Banana Crop Expansion and Increased River-Borne Sediment Exports to the Gulf of Urabá, Caribbean Coast of Colombia
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Synopsis

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# Banana Crop Expansion and Increased River-borne Sediment Exports to the Gulf of Urabá, Caribbean Coast of Colombia

Sedimentation is a major environmental issue in the Gulf of Urabá (southern Caribbean coast of Colombia) (1), yet driving forces and influences on coastal ecosystems are poorly known by local scientists and natural resource managers. This is partially a result of the small temporal and spatial windows employed in scientific studies and management strategies that hide the complex interactions among hydrologic, geographic, and socioeconomic processes operating at basin level. For instance, sediment accumulation in the nearshore has been managed at a local scale by dredging access channels in shoaling areas and by constructing barriers to prevent littoral erosion at other sites, with little recognition of sediment sources and transport (2). Moreover, causes of such problems have not been investigated throughout entire river basins, several of which are world-class producers of banana, and therefore become potential sources of sediments to be transported to the coastal zone. Elsewhere, conversion of native forest to agriculture lands has been implicated as a major driver of increased land erosion and sediment yields (3). Specifically, deforestation and urbanization may have accounted for a positive trend in sediment delivery to the Caribbean Sea through the Magdalena River basin, Colombia's largest system (4). Agricultural lands doubled in area between 1970 and 1990, while sediment loads increased in 17 out of 32 river subbasins. Maximum water discharge and a deforestation index explained 96% of the variation in sediment yield across the upper Magdalena basin. Here, I discuss the hypothesis that sediment yields in the Urabá region are greater in river basins with extensive banana crops than in basins under other land covers.

The Urabá region or Darién, part of the Chocó biogeographic diversity hotspot, comprises an alluvial coastal plain (11 644 $km^2$) limited by the Serranía del Darién to the west on the border with Panamá, the foothills of the Western Cordillera (northern Andes) to the south, and the Serranía of Abibe to the east (5). Banana and plantain crops cover 73% of the cultivated area within this region (6), and thus are the top agricultural activities, contributing 72.9% (1994) of the gross product (5).

Cultivated area has steadily expanded over the last 15 years at a rate of 709 ha $y^{-1}$ (Fig. 1A, $r^2 = 0.77$, $F_{1,13} = 47.07$, $p < 0.001$). Such an expansion coincided with a decrease in planted area in the rest of the country over the last decade, and currently the Urabá region is Colombia's main producer of bananas driven by a growing international market (Fig. 1B, $r^2 = 0.46$, $F_{1,13} = 13.18$, $p < 0.005$). Seven companies buy the production of local farmers and control the export process; however, there is a growing monopoly, and two transnational companies are currently responsible for 23% of all exports. Therefore, expansion of banana agriculture in this region may continue at a constant rate in the future despite the decline observed after 1999 due to global overproduction, higher standards (green crops and labor welfare) set by the European Union, and protective policies to benefit Pacific, African, and European (e.g., Canary Islands) producers. Nonetheless, Colombia is still a top producer of bananas, contributing 12% of the global market, and at an annual profit of USD 280 million (2001). During 1998, exports from the Urabá region alone peaked at USD 290 million, representing 62% of national exports (USD 470 million). Most of the produce is exported to the United States (33.9%), Belgium (27.2%), Germany (17.5%), and Italy (14.2%). In contrast, plantain, the second most important crop (e.g., 10 500 ha in the Turbo municipality), is mainly destined for local and national markets, with exports fluctuating (6). In either case, 90% of market demand is supplied by small household farms (3 ha), with a smaller fraction produced by larger industrialized farms. In contrast, banana production is supported by 406 large farms (about 70 ha) (5), and they, in response to globalization, could be responsible for most of the soil erosion and sediment transport to the ocean.

Although statistics on cultivated areas for other crops are unavailable in the Urabá region, it is believed that banana and plantain are the most extensive (5, 6). The highest proportion of cultivated land occurs in municipalities such as Apartadó, Carepa, Chigorodó, and Turbo (Fig. 1C). For instance, Turbo, the largest municipality, contains the most cultivated land (36 000 ha) and pastures (146 000 ha). Native forest cover is <20% of the municipalities in the coastal plain and most of the total forest cover is represented by secondary forests. Even at Mutatá, a municipality located in the northern Andes piedmont, native forests cover is <40%. Nonetheless, pasture lands are the category with the largest cover in all municipalities because of the economic importance of cattle ranching. Altogether, the preceding figures indicate that the coastal plain landscape in the Urabá region has been severely transformed by deforestation and conversion of native forest into pastures, crops, and shrub lands for more than half a century (6).

