

SUSTAINABLE INFRASTRUCTURE: PUTTING PRINCIPLE INTO PRACTICE

GUIDING PRINCIPLE 4: AVOIDING ENVIRONMENTAL IMPACTS AND INVESTING IN NATURE

Adverse environmental impacts from infrastructure should be minimized, and natural capital enhanced to the greatest degree possible. Construction should be avoided in areas important for the persistence of biodiversity or having high ecosystem service value. The development of physical infrastructure should seek to complement or strengthen, rather than replace, nature's ability to provide services such as water supply and purification, flood control and carbon sequestration. Nature-based solutions should be prioritized.

CASE STUDY: GREEN-GRAY SOLUTION TO PROTECT THE CIÉNAGA GRANDE DE SANTA MARTA (CGSM) IN COLOMBIA

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Location: Ciénaga Grande de Santa Marta, Colombia

Organization: Conservation International

Partners: Autocase, INVEMAR, Tras la Perla, University of los Andes and Padilla Ingenieros



The Ciénaga Grande de Santa Marta wetland is bound by the highway coastline to the north – constructed in the 50s. Photo credit: Emily Corwin and María Claudia Díazgranados.



Need for Infrastructure Project/System:

Colombia's largest marsh ecosystem, the Ciénaga Grande de Santa Marta (CGSM), has experienced substantial erosion since the 1950s, when a highway was constructed along the Salamanca Island. The highway, which extends between the towns of Barranquilla and Ciénaga, obstructed natural water circulation between the marsh ecosystem and the Gulf of Salamanca. Subsequently, the freshwater flow between the main body of the CGSM and the River Magdalena was reduced due to the construction in the 1970s of control dykes and a second highway along the eastern bank of the river.

Due to these infrastructure modifications, by 1995 mangrove forest in the CGSM covered only 226 km², less than 50% of its original coverage. The subsequent eutrophication events and decline of commercial fish populations affected the livelihoods of fisherfolks dependent on the CGSM.



The Government of Colombia has proposed to refurbish and expand the highway to make it more resilient to coastal erosion and sea level rise, and to accommodate increased vehicle traffic. The proposed conventional “gray” design consists of (1) a widening of the highway from two to four lanes along a 42-km stretch of the existing alignment, and (2) the construction of two elevated roadways in specific areas where the current road presents significant coastal erosion issues. The current proposal does not include comprehensive environmental considerations and could result in further ecosystem degradation.

Project Description:

The project’s objective was to make the business case to government that a green-gray infrastructure system could be a viable alternative to the conventional gray proposal for the CGSM. Working with local partners (Tras La Perla, INVEMAR, and Uniandes), Conservation International developed a design to widen the highway while also improving the hydrologic connection between the marsh and the ocean, and restoring and protecting the mangroves and sand dunes of the region. The presented alternative would not only result in a highway capable of fulfilling the requirements of increased traffic, but also bring additional benefits to people and nature.

An engineering analysis revealed that the cost of the green-gray alternative would be approximately half that of the gray alternative. By strategically locating the elevated roadways where exchange of water is optimized between the ocean and the marsh, approximately half of the mangroves will be restored. Under the proposed green-gray plan, the mangrove cover is estimated to increase by 344 hectares per year, even when taking into account periodic El Niño diebacks. Each hectare of restored mangrove forest can sequester approximately 23 tonnes of carbon each year.

A Triple Bottom Line Cost-Benefit Analysis was conducted by Autocase to take into account not only the financial impacts of the projects, but also the social and environmental benefits. The analysis is intended to serve as a robust technical tool for decision makers at high levels within the Colombian Government.

WHAT IS TRIPLE BOTTOM LINE – CBA?



