parameters: Temperature, pH, Dissolved oxygen (mg/L); Conductivity ( $\mu\text{S}/\text{cm}$ ); Total dissolved solids (mg/L); Salinity (UPS); Chemical Oxygen Demand; Total Phosphorus (mg/L); Total Nitrogen (mg/L). For water and sedi-

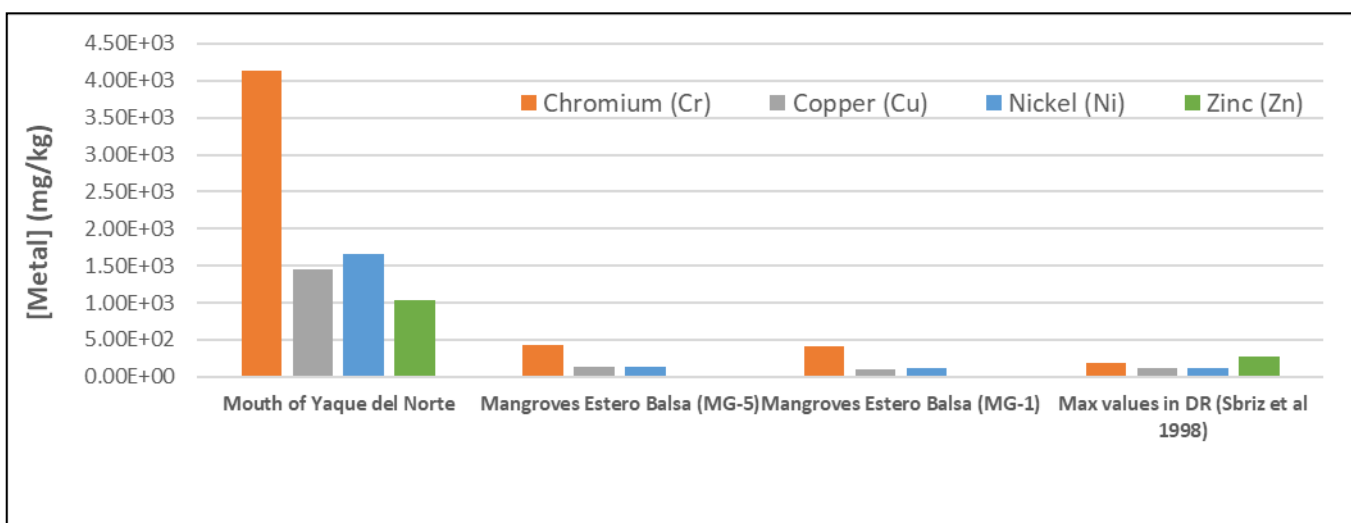
ments, the quantities of thirty-two heavy metals were analysed, measured as milligrams per litre of water and micrograms per kilogram of sediments. The results are not complete because we are still waiting for the results of the analysis of contaminants such as herbicides and pesticides. The analyses carried out so far have revealed some interesting facts. The numbers of some heavy metals at the mouth of the Yaque del Norte river are higher compared to the values recorded in 1995 (Sbriz et al. 1998) (Graphs 1 and 2).

**Outcomes of the DR EBM-DSS: Data Management, Synergies and Inter-institutional Network**

The meetings carried out in 2017 created the first foundations for the inter-institutional working unit. Another outcome of the project was the synergy created later with BCyT, that is ensuring continuity and is investing resources to continue the process of uploading and the use of the EBM-DSS approach and the software. As a further step, coordination meetings within technical and manager professionals are planned in the future in order to use the EBM-DSS to recalibrate the monitoring activities of the BCyT project. More in detail, three synergic entities have been created: i) Monitoring technical team: this group is working in MARENA and coordinates the other professionals responsible for the monitoring of the natural resources, the analysis, for reporting and communicating the outcomes obtained. This team is considered one of the components of the institutional strengthening of the Coastal and Marine Vice-minister of MARENA and the BCyT project is working for the organisation and the operativity. ii) Interdisciplinary multisectoral work unit: this team is composed by the stakeholders of the EBM-DSS workshops. Their aim is to facilitate the connections within the professionals that are producing information about the coastal and marine areas and, using the knowledge of the



**Graphic 1 (Aluminium and Iron):** Concentrations (mg/Kg) found in the mouth of Yaque del Norte river and in two different points of the Estero Balsa mangrove, compared with the maximum levels, sampled in all the Dominican Republic and published by Sbriz et al. (1998).