Sediment yields to the Gulf of Urabá from coastal river basins rank among the highest in the world. The largest sediment yields are observed from the following river basins: Carepa, Chigorodó, Currulao, and León (2048, 1088, 1023, and 1007 t $km^{-2}$ $y^{-1}$) (7). Lands in these basins are predominantly covered by banana crops and yield more sediments than nonbanana lands within the Urabá region and the rest of the Caribbean coast of Colombia (Fig. 1D). Rivers crossing banana lands yield more sediments than even the largest rivers such as the Atrato (315 t $km^{-2}$ $y^{-1}$, the largest river discharging into the Gulf of Urabá), and the Magdalena (559 t $km^{-2}$ $y^{-1}$, the largest river in Colombia, draining 24% of the country within the extensively deforested northern Andes) (7). Sediment yields from banana lands in Urabá rank within the upper 15% of the world's river ranking, equaling orders of magnitude observed at coastal basins in Oceania and Asia where the highest yields occur because of small mountainous areas, high precipitation, and active tectonics (7, 8). Yields in Urabá even exceed those from the Pacific coast in Colombia, which receive two times more annual rainfall (2500 and >5000 mm, respectively) (7, 8). Although sediment yields are controlled by climate, hydrology, geology, geomorphology, and land cover (9), the last seems to be of utmost importance for the Urabá region because no significant statistical relationship between sediment yield and drainage area or water discharge was observed. Elsewhere, clearance of natural vegetation and land use change may be responsible for increase of sediment yields from river basins of several orders of magnitude (9). At Urabá, similar trends could be promoted by poor soil management in both plantain and banana plantations because top soil is denuded at the onset of the plantation; afterward weeds