Triple Bottom Line Cost-Benefit Analysis

Challenges to Making Infrastructure Sustainable:

Technical and/or Programmatic – Colombian engineers are not fully trained to independently develop “sustainable – Nature-based Solution (NbS)” projects. In addition, there is currently no national guiding framework on how to use TBL-CBA type analyses for project evaluation. The Colombian government is in the early stages of developing a Sustainable Infrastructure Pillar that could integrate such analyses in the future. Meanwhile, the conventional gray infrastructure approach remains the norm in Colombia and it is difficult for politicians and communities to consider alternative approaches that prioritize nature.

Governance and/or Political Challenges – National-level policies for systematically developing sustainable projects remain limited. Meanwhile, the CGSM is located within four different conservation areas, each with unique requirements, conservation categories and governance structures. As a result, aligning and prioritizing activities requires a lot of coordination with different entities. Also, the stigma remains that the infrastructure sector is in conflict or opposition with the environmental sector, making it challenging to create common ground to collaborate.



Financial and/or Economic Challenges – One financial challenge is the limitations on tracking how funds are being distributed through different stakeholders. It is also a challenge to ensure the project is seen as a coherent and complete approach addressing the infrastructure problem.

Outcomes and Lessons Learned:

Outcomes

The results of the TBL-CBA suggest that the benefits of the green-gray highway design alternative are significant for the CGSM. The social and environmental benefits total nearly US \$2.7 billion over the 55-year analysis period. Approximately 70% of the benefits of the project would be derived from the ecosystem goods and services provided by mangroves, such as the more productive artisanal fishery and the carbon sequestration value. Other impacts generating strong positive economic outcomes were reduced vehicle collisions with wildlife (US \$4.3M) and reduced capital and operation expenses (US \$329M) of the green-gray highway compared to a gray conventional design.

Lessons Learned

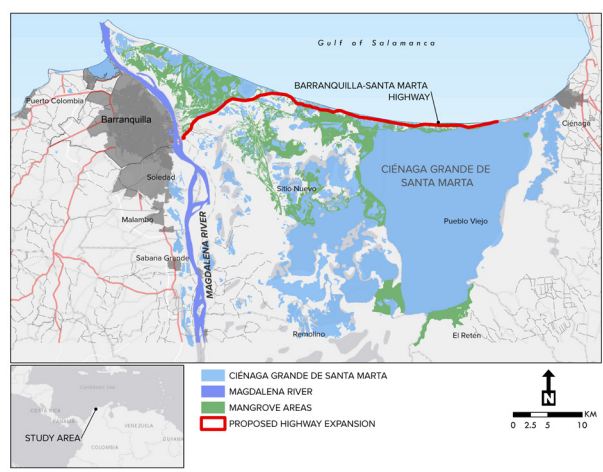
- *Political / governance impediments:* Keeping all stakeholders informed on the project status and results in a timely manner ensures that everyone is on the same page, and also provides a space where questions can be clarified and concerns understood.
- *Lack of environmental priority criteria for development projects:* Active participation of stakeholders in the various processes is needed to ensure environmental concerns are being considered and addressed. Additionally, it is important to build public awareness of the implications of the proposed project, since outcomes are not yet realized.

Net Present Value Over 55 Years Discounted at 3% (\$ Million)			
	Expected	Min	Max
Life Cycle Cost Analysis	\$329.0	\$320.6	\$337.4
Artisanal Fisheries	\$1.1	-\$17.8	\$15.8
Mangrove Carbon Sequestration	\$484.5	\$172.6	\$915.7
Mangrove Ecosystem Services	\$2,179.8	\$23.9	\$7,885.6
Reduced Vehicle-Wildlife Accidents	\$4.3	\$3.5	\$5.0

Results of the Triple Bottom Line Cost-Benefit Analysis

For Further Information:

- [Sustainable Infrastructure: Avoiding Environmental Impacts and Investing in Nature webinar recording \(starting at 31:31\)](#)
- [Conservation International’s Green-Gray Infrastructure Program](#)
- [United Nations Environment Programme. \(2021\). International Good Practice Principles for Sustainable Infrastructure. Nairobi](#)
- [The Global Green-Gray Community of Practice](#)



Map of the CGSM