**Graphic 2 (Chromium, Copper, Nickel, Zinc):** Concentrations (mg/Kg) found in the mouth of Yaque del Norte river and in two different points of the Estero Balsa mangrove, compared with the maximum levels, sampled in all the Dominican Republic and published by Sbriz et al. (1998).

EBM-DSS approach, to collect a selected kind of data, in order to upload the indicators inside the software and use them for management purposes. iii) Team of the Management of the EBM-DSS digital system. All the experts, professionals, stakeholders, already contacted with the “institutional letter”, that they were asked to provide the data and that they should continue to send the suitable and editable versions of the information (e.g. Excel, csv).

The final workshop is going to be planned for the 31<sup>st</sup> of October (2019), where the stakeholders involved in all the process will be invited, as well as the people in charge to provide the data in the institutions contacted during the second phase of the project and their supervisors. The organizers of the final workshop will ask the presents to express their opinion about their perception of the DR EBM-DSS project, the potential of the development and the use of this holistic system in the future.

## DISCUSSION

### Stakeholder Participation

In the Dominican experience, the stakeholders had a prominent role in the development of the EBM-DSS suite software developed for Dominican pilot areas of Montecristi and Puerto Plata. The step-by-step procedure to create the EBM-DSS tool allowed the participants to be constantly involved, to efficiently metabolise the knowledge of the principles of the EBM approach and to avoid possible reluctance in the use of this new tool (Pinarbaşı et al. 2017). They contributed with information and data during the project, and they are engaged to continue to send the material to the institutional database expert. The stakeholders were proactive in the management proposals of action plans and their coordination. The mentioned contributions from the people involved are essential component of the EBM as a participatory process (Ward et al. 2002; Fletcher et al. 2015; Leslie et al. 2015;

Wasson et al. 2015; Smith et al. 2017). The Dominican stakeholders took the initiative to meet each other apart from the “official” participative workshops to better define the boundaries of the area involved in the EBM-DSS exercise (one of the relevant aspects highlighted by Arkema et al. 2006).

### Data Collection

During the first phase of data collection (June-October 2017), after that the EBM-DSS team requested the data in order to make the indicators developed functional inside the suite software, some challenges were faced. The first issue consisted in the fact that often the data were handed spread in written documents instead than files Excel or other suitable format to be directly entered in the software. Elher (2008) identified the database collection as the most demanding - in term of time - aspect of the planning activities and moreover it was previously reported that collating spatially-explicit material and their management and consult could be limiting factors when EBM is applied in developing countries (Leslie et al. 2015). This would have compromised the full functionality of the EBM-DSS tool. To overcome the problem, in the second phase of the project (August 2019), during the interinstitutional multidisciplinary meetings, the communication of the description of the data format was improved, and made more detailed, explaining the reasons. Initiatives, such as capacity building aimed at improving the stakeholder’s skills in the data storage and management and a higher involvement of scientists in the planning and writing process of the procedures, monitoring initiatives and data analysis, could help to strength the scientific robustness and optimise the use of all the information (Ortner et al. 2014). A second challenge recorded was the long time required to obtain the requested data due to the lack of inter-institutional agreements for sharing and managing the necessary material. This was tackled in the second phase

preparing the official letters from the MARENA minister to the other ministers or managers leading the offices where there was the necessary information. When a member of one of these institutions had been an EBM-DSS workshop participant, his/her name was reported in the letter as well, becoming in this way the main referent. In exchange MARENA proposed itself as the entity responsible of the collection, the entry process of all the records and of the management of the database and the GIS data inside the EBM-DSS tool. In order to guarantee these performances, it has been necessary to hire an Administrative - Operative Assistant and an IT consultant. The first professional helps in dealing with all the institutions involved in the project, the second is the institutional responsible database expert. And to ensure a long-term sustainability to the system, MARENA established synergy with BCyT, that is using part of its resources to maintain the EBM-DSS centre and the IT mentioned just above.

