ISSN 1880-7682
Volume 9, No. 3 June 2011

ISME/GLOMIS Electronic Journal

An electronic journal dedicated to enhance public awareness on the importance of mangrove ecosystems

The Urabá Gulf Mangrove Expedition of Colombia

Background

Much of the mangrove areas in Colombia remain poorly studied. The Urabá Gulf in the north, bordering the Caribbean Sea, is one of such areas. The gulf is unique in that: a) it is the biggest gulf (80 x 25 km) within the region, b) it has high freshwater discharge of 4500 $m^3 s^{-1}$ and sediment discharge by the Atrato river, the largest river draining into the gulf, and c) it is dominated by well-developed mangroves [1-6]. In some areas, the vegetation reaches heights of 12−23 m with trees having 20−57 cm diameter. *Rhizophora mangle* is the dominant species in more than 80% of the area, while *Avicennia germinans* stands are scarce. However, given the uniqueness and large size of the gulf, the knowledge about its biota and ecosystems remains scanty [3,4,7]. Besides, mangrove ecosystems are being threatened by human activities of pole extraction, over-fishing, and land reclamation, and by natural hazards of storm surges and wind-throws. In addition, plans are underway to build the Pan-American road and a deep-water port which could adversely affect the area [3,4]. The Urabá Gulf has been poorly studied, and the cartographic and oceanographic studies are either limited in spatial coverage or outdated [5,8]. A brief description of the physical geography of the gulf is given in Box 1.

> The Urabá Gulf (7º55'−8º40' N, 76º53'−77º23' W) is a semi-enclosed body of water (length: 80 km, width: 6−45 km), N-S elongated, with mean and maximum depths of 25 and 60 m, respectively. The 609 km coastal zone, which extends between Cape Tiburón and Peñoncito Creek, falls under the jurisdiction of the states of Antioquia and Chocó [8]. The gulf is a geomorphic mosaic with coastal relief landforms and fluvial-marine plains. Relief landforms of Urabá-Darién are characterized by hills, alluvial valleys, marine terraces (emerged and submerged), small islands, stacks, submarine scarps, channels, diapiric domes and mud volcanoes. The fluvial-marine plains are formed by the accumulation of materials eroded from the Darién and Caribbean coastal plains. Dissected by river channels, these wide plains consist of natural levees and fresh-water swamps. Typical landforms of the inter-tidal zone are sandy and/or cobble beaches, and tidal flats which support mangrove vegetation in sheltered areas with high siltation (e.g. Rionegro Inlet, Bay of Turbo, and river deltas of Atrato, Caiman Viejo, Caiman Nuevo, Turbo and Currrulao). Between Punta Caribaná and Arboletes, rapid shore erosion has destroyed most mangrove areas, with remnant areas left at the embouchures of the Mulatos, Zapata, Damaquiel, San Juan and Hobo rivers [7].

Box 1. Physical geography of the Urabá Gulf

The Expedition

These situations have motivated an expedition (Expedición Estuarina, golfo de Urabá, fase 1) to explore the mangrove areas located in the estuaries of the gulf, including the Atrato river delta. This expedition was supported by a state-government research program named “Expedición Antioquia 2013” and involved marine biologists, mangrove foresters, geologists and coastal oceanographers. It involved mapping a 2.5 km coastal fringe using 1:10,000 colour aerial photographs (30 cm pixels) taken in mid-2009, and conducting field sampling to assess mangrove root fouling invertebrates and algae, as well as benthic foraminifera, mangrove structure and composition, sediment and rock characteristics, and near-shore dynamics from 2009 to 2010. Although in-depth analyses are still in progress, compilation of baseline information of species inventory, mapping and photo-interpretation of landforms and vegetation, as well as coarse-grain wave dispersion modelling was completed in 2010.

Wave-generating Processes

Using a combination of long-term datasets and field measurements, the Gulf was divided into two distinctive zones relative to dominant wave-generating processes. The Northern Zone (NZ), dominated by swells, extends from the outer part of the Gulf between Capurganá and Punta Caribaná to the deltas of the Atrato and Turbo rivers. The Southern Zone (SZ), dominated by wind fetch on local sea surface, extends south of the Atrato river delta. During the wet season, wind direction is W-SW in the NZ and S-SW in the SZ. During the dry season, the direction changes to NE-SW in the NZ and N-S in the SZ. During the dry season, swells in the NZ (mean height: 1.7 m; period: 10 s; direction: N) travel into the SZ, dissipating to 0.6 m mean height. Storm- and hurricane-driven waves from the Caribbean Sea may reach the Urabá Gulf. However, local-wind-driven swells seem to be the most important force causing coastal erosion and mangrove retreat in various parts of the bay [7].

Mangrove Inventory

Sampling effort for the vegetation inventory was unprecedented during the expedition. The assessment of coastal vegetation using the 1:10,000 aerial photographs showed 4910 ha of mangroves, located mainly in the Atrato river delta (3846 ha) and in the Rionegro Inlet (356 ha). A map of the mangrove vegetation and associated coastal ecosystems of the Rionegro Inlet is shown in Fig. 1.