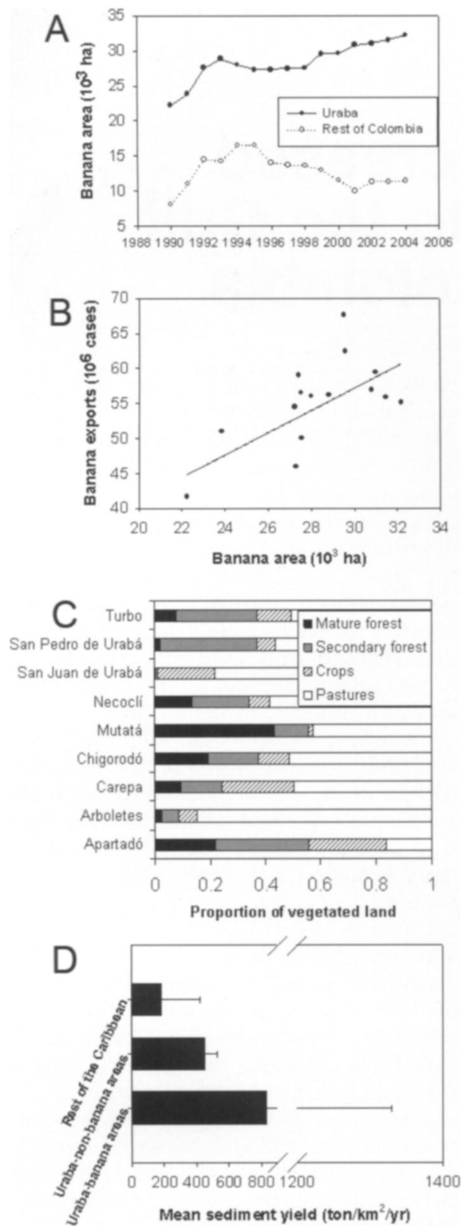


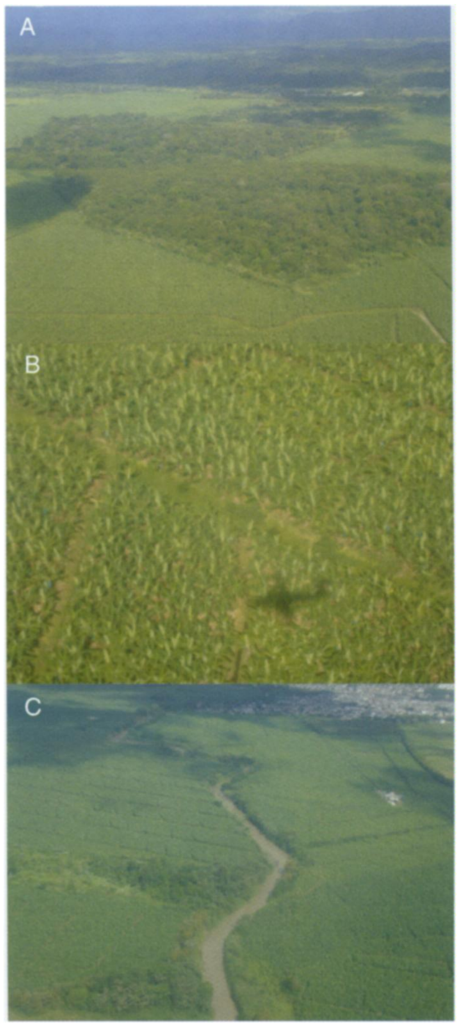

**Figure 1. Banana crop expansion and river sediment yields in the Urabá region. (A) Expansion of banana cultivated area in Urabá relative to the rest of the country. (B) Positive correlation between crop expansion and banana exports in number of 18.4-kg cases. (C) Proportion of agriculture and other land covers in all municipalities of the region. (D) River-basin sediment yields relative to banana crop cover and the rest of the Caribbean.**

and stumps are manually removed several times before cutting trees to ground level during harvest 12 to 18 months later (6). In addition, channels are dug for draining irrigated soils, thus conveying high sediment loads to natural and artificial watercourses. Furthermore, sandy and poorly structured soils (entisols and inceptisols) in the alluvial coastal plain may be highly sensitive to erosion as a result of greater rainfall compared with the rest of the Caribbean (6).

Awareness of the influence on coral reefs and mangroves of land use change in coastal river basins via sediment loads has recently increased. For instance, Islas del Rosario coral reefs located southwest of the Magdalena River's turbid plume on the Colombian Caribbean coast have experienced an increase in coral mortality and algal overgrowth; increased bioerosion by boring sponges; and shrinkage of seagrass areas correlated with a rapid increase in sediment loads after 1987 (7). Contrary to the case of coral reefs and sea grasses, impact assessments of sedimentation on mangroves are not available for the region, though examples exist elsewhere. Experimental studies in southeast Asian mangroves suggest that high sedimentation rates (i.e., 32 cm) promoted 100%, 70%, and 40% seedling mortality in *Avicennia*, *Rhizophora*, and *Sonneratia*, respectively, that might result in adult-tree species composition turnover (10). In addition to detrimental effects on mangrove seedlings, field observations in New Zealand estuaries recently reported reduced abundance and diversity in macrobenthic communities due to a dominance by deposit-feeding oligochaetes and polychaetes, and low numbers of suspension feeders under high sedimentation rates (11).

Impacts due to increased siltation on the extensive mangroves within the Gulf of Urabá can be indirectly inferred. For instance, delta progradation off the Turbo river (sediment load of 73 000 t $y^{-1}$; sediment yield: 445 t $km^{-2}$ $y^{-1}$) has steadily occurred since 1946 (0.27 $km^2$ in 1970 to 1.41 $km^2$ in 1994) (2). Moreover, progradation rates vary seasonally, being faster during the rainy season (1456 $m^2$ $month^{-1}$) than during the dry season (856 $m^2$ $month^{-1}$) (12). Accordingly, I roughly estimate a sedimentation rate of 52 000 t $km^{-2}$ $y^{-1}$ (52 kg $m^2$ $y^{-1}$) in the Turbo River Delta, most of it within mangroves (191 ha). This figure may well explain the continuous shoaling observed in recent years at the El Uno coastal lagoon formed south of the delta because a barrier island has progressively expanded southward (2, 12). High sedimentation rates have been also recorded at locations (e.g., Bahía Colombia) far from source river mouths (e.g., the Atrato River) due to particle transport by littoral drift currents (1), and therefore, sediment accumulation in coastal ecosystems might be a complex interaction of both local and distant sources. Mangroves at progressing deltas such as Turbo are actually experiencing dual effects from sedimentation because the windward is being colonized by *Rhizophora mangle* seedlings while the leeward exhibits tree die-off, most of it in *Avicennia germinans*, and replacement by freshwater-tolerant grasses and shrubs. Further, small-scale impacts of high sedimentation on mangroves, coastal lagoons, and nearshore subtidal zoobenthic communities might be similar to those reported elsewhere. Yet, through increased inputs of dissolved and particulate fractions of carbon and other elements, and altered stoichiometric relationships (13), river-borne sediments may further affect coastal ecosystems in unknown ways. For instance, producing 30 t $ha^{-1}$ of banana fruit requires fertilizing a plantation with 150–200 kg $N\text{-}NH_3$ $ha^{-1}$ $y^{-1}$ (6).