### Implementation of the EBM-DSS approach

To test the achievement of the Dominican EBM-DSS pilot project, the action plan proposed and carried out was focused on a challenging area and a very specific topic. From this perspective, it is accepted that EBM does not require managing all aspects of a system at once (UNEP 2011), neither is the panacea (Smith et al. 2017). The analysis of waters and sediments in the mangrove of Estero Balsa and its tributaries could be considered a demonstrative action plan. At this stage, the EBM group have the challenge to collect the lacking results of the herbicides and pesticides in order to have as many elements as possible to properly describe the conservation status of the area. At the same time, the members of the inter-institutional inter-disciplinary group should understand how to use all the information recorded to face the process of the reduction of the nutrient from cities and agriculture.

The changes to decrease the pollutants in a certain area require a coordinated effort of the institutions involved and several stages. First, it is necessary to make the population aware of the nature of the problem. Moreover, the experience of the action plan showed that the equipment and the capacity of the Dominican laboratories cannot cover all the analyses needed to properly understand the magnitude of the pollutants present in a certain area, but they constantly have to lean to a laboratory abroad. One of the possible management suggestions could be investigating in strengthening one of the Dominican laboratories, for example the MARENA centre, in order to become more efficient. As second stage, it is necessary to obtain consensus on the details of the problem and of the steps needed to remedy it, taking into account the often-conflicting interests of various segments of the community. The development of this step will be introduced in the final workshop organised the 31<sup>st</sup> of October 2019, where the participants of the interinstitutional group will be asked to express in a written form their opinion about: 1) the importance of the application of the EBM approach to help exchanging data; 2) possible suggestions for adding new

indicators and information; 3) possible obstacles in getting the data and correlated solutions; 4) what kind of benefits the EBM-DSS tool will provide for their own institutions. The next stage would be the implementation of the solution, after which it is necessary to put in place a monitoring programme that will enable judgments to be made about the effectiveness of the steps taken.

### Outcomes from the Action Plan

Some metals showed a considerable increase, compared to the values recorded twenty years ago. Mangroves not only survive against changes in salinity but can also cope with heavy metals and other stresses. It has been shown that some halophyte species can thrive in both high salt and toxic metal conditions. However, the mechanism of metal tolerance in halophytes is still unclear (Nikalje and Suprasanna 2018). In case of bioaccumulation of heavy metals in food chains, in particular of chromium in the case in Montecristi, higher trophic levels in food chains have a higher risk. Metal concentrations in organisms of higher tropical zones, as a result of biomagnification, may present risks to the health of these organisms or their human consumers (Ali et al. 2019). Cr is used in the processing of leathers, and we know that in Santiago there has been a constant increase in shoe industry in recent years. One of the areas where plausible additional sampling should include that area. Another aspect is to verify whether agrochemicals with Cr exist and are used in the plain of the Yaque del Norte river. The iron is another element that was high compared to the analysis of Sbriz et al (1998). In particular, it is high everywhere, but there is a peak in the Canal Puente Castañuela. One of the fertilizers used for rice cultivation is rich in Fe; the main crop around Villa Copa is rice. The use of this kind of products is still to be investigated, the effort of the action plan has helped to identify one of the possible areas of future interventions.

The action plan experience allowed:

- i) To collect new and valid information about the heavy metals. All the data are entered in the ISP and available,
- ii) To report that an improvement of the capacity of the Dominican laboratories could be considered as a driver management suggestion, and
- iii) To set a pragmatic first path for the interinstitutional interdisciplinary group that they can follow for a thoughtful planning of the most important next management actions and activities.

### Lessons Learnt

The Ministry of environment and natural resources had the vision and the decision to face the problem of analytical management of information by the environmental sector.

During the EBM-DSS project in Dominican Republic, the project experienced that one critical aspect was the collection of necessary data to full fill the EBM-DSS indicators. The process of collection, selection, standardisation, and transformation of the data is quite a long and sensitive process. This phase is hard to metabolise



immediately by the stakeholders, maybe depending on the lack of the previous experiences of data analysis or by the limited confidence with the management of dataset and proper databases. The stakeholders involved in the workshops often participated to field works but they were not always the first actors in the data entry or in the data management. Often at the end of the tasks only simple documents or reports in Pdf or Word format were provided to them. The data scattered and dispersed in written documents require longer time than managing directly Excel or Access files. Initiatives, such as capacity building aimed at improving the stakeholder's skills in the data storage and management and/or a higher investment of project resources in the data collection and analysis, could help to save time and energy in collating information from several not-appropriate sources. Improving the efficiency of the data collection and analysis means that, potentially, all the data available are fully used and the standardisation and analysis phases can focus in increasing the number of indicators inside the EBM-DSS.