Of the total of 99 circular plots (500 m^2) established, 83 were located within mangroves. Fringe mangroves, the main physiographic type, are dominated by *R. mangle* and *Laguncularia racemosa*. Basin mangroves are found further inland where there is less influenced by freshwater discharge, tidal inundation, and greater accumulation of sand. They are dominated by *R. mangle* in the seaward side with mixed leeward stands of *L. racemosa* and *A. germinans*. Small mangrove patches in early succession are dominated by *R. mangle*. In general, diameter and height growth suggested sufficient sapling recruitment and good tree survival. Although mangroves in most parts of the Urabá Gulf are fairly well developed, they are degraded at Punta Yarumal and Punta de Las Vacas due to timber over-exploitation and land reclamation for establishing pastures and crops. At Bocas del Atrato, there is high incidence of aerial-root boring by the shipworm bivalve (*Neoteredo reynei*), and massive galls on tree trunks seemly produced by bacteria or fungi [9].

Root-fouling Communities

Sampling effort for the root-fouling communities was painstaking with (86 stations, and 3-5 roots collected per station). The community of mangrove root-fouling molluscs was extremely poor with only eight species recorded. The mussels *Mytilopsis* cf. *sallei* and *Brachidontes* cf. *exustus* were the dominant species, accounting for 94% of the total of about 70,000 individuals collected. Populations of the virgin snail *Neritina virginea* and the mangrove oyster *Crassostrea rhizophorae* exhibited significant positive correlation with salinity. Overall, species composition was very homogeneous throughout the gulf, with the exemption of the Rionegro Inlet where water salinity is higher. The polychaete diversity was also low. Out of the 12 species identified, those of the family Nereididae were the most abundant, and at least, two species may be new. A total of 19 species of macroalgae were identified. Out of 22 species, four agglutinated and one calcareous species of benthic foraminifera were found to be dominant. Mud and content of organic matter in sediments correlated with the most abundant species. Most molluscs, polychaetes, macroalgae and benthic foraminifera were widespread estuarine species.

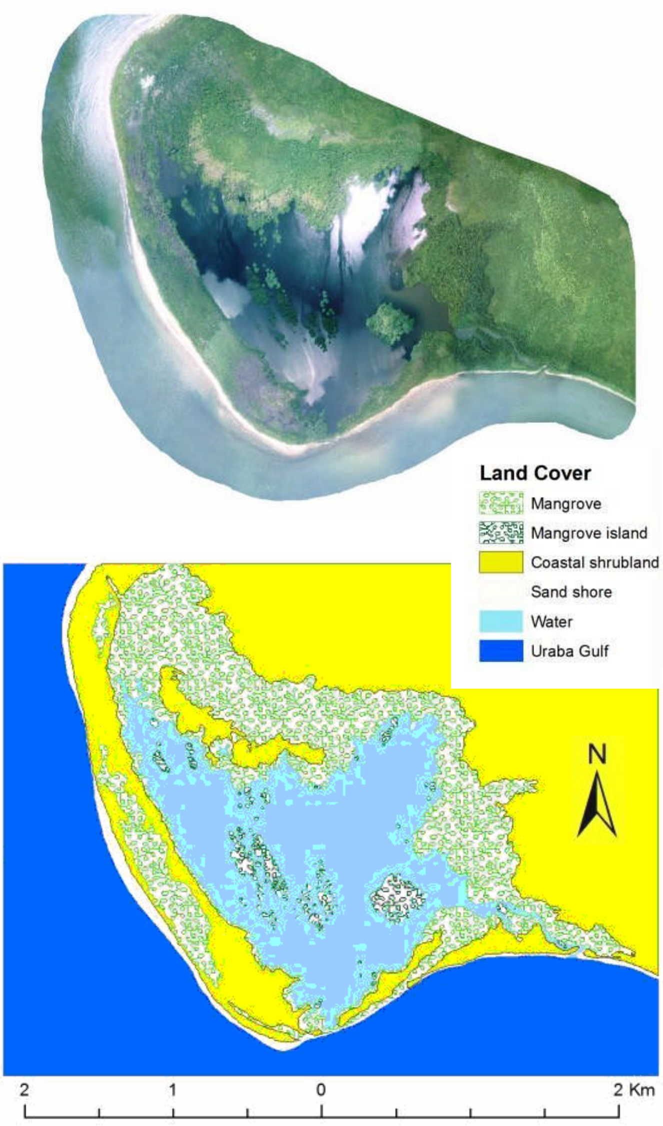

Fig. 1. Map of the mangroves (355 ha) and associated ecosystems at Rionegro Inlet, NE part of the Urabá Gulf, using 1:10,000 colour-aerial photographs

Conclusion

In conclusion, this expedition sets a new era in the study of mangroves within the Urabá Gulf It provided the first fine-scale mapping of mangroves and other vegetation, along with surrounding coastal landforms. Current figures on the area of mangroves are more reliable compared to previous estimates with lower resolution (1:100,000). The gulf is a large, low-salinity estuarine area dominated by discharge from the Atrato river. Despite of the low diversity of mangrove species, and root-fouling fauna and flora compared to other estuaries in the Caribbean, communities seem to be spatially homogeneous throughout the gulf. Our detailed inventory and mapping of species and communities would allow us to monitor changes in biodiversity and ecosystem dynamics over time.

