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CASE STUDY
Flood Planning and Coastal Resources

MAY 2008
LA CIEBA, HONDURAS

This study is of particular relevance to those engaged in:

- *Urban water and sewer planning;*
- *Urban flood management from storm surges or river flooding; and*
- *Reducing coastal erosion.*

BACKGROUND

La Ceiba is a city of over 150,000 people on the northern coast of Honduras. It is situated between the Caribbean Sea, Nombre de Dios Mountains, and the Cangrejal River. La Ceiba and the surrounding mountains receive a considerable amount of precipitation (1.5 m annually), and the city and its river are subject to frequent flooding events. Because it is situated in a low lying coastal area exposed to hurricanes, La Ceiba is also particularly susceptible to storm surges. Hurricane Mitch, the most severe storm known to have hit the region, deposited 0.88 m of rainfall in one week,[1] flooded two-thirds of the city, and had severe impacts on lives and infrastructure. La Ceiba has strong but largely untapped potential as a tourist destination, due to its easy access to both the Caribbean, and excellent outdoor recreation opportunities in nearby Pico Bonito National Park. It is also economically important as the administrative hub for the Standard Fruit Company, a major exporter for Honduran agricultural products.

DEVELOPMENT CHALLENGE

To improve economic growth while protecting lives, property, and the environment from climate-sensitive environmental stresses such as storm surges and flooding.

CORE PROJECT

Manejo Integrado de Recursos Ambientales – Integrated Management of Natural Resources (MIRA) is a USAID sponsored project working in 12 of 21 watersheds in Honduras. One of the focal areas is La Ceiba, where the goals are to improve watershed and natural resource management, while stimulating economic growth. At the time of this case study, MIRA was in the early stages of design and implementation.

ADAPTATION OBJECTIVE

To develop infrastructure and strategies to address the city's serious urban drainage and flooding problems, which are expected to worsen due to climate change and lack of action.

1. National Hurricane Center Report on Hurricane Mitch, revised May 4, 2000.

FOLLOWING THE STEPS IN THE USAID ADAPTATION GUIDANCE MANUAL

STEP 1: SCREEN FOR VULNERABILITY

Preliminary assessments, specifically the observation of frequent serious urban flooding events, indicated that the MIRA project was vulnerable to the impacts of climate variability.

STEP 2: CONVENE STAKEHOLDERS AND DEVELOP A PLAN FORWARD

In workshop discussions, stakeholders from federal and municipal government, the business community, NGOs, and the consulting community agreed that climate change could pose serious risks to La Ceiba. Stakeholders asked Stratus Consulting (who managed this pilot study) to evaluate potential climate change impacts in 50 years, on La Ceiba and the surrounding community. Stratus was asked to provide adaptation recommendations that would take into account both economic and environmental needs, particularly in regard to addressing problems of coastal development, urban drainage, and upstream land management. (This varies from the guidance in the manual, which recommends that stakeholders themselves help in identifying adaptation options.)

STEP 3: ANALYSES

The analysis addressed several issues.

Change in climate by 2050 was analyzed by Stratus Consulting with advice from Tom Wigley of the National Center for Atmospheric Research.

Changes in temperature, precipitation, and hurricane intensity were estimated for several different climate scenarios, which were based upon different levels of greenhouse gas accumulation and climate sensitivity. Further technical details are available on the CD accompanying the adaptation manual.

It was projected that by 2050 temperature (+1.5°C, range: 0.8-2°C), the frequency of intense precipitation events (+11%, range: 6-13%),[2] precipitation during hurricanes (+17%, range: 8-25%), and hurricane maximum wind speed (+6%, range: 3-8%) would all increase, relative to 1990 levels.

The likely impact of sea level rise and storm surges on coastal resources was analyzed by Julio Cardini of Serman & Associados of Buenos Aires, Argentina, with advice from Dr. Julie Richard and Dr. Robert Nicholls, of the University of Southampton. This team also identified strategies to protect coastal resources.

Sea level was projected to rise 20 cm (range: 6-60cm) by 2050, relative to 1990 levels. The area with the highest risk of flooding was the rapidly developing region between the Rivers Danto and Bonito. Additionally, the area near the port was also at risk for coastal flooding. Parts of downtown La Ceiba had the largest number of people at risk and also risked damage to infrastructure, such as a downtown boardwalk project currently being planned.

Possible adaptation strategies suggested by the analysts included: protecting and reestablishing natural defenses such as sand dunes and vegetation, limiting development near the coast in currently undeveloped areas, relocating current infrastructure as necessary, putting structures on stilts utilizing sand pumping to protect against erosion, and building breakwaters or sea walls.

Infrastructure needed to protect against flooding was analyzed by Dr. Castaneda of UNITEC in Tegucigalpa, Carlos Quiroz – an independent consultant, and Dr. Ken Strzepek from the University of Colorado.

River runoff was analyzed for both Hurricane Mitch, and for frontal systems resulting in heavy rainfall (of a magnitude expected only once every 50 years). Hydraulic analysis indicated that the existing plans for the levees could probably handle runoff for a hurricane of Mitch's intensity, which was category 5 prior to landfall, diminishing to category 1 on land. However, under projected conditions of more intense frontal systems with heavier rainfall, the planned levees were likely to be insufficient.

Additionally, the city lacks a storm sewer system and many natural drainage paths have been blocked, so even low intensity rainfall events can result in flooding and pools of standing water forming in the streets. The cumulative

2. Note that climate models tend to project a decrease in annual precipitation for Central America.

impact of these low intensity events on income, quality of life, and health is of as much concern as the less frequent but more intense storms. A subterranean drainage system with portable pumps to remove water was proposed as a solution to the frequent flooding the city currently experiences. Possible adaptations for coping with stronger 50 year rainfall events included raising the planned levees by one to two meters, and rehabilitating blocked natural drainages to divert high flows. Adaptations for addressing the problem of very extreme events, such as stronger hurricanes, included a high sea wall combined with pumps to clear water, higher levees, and placing buildings on stilts.

