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The BASIC Cartagena Project is an applied research project on Basic Sea Interactions with Communities focused on the generation of adaptation tools for integrated coastal water resource management in the coastal zone of Cartagena, Colombia. Started in July 2014, this 3-year multidisciplinary project is financed by the International Development Research Centre (IDRC) of Canada. Implementation of the project is led by EAFIT University, in collaboration with the University of Los Andes, University of Cartagena, the Foundation H.E.O., and the Regional Corporation CARDIQUE.

Editorials

Metals in the coastal environment of Cartagena

Metals are commonly found in sediments and soils due to the natural erosion of the Earth's crust. Elevated concentrations are usually due to human industrial activities. Depending on the concentrations and their biological availability, metals in sediments can pose a risk to aquatic organisms that live in the sediments or are in contact with them. The accumulation of metals in the tissue of aquatic organisms, such as fish, can similarly pose a risk to those who consume the affected organisms, such as humans.



Results from the BASIC Project's research on sediment quality and fish ecotoxicology show that such risks may exist in the coastal zone of Cartagena. In the sediments of Cartagena Bay, concerning concentrations of mercury, nickel, copper and chromium were found. In the tissue of fish collected by artisanal fishermen in Cartagena's coastal zone, concentrations of chromium and mercury



exceeded the maximum limits recommended for human consumption used by the United Nations Food and Agriculture Organization (FAO) and the World Health Organization (WHO). Concentrations of lead exceeded the maximum limit of consumption recommended for children used by the European Union (EU).

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Community leaders meeting at the University of Cartagena

Leaders of the communities of Ararca and Barú met with the project's lead researchers from the Universities of Los Andes, Cartagena and EAFIT, and the Foundation HEO in order to discuss the current activities of the community intervention in the framework of BASIC. At this time presentations were made on the research components of public health, socioeconomics, artisanal fishing and water resources. This gave the community leaders the opportunity to better understand the use and benefit of the information collected by the project and to put forth questions and suggestions towards the optimization of the research.



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Research Activities

Ethnography and economic games with the community of Barú

During the first semester of 2016, the socio-economic team from the Universidad de Los Andes conducted an ethnographic study in the Barú community, which identified strategies that the fishermen have been implementing to ensure the sustainability of the marine ecosystem and traditional fishing practices. Additionally, they studied factors that allow these strategies to be effective as well as the difficulties faced by the private and public institutional environment on the island of Barú. During this semester, several sessions of economic games were also done to explore strategies to improve income and the conservation of ecosystems through the development of ecotourism activities and ecological restoration. Both the ethnographic work and the economic games revealed that fishermen are open to engaging in activities that generate income from tourism, such as snorkeling. In this sense, the results obtained indicate that tourism can compensate for the loss of revenue resulting from unsustainable fishing.



Educational health campaign in the communities

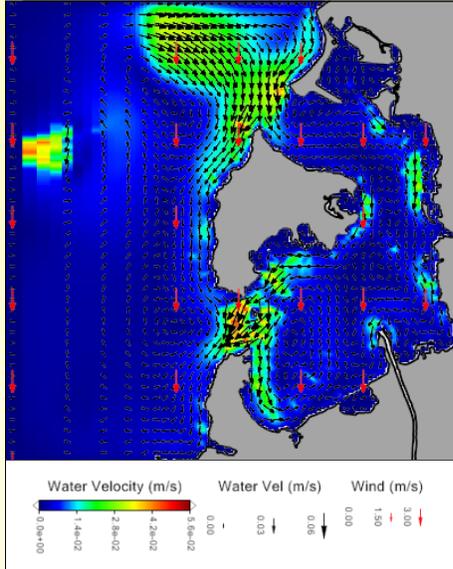
During the first semester of 2016, researchers from the University of Cartagena carried out the first stage of a community intervention aimed at controlling risk factors of water-borne diseases. This strategy includes the formation of young leaders from local high schools, who will compete in order to improve community knowledge, attitudes and practices. The management of domestic waters forms a part of the health problems found in the coastal communities, for which this campaign focuses on education in order to influence attitudes and finally the practices of water management. Another health problem found is that of congenital malformations identified in Ararca which has recently been reported in a scientific publication in Revista Ciencias Biomédicas, an indexed journal edited by the Faculty of Medicine of the University of Cartagena.



Research Activities

Hydrodynamic modeling of Cartagena Bay

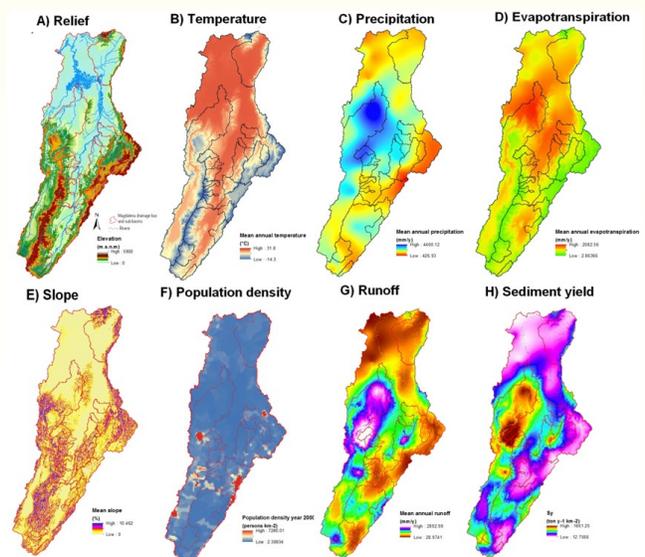
During the past semester, the project's coastal hydrology component oriented its research on the hydrodynamic modeling of Cartagena Bay. This work is being done using the MOHID water modeling system, an integrated model that uses open-source code and a number of coupled