It is urgent to study the influence of land use change on sediment yields, particularly under the predicted climate change scenarios for the neotropics. However, separating the effects of land use change from climate change on sediment yields is a major methodological challenge because agricultural conversion and deforestation may have been well established before river gauging began in many parts of the world (9). Taking advantage of gauging stations, time series, and double mass (discharge *vs.* sediment load) plots may be useful tools. For example, a global analysis using these techniques showed that positive trends in sediment yields are observed in many locations, although rivers from Latin America, Africa, and Southeast Asia were not included and, therefore, such cases would be more common than shown (9).




**Landscape structure in the Urabá region. (A) Mature forest patch encroached by the banana crop matrix. (B) Bare soils and drainage channels within an active plantation. (C) Turbid waters in a realigned river segment crossing an extensive plantation. Note the reduced riparian buffer zones, and a major municipality in the background. Photos: María Cecilia Castaño.**

This synopsis concludes that expansion of banana agriculture in the Urabá region threatens not only megadiverse terrestrial ecosystems but also coastal ecosystems by releasing enormous amounts of sediments into the rivers and ocean. Accordingly, this region may be considered a soil erosion hotspot. Because extensive agriculture and erosion hotspots may occur in other regions within the Caribbean, river-borne sediments may be major stressors of mangroves, overlooked as a main anthropogenic disturbance in previous reviews (14), probably because it does not originate *in situ*. Greater insights will be gained if scientists and managers integrate processes in coastal ecosystems to the possible drivers operating upriver. Finally, revenues from the banana industry, not currently invested in the region (5), must focus on solving social and environmental issues derived from soil erosion in river basins.

## References and Notes


1. Bernal, G., Toro, M., Montoya, L.J. and Garizábal, C. 2005. Study on sediment dispersion from Atrato River plume and their impacts on environmental coastal problems in Urabá Gulf. *Gestión y Ambiente 8*, 123–135. (In Spanish).
2. Correa, I.D. and Vernette, G. 2004. Introduction to the coastal erosion problem in Urabá (Arboletes-Turbo sector) Caribbean coast of Colombia. *Boletín de Investigaciones Costeras y Marinas 33*, 7–28. (In Spanish).
3. Walling, D.E. 1999. Linking land use, erosion and sediment yields in river basins. *Hydrobiologia 410*, 223–240.
4. Restrepo, J.D. and Syvitski, J.P.M. 2006. Assessing the effect of natural controls and land use change on sediment yield in a major Andean river: the Magdalena drainage basin, Colombia. *Ambio 35*, 65–74.
5. INER (Instituto de Estudios Regionales). 2003. *Urabá Region Development: A Joint University-community Task*. Dirección de Regionalización. Universidad de Antioquia. Medellín, Colombia, 106 pp. (In Spanish).
6. INVEMAR-CORPOURABA. 2003. *Diagnose, Zoning, and Administrative Framework of the Darién Coastal Management Area, Caribbean Coast of Colombia. Phase I: Characterization and Diagnostics*. Technical Report. Santa Marta, Colombia, 470 pp. (In Spanish).
7. Restrepo, J.D. (ed). 2005. *Magdalena River Sediments: A Reflection of the Environmental Crisis*. Fondo Editorial Universidad Eafit-Colciencias, Medellin, Colombia, 267 pp. (In Spanish).
8. Restrepo, J.D. and Kjerfve, B. 2000. Water discharge and sediment load from the western slopes of the Colombian Andres with focus on rio San Juan. *J. Geol. 108*, 17–33.
9. Walling, D.E. and Fang, D. 2003. Recent trends in the suspended sediment loads of the world's rivers. *Glob. Planet. Change 39*, 111–126.
10. Thampanya, U., Vermaat, J.E. and Terrados, J. 2002. The effect of increasing sediment accretion on the seedlings of three common Thai mangrove species. *Aquat. Bot. 74*, 315–325.
11. Ellis, J., Nicholls, P., Craggs, R., Hofstra, D. and Hewitt, J. 2004. Effect of terrigenous sedimentation on mangrove physiology and associated macrobenthic communities. *Mar. Ecol.-Progr. Ser. 270*, 71–82.
12. Estrada-Urrea, E.A. and Gil-Gutierrez, S.M. 2005. *Analysis of Current Geomorphology as an Indicator of Sand Ridge Dynamics at Turbo River Delta, Antioquia.* BSc Thesis, Universidad de Antioquia, Turbo, Colombia.
13. Ludwig, W., Probst, J. and Kempe, S. 1996. Predicting the oceanic input of organic carbon by continental erosion. *Glob. Biogeochem. Cy. 10*, 23–41.
14. Ellison, A.M. and Farnsworth, E. 1996. Anthropogenic disturbance of Caribbean mangrove ecosystems: past impacts, present trends, and future predictions. *Biotropica 28*, 549–565.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