Acknowledgements

This expedition was funded by “Expedición Antioquia 2013” an Antioquia State Government consortium involving Universidad de Antioquia, Universidad Nacional de Colombia-Medellín and Universidad EAFIT. Field, laboratory and computer work was assisted by Sara Raquel López, Ana M. Gómez, Andrés Estrada, Luis F. Ortíz, Sara Cadavid, María Cecilia Castaño, Nataly Gutierrez, Eliana Molina, Yuly Suárez, Hiara Ruíz, Luis G. Molina, Juan D. Osorio, Johanna Prussman, Astrid Garrido, Eliana Gómez, Catalina Arteaga, Kathleen Hurtado, Verónica Meneses and David Mazo. Support by Environmental Authority of Uraba (CORPOURABA), particularly from Jairo Guillermo Vásquez is acknowledged. Additional, we are grateful to Maritime Authority (DIMAR, Turbo Office), Center for Marine and Hydrographic Research (CIOH), and Universidad Javeriana for the field support. Local communities of Bocas del Atrato and Chocó Norte kindly allowed access and provided field assistance. Figure 1 was kindly prepared by Andrés Estrada.

References

[1] Sánchez-Páez, H., Álvarez-León, R., Pinto, F., Sánchez, A.A., Pino, R.J., García, I. & Acosta, P.M., 1997. *Diagnóstico y zonificación preliminar de los manglares del caribe de Colombia.* Ministerio de Medio Ambiente. Santa Fe de Bogotá D.C., Colombia, 511 pp.

[2] Marín-Zambrana, B.G., 2002. Lagunas costeras y estuarios. Pp. 183-206. In: INVEMAR (Ed.) *Informe del estado de los ambientes marinos y costeros en Colombia: 2001.* Serie de documentos generales. Santa Marta.

[3] INVEMAR-CORPOURABA, 2003. *Diagnóstico, Zonificación y Definición de la Estructura Administrativa de Manejo de la Unidad Ambiental Costera del Darién, Caribe Colombiano Fase I. Caracterización Diagnóstico.* Informe Técnico Preliminar.

[4] Bernal, G., Toro, M., Montoya-Jaramillo, M., Garizábal-Carmona, L.J. & Ernesto, C., 2005. Estudio de la dispersión de sedimentos del río Atrato y sus impactos sobre la problemática ambiental costera del Golfo de Urabá. *Gestión y Ambiente* 8: 123-135.

[5] Thomas, Y.F., García, C., Cesaraccio, M. & Ménanteau, L., 2007. Contribución de la hidrografía histórica al estudio de la cinemática de los fondos marinos: evolución del golfo de Urabá, Colombia. *Boletín Científico del Centro de Investigaciones Oceanográficas e Hidrográficas* 25: 110-119.

[6] Blanco-Libreros, J.F., 2009. Banana crop expansion and increased river-borne sediment exports to the Gulf of Urabá, Caribbean coast of Colombia. *Ambio* 38(3): 181-183.

[7] Correa, I.D. & Vernette, G., 2004. Introducción al problema de la erosión litoral en Urabá (sector Arboletes-Turbo) Costa Caribe colombiana. *Boletín de Investigaciones Marinas y Costeras* 33: 7-28.

[8] García-Valencia, C. (Ed.), 2007. *Atlas del golfo de Urabá: una mirada al Caribe de Antioquia y Chocó.* Instituto de Investigaciones Marinas y Costeras –Invemar– y Gobernación de Antioquia. Santa Marta, Colombia. Serie de Publicaciones Especiales de Invemar No. 12, 188 pp.

[9] Sánchez-Alférez, A.S., Álvarez-León, R., Godoy-Bueno, S., López, C. & Pinzón-Florián, O.P., 2009. Aspectos fitosanitarios de los manglares del Urabá Antioqueño, Caribe colombiano. *Pan-American Journal of Aquatic Sciences* 4: 339-346.

Juan F. Blanco[1], Mario H. Londoño-Mesa[1], Lizette Quan-Young[1], Ligia Urrego-Giraldo[2], Jaime H. Polanía[2], Andrés Osorio[3], Gladys Bernal[3] & Iván D. Correa[4]

[1] Institute of Biology, Faculty of Exact and Natural Sciences, Universidad de Antioquia, Medellín, Colombia (Calle 67 # 53-108)
[2] Department of Forestry Science, Universidad Nacional de Colombia, Medellín, Colombia
[3] School of Earth and Environmental Sciences, Faculty of Mines, Universidad Nacional de Colombia, Medellín, Colombia
[4] Department of Geology, Engineering Faculty, Universidad EAFIT, Medellín, Colombia

E-mail of Juan F. Blanco (lead author): blanco@exactas.udea.edu.co