modules that describe water properties, hydrodynamics, geometry, advection-diffusion processes, atmosphere and benthos, amongst others. Initial modeling activities have focused on the preparation of bathymetric data and the determination of the optimal grid size for the study area. Various options were evaluated for the model's grid before establishing an equidistant Cartesian horizontal grid of 75 m resolution and a non-equally spaced Sigma vertical grid of 20 layers. Initial hydrodynamic characterizations will assess water transport using passive particle tracing while future work will simulate scenarios of future conditions of water quality in Cartagena Bay.

Hydro-climatic characterization of the Magdalena River basin

The PhD student Rogger Escobar, of EAFIT University, is currently working on the spatial characterization of hydro-climatic variables in the Magdalena River basin. This research focuses on the spatial differentiation of the climatic and human factors controlling the riverine fluxes of the Magdalena River. Maps have been generated for temperature, precipitation, evapotranspiration, runoff and sediment yield at a resolution of 500m using geostatistical and hydrological modeling techniques. Further work will include the development of spatial maps of trends in precipitation, runoff and sediment yield to evaluate the relationship between these variables. Finally, abnormal responses detected in relation to runoff and sediment yield will be contrasted with anthropogenic variables such as population density and deforestation indices.



Events

Project presentation to the Board of Directors of CARDIQUE

On June 13th 2016, researchers from the BASIC Project had the opportunity to present the project's advancements to the Board of Directors of the Autonomous Regional Corporation for the Canal del Dique (CARDIQUE). The Board of Directors includes representatives of the Office of the President, the Ministry of Environment and Sustainable Development, the native communities, the private sector, the agricultural sector, NGOs and various mayors' offices from the area. On this occasion, there was particular interest in the risks of metal pollution. After introducing the structure and objectives of the project, the researchers presented recent results concerning metals in the sediments and fish of Cartagena's coastal zone (see pg. 1) as well as other results on the bay's lack of oxygen and seasonal problem of coliforms. Finally, a proposal was made for the development of an Integrated Management District as an instrument for the bay's zoning and the management of its natural resources.



Community leaders meeting at the University of Cartagena *(Continued from page 1)*

Carried out on April 11th, 2016, the meeting included a description concerning water resource pollution and aspects of public health such as infectious and non-transmissible diseases, and chronic intoxication due to metals. A contextualization of the "economic games" was presented with an emphasis on the sustainable use of fishing resources while the development of alternative activities, such as snorkelling and eco-tourism, were also discussed in order to diversify the local economy. It was made clear that the project will produce management tools that influence public policy concerning pollution and that the generation of information by the communities will contribute to this goal. In general, the group was enthusiastic about the strategy for young leaders in the communities. Finally, a visit was made to the new laboratory of tropical medicine to observe the facilities and techniques with which students conduct their research.



VII European Coastal Lagoons Symposium

The VII European Coastal Lagoons Symposium was held between March 1-4, 2016 in Murcia, Spain. This international event brought together coastal researchers from across Europe as well as invited presenters from Africa and the BASIC project from Colombia. On behalf of BASIC, Marko Tomic presented the project's work on marine water and sediment quality in Cartagena Bay with a focus on seasonal variability and potential impacts of pollution. This research demonstrated the seasonal nature of sediment plumes and hypoxic conditions in the bay as well as the potential risks presented by coliforms in the wet season and metals in sediments. These results show that Cartagena's coastal waters and sediments are strongly influenced by the effluents of human activities, and that this may be impacting the marine ecosystem, artisanal fisheries and tourism.



Capacity Building

Community capacity building in marine water quality monitoring

Environmental students of the National Educational Service (SENA) from Barú community actively participated in the sampling of marine water quality, both measuring and learning how different oceanographic variables are related to the water's quality. The students participated on two training sessions in recent months in areas important to the community's economy: the fishing zones of Barú Point and Ciénaga Cholón as well as the touristic beach "Playa Blanca". They also learned techniques in the measurement and sampling of marine waters using specialized equipment such as a CTD Castaway, Niskin bottle, secchi disk, anemometer, GPS and multivariable sensors in order to measure parameters such as salinity, depth, dissolved oxygen, turbidity and chlorophyll-a. The results of these sampling campaigns will later be shared with the community, towards building their knowledge of the environmental conditions in their surrounding marine waters and to motivate future monitoring activities within the community.