STEP 4: SELECT COURSE OF ACTION

Stakeholders evaluated the suggested adaptations and decided that some, such as the sea wall, were unacceptable because they could have a negative economic impact on the growing city. The stakeholders also suggested additional nonstructural adaptations such as enhancing the existing flood warning system, improving environmental awareness, and stopping deforestation. A proposed hydropower dam was also discussed, but the consultants indicated that it was unlikely to be adequate to prevent flooding from major storms, and that it would probably lead to further erosion by trapping sediments which would otherwise be deposited downstream.

Stakeholders decided that improving urban drainage was their highest priority, because of the frequency of this problem and its impact on economic development. However, concern was also expressed about the cost of installing an urban drainage system. To address Cangrejal flooding, the favored approaches were raising the levees, improving the flood warning system, and reducing deforestation. The best solution for coastal protection was thought to be employing sand pumping in developed areas, and limiting development in currently undeveloped areas. However, there was disagreement over how to balance this objective against promoting economic growth.

STEP 5: DEVELOP IMPLEMENTATION PLAN

Funding for the MIRA project was reduced to below anticipated levels, and much of the urban infrastructure work, including the planned boardwalk, was eliminated. MIRA is currently implementing improvements in micro-watershed management, disaster preparedness and response, and local governance and environmental policy.

Consequently, adaptations are not yet underway, and other sources of funding are being investigated.

OUTCOMES

1. Change in local perceptions: This project had a major impact on local perceptions of the need to consider climate variability and change during development planning activities. USAID work was featured three times on local television, and Ken Strzepek has presented results of this study to relevant governmental ministries in Tegucigalpa. The mayor of La Ceiba, who had little prior familiarity with climate change issues, has expressed a strong desire to implement appropriate flood control measures, and has given impassioned speeches about the significance of this problem.

2. Development of high quality data: The stream flow data obtained during this project indicates that La Ceiba is at much greater risk of flooding than previously believed. High quality information, such as this, is necessary for the development of an appropriate adaptation plan.

3. Identification of ways in which USAID can help La Ceiba cope with its problems of flooding and urban drainage include:

a) Working with disaster management officials to develop a risk management strategy;

b) Promoting zoning strategies that limit or prevent development in areas most vulnerable to sea level rise and flooding;

c) Improving risk awareness and community preparedness through measures such as a flood warning system;

d) Improving both watershed management and the opportunity for tourism by preventing further deforestation of the Cangrejal watershed; and

e) Identifying partners to help implement adaptations requiring large capital investment, such as pumping sand to protect against erosion, raising the levees, and developing an urban drainage system.

UPDATE ON RESULTS

Follow up work on this project has been carried out through the pro bono efforts of Dr. Ken Strzepek and some of his students from University of Colorado. As part of a water resource planning and design class, students examined design options for levees for the Cangrejal River, and concluded that the most cost effective approach would be to build levees which could be raised in the future. Other students examined design options for a storm water management system capable of resisting 10 year floods now, and in 2050.

At this point considerable planning has been done, and the remaining obstacle is obtaining funding to implement appropriate adaptation measures. The next step is to identify partner organizations that have overlapping interests, and can support implementation activities.

LESSONS LEARNED

1. Backup plans for funding or involving multiple funding partners from an early stage would facilitate implementation. It was originally expected that the MIRA project would be able to follow up on the results of this study, but its budget was cut, and it was not immediately clear who might be able to step in to fill this role.
2. A small additional amount of money ($5,000 to $10,000) would allow for direct follow up engagement with local parties and potential partners who might be interested in implementing adaptations identified by this pilot.
3. Local advocates are critical to project success. Peter Hearne from the USAID Mission, Pepe Herrero of the MIRA project, and now the Mayor of La Ceiba, have acted as local champions of this issue.

QUESTIONS TO CONSIDER AS YOU THINK ABOUT ADAPTING SIMILAR PROJECTS

Current Obstacles to Development

1. To what extent do coastal and river flooding threaten lives and property?
2. Are natural barriers to flooding, such as vegetation and dunes, being lost?
3. Who makes decisions about development planning of coastal or riverside lands that are subject to the most extreme flooding? What data and other considerations are used in making these decisions? Is it feasible to shift development so as to protect these areas?
4. How much lead time do you currently have to prepare for approaching storms? Would it be feasible to obtain and disseminate relevant information sooner?

Observation of Change in Climate

5. Has the frequency, magnitude, or timing of precipitation changed in the last several decades?

Impacts of Climate Change

6. Has the frequency and magnitude of flooding changed in the last several decades?
7. Does flooding appear more severe in regions where natural barriers have been destroyed?

Sources of Advice, Support, and Training

8. Where do you currently get information about approaching storms? How is this information distributed throughout the local community, and could it be distributed more effectively?
9. Is environmental information utilized in the design, engineering, and planning of infrastructure projects? If so, what are the sources of this information?

Current Coping Strategies

10. What practices are currently employed to improve drainage, reduce flooding, or reduce flood damage? Who is responsible for developing and implementing such measures? How effective are these measures?

For more information on Honduras, visit: http://www.usaid.gov/hn/

For a copy of the USAID Adaptation Manual, visit:
http://www.usaid.gov/our_work/environment/climate/docs/reports/cc_vamanual.pdf