The representation of the socio-ecological system inside the EBM-DSS software is implemented through to a graphic diagram composed by boxes and arrows. This may entail that the visualization of a specific part of the system can become "visually chaotic" if the information and the interactions of this part of the system are many and complex. In order to avoid any visual disorder that can possibly confuse the observers (stakeholders, decision makers, scientists, etc.), the work of the EBM-DSS team during participative workshop should find the best compromise between the realistic descriptions of the system and a detailed, but not confusing, diagram. An example is represented by the wildlife diagram, where the stakeholders have related all the most important taxa both within each other and with other elements such as ecosystems, human activities and so on. Some of the people were very knowledgeable so they suggested to add several details, such as taxonomic ranks of the single taxon, with the relative relations. This would have created a complicated representations and unclear overlaps of the relations. In order to overcome the possible confusion in the analysis phase of the diagram, preserving at the same time the effective modelling of the intrinsic complexity that ecosystems have, a new specific functionality has been implemented in the EBM-DSS software. This new functionality allows to hide all those parts of the diagram that are not necessary to the specific "relations" under analysis and that could confuse the user. The result was that the resulting "picture of the system" was then quite intuitive, but the general complexity was not lost, only hidden and still available to perform more detailed analyses.

The stakeholders took the initiative to meet each other apart from the "official" participative workshops to better define the boundaries of the area involved in the EBM-DSS exercise (one of the aspects highlighted by Arkema et al 2006). The institutional counterparts showed a genuine interest in the EBM-DSS and the wish to understand and metabolize the steps in an autonomous way. Moreover, the stakeholders showed a significant knowledge of the

ecosystems and an edifying attitude to listen the contributions of the other participants. It was definitely a positive and constructive environment, not at all to be given for granted. Often decision-makers are not always provided with a comprehensive ecological knowledge or inclination of listening and understanding each other. In the Dominican project Proges stressed a more active participation of Dominican stakeholders during the workshops. This has allowed them to reach a much higher level of ownership of the EBM-DSS process. This "new process" required more energy and time but it has been entirely compensated with a matured awareness of the approach that brought the stakeholders, and MARENA in particular, to become able to effectively communicate the EBM-DSS to audiences. In order to promote the helpful attitude of the stakeholders and to improving the confidence in the EBM-DSS approach, in designing and evaluating future projects particular attention should be devoted to check the stakeholder initial capacities and EBM-DSS performances to better define case-by-case the "most suitable extent" of reducing the contribution of external consultants in the EBM-DSS process in line with the above illustrated experience.

Compared to other previous experiences, in the Dominican Republic a considerable amount of data was available about natural resources, as well as on economic and social aspects, mainly resulting from several researches and surveys carried out on the island. During the workshops the stakeholders, both because they were directly involved in the data collection and management or because they had the indirect knowledge about their existence, started to share the data or clearly indicated the institutions that have these data available. When the EBM-DSS team requested them, in order to create the data base system to make the indicators developed functional, some challenges were faced: a) Data stored in Word or PDF files; b) Need for inter-institutional agreements for sharing and managing the necessary data; this has led to an important lengthening of the time required to obtain the requested information or to the impossibility of obtaining such data where the agreements have not been reached; c) Some data from non-institutional organizations such as universities or research groups were not available because they were not yet used in scientific publications. As the consequence, some indicators in the EBM-DSS software was left blank. Procedures for the data sharing should be established as a priority with project counterparts as early as possible in the project design and implementation path. Due to the complexity of project management, it has been necessary to hire an Administrative - Operative Assistant and a local IT consultant. The first professional helps in dealing with all the institutions involved in the project, the second is a crucial figure involved in the collection and the entry of all the necessary data and to maintain and to update the database and the GIS data of the EBM-DSS. Moreover, in order to guarantee the sustainability of the EBM-DSS and to analyse the information to be submitted to the decision makers, the establishment of a permanent unit, expert in EBM and data management, was recommended and created in the second phase of the project.

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