University students complete academic degrees

It is a pleasure to congratulate the following students on completing their university studies this past semester in the framework of the BASIC Project:

University of Los Andes

- ✓ Rosana Escobar - Bachelor of Science, Biology
- ✓ Camilo Andrés Garzón Medina - Masters in Economy and Public Policy
- ✓ Laura Patricia Castillo Ardila - Master in Public Policy

University of Cartagena

- ✓ Gustavo Mora García - Doctorate in Tropical Medicine

Publications

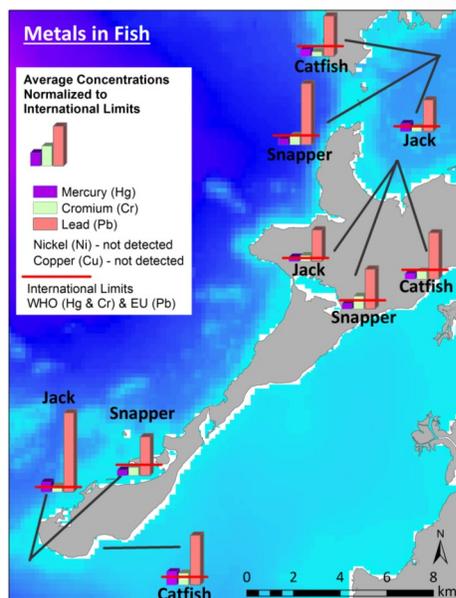
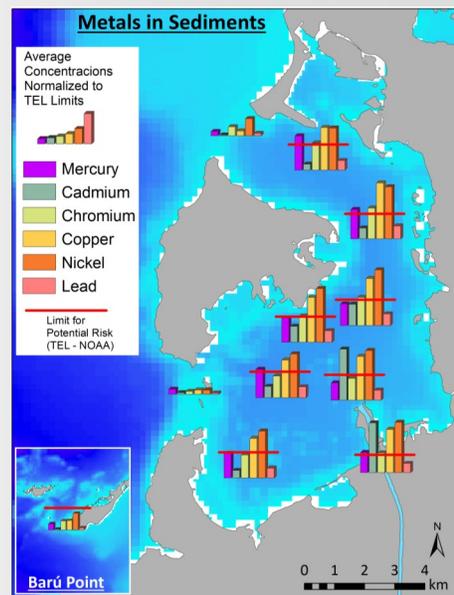
The following articles have been published this past semester in the framework of the project:

- Restrepo JD, Kettner AJ, Syvitski JPM. 2015. Recent deforestation causes rapid increase in river sediment load in the Colombian Andes. *Anthropocene* 10: 13-28.
- Espitia F, Ospina L, Mora G, Gómez D, Malambo D. 2015. Anomalías congénitas en familias de Ararca (Isla de Barú), Bolívar-Colombia. *Revista Ciencias Biomédicas* 6 (2): 251-258.

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Metals in the coastal environment of Cartagena

Sediment samples were collected from 11 locations in and around Cartagena Bay in March, June, October, and December of 2015. Laboratory analyses of these sediments consistently showed that concentrations of mercury (Hg), nickel (Ni), copper (Cu), and chromium (Cr) inside the bay were above the Threshold Effects Levels (TEL) indicative of potential risk. Cadmium (Cd) was high in the Dique Canal and increased in the bay to TEL limits in the rainy season (Oct.-Dec.), while lead was not high in the analyzed sediments. Concentrations of Ni were near to the Probable Effects Levels (PEL) indicative of a probable risk. It is relevant that one sediment sample had mercury concentrations of 1.34 mg/kg, which is far above the PEL limit. This result is similar to those of a previous study done by INVEMAR in 2010 that found potentially dangerous concentrations of mercury in sediments 55-65 cm beneath the bay's surface due to the operations of a chlor-alkali plant in the 1970s.



Fish were collected with the help of artisanal fishermen from the coastal communities of Ararca, Barú, and Caño del Oro. Fish tissue was analyzed in a total of 90 fish samples, including 3 different species (snapper, jacks, catfish) collected from 3 different fishing zones in March and November 2015. Laboratory analyses showed that the fish had accumulated chromium, mercury, and lead in their tissues, while nickel and copper were not detected. Chromium concentrations in the fish were above the limit of the FAO/WHO for human consumption and were highest in the dry season of March. Mercury was also highest in the dry season, exceeding the limit of the FAO/WHO in various samples, and showing similar results to a previous study done 20 years ago (Olivero et al. 2009). Lead concentrations in fish samples were highest in the rainy season; although results only exceeded the FAO/WHO limit in one case, all of the results exceeded the limits recommended for children used by the EU.

As a result of these findings, further investigations into the risks posed by sediment contamination to the aquatic ecosystem and the risks posed by fish contamination are strongly recommended. Sources of these contaminants should be identified and management actions taken to reduce any continuing inputs. The possibility of management actions to address historic contamination should be assessed, ensuring that any management actions do not create more problems than they solve; for example, dredging has environmental costs that need to be assessed including the potential risk of deeper sediments with high concentrations of metals that could be released to the water column.