

Chapter 7.

Best Management Practices

Introduction

Because of its complexity, addressing Guam's erosion-sedimentation problem presents numerous challenges, including a lack of information and public understanding of the issues, and a shortage of financial resources. Coupled with local governmental apathy, these challenges make successfully mediating this significant environmental threat difficult. Any efforts to reduce erosion-sedimentation impacts need to be cognizant of the challenges, or success will be highly unlikely. This limits the strategies to relatively small-scale efforts that must mediate the most immediate and severe problems until public and government involvement can be increased. Until the seriousness of the environmental degradation and the magnitude of the problem is fully realized by the public and their elected representatives, long-term solutions to this problem will be unattainable.

This project has demonstrated that erosion and nearshore sediment loads are at a sufficiently high level to raise concerns for the long-term health and persistence of Guam's terrestrial savannas and its nearshore coral reefs ecosystems. Effective watershed management is the only way to achieve long-term reductions in these environmental impacts.

This chapter will propose several Best Management Practices (BMPs), weighing their overall environmental effectiveness, cost, likelihood of successful implementation given the cultural and political state of the island, and the time frame for success. Two categories of BMPs will be discussed: 1) those that address marine sedimentation; and 2) those that discuss upland erosion.

Materials and Methods

BMPs were brainstormed, developed, investigated, and ranked in five categories: 1) The level of environmental effect the BMP would have on reducing erosion or sedimentation; 2) the cost of implementing and maintaining the BMP; 3) the technical difficulty in implementing the BMP; 4) the local political will to support the BMP; and 5) the public will to support the BMP. All categories were ranked as low, medium, or high. Based on the rankings in the five categories, an overall score could be developed to suggest a possible priority ranking for implementation.

Results and Discussion

Guam is a developing island territory, and as such has often placed its environmental health behind its economic growth. Since the 1980s tourism has become the primary economic force on the island, with over 1 million tourists visiting each year. To stay competitive in the tourism market, however, requires continued "improvements" to distinguish Guam from other tropical Pacific Islands. In the drive to improve Guam as a "product," environmental concerns often become of secondary importance. This was

especially true during the Asian recession in the 1990s, when fewer Asian citizens were traveling, and Guam found itself competing for tourism dollars with other tropical destinations such as Hawaii, the Commonwealth of the Northern Mariana Islands (e.g. Saipan), Palau, Indonesia, and southeast Asia. As a result, the general political mindset on the island has drifted away from environmental stewardship and toward market forces.

The public's understanding of Guam's environmental issues is also limited. The environmental issues facing Guam are complex, and the composition of Guam's population raises unique challenges. Guam has many citizens from other Pacific islands, many of who do not speak English as their first language and who were raised with a different environmental ethic.

Educating lawmakers and the general public about Guam's environment and the impact of humans is the most important need for the island. Without education, many of the proposed BMPs will not have the political or public support necessary for them to succeed.

Sedimentation BMPs

The only way to fully address Asan's coastal sedimentation issue is to reduce soil erosion and/or soil transport. Any BMP that does not directly reduce soil erosion must be considered a short-term, stopgap measure. The data from this study suggest that Asan's coral reefs evolved under sediment conditions that were 20% of their current load. The ability to achieve this level of success is minimal given the current conditions of the watershed. To return to these pre-human sediment levels, all of the Asan sub-watershed would need to be converted to forest, a state that is unlikely to happen. The landscape, due to centuries of human activity may no longer be able to support the pre-human environment. Therefore, the goal of managers should be to reduce sediment inputs as much as possible, and a combination of actions that reduce upland erosion and divert sediment that is being transported to the ocean will be necessary. Reducing upland erosion is discussed in the next section. Diverting sediment can be accomplished with two types of BMPs: 1) those that trap and remove sediments and 2) those that slow the flow or reduce the amount of water moving through the watershed.

The sediment dynamic model developed in Chapter 6 provides guidance for developing tenable BMPs. BMPs to mediate sediment transport should focus on Asan's primary point sources, including the Asan River and the drainage pipe along Route 1 on the eastern edge of the watershed. Efforts should be of a suitable magnitude and timed so that their greatest effect occurs at the start of the wet season, when sediment load are at their highest. Ten BMPs (Table 7-1) were developed to address sedimentation issues in the Asan watershed. These could easily be generalized to other locations on Guam.

Education about coral reefs and sediment impacts ranked as the number two BMP. Success with this BMP is necessary to achieve success with many of the other BMPs, which ranked low primarily because of the lack of public and political will (i.e., ponding basins, green roofing, etc.), which is directly correlated with their understanding of the issues and threats.

Not surprisingly, BMPs that would have the largest environmental effect (e.g. sediment basins, ponding basins) also required the greatest monetary investment. The structures require considerable engineer expertise, would most likely necessitate the

Table 7-1. BMPs to reduce sedimentation on Asan’s coral reefs. All BMPs have been ranked as a High, Medium, or Low for environmental effectiveness, cost, difficulty to install and maintain, political will to support, and public will to support. Total score is derived from assigning a rank to each of the five categories as follows: For the Environmental effectiveness, Political will to support, and Public will to support H=5, M=3, and L=1; For Cost and Difficulty to install and maintain H=1, M=3, and L=5.

BMP	What it is/What it does	Environ. Effect	Cost	Difficulty	Political Will	Public Will	Total Score
Rainwater Catchment	Installing catchment systems on all buildings in Asan would capture storm water before it entered streams and other drainages. Because of the watershed’s steep terrain, land runoff could b captured in a large municipal tank for use as an emergency water supply. This has the additional benefit of providing water to the village.	M	L	L	M	H	21
Sedimentation Education	Educate the public on the impacts of sedimentation on Guam’s coral reefs. Use education to highlight the environmental damage in a meaningful way to the public (e.g., declining coral reef impacts on fisheries) teach about ways to reduce runoff and sedimentation.	M	M	H	L	L	17
Permeable surfaces	All paved surfaces could be replaced with permeable materials or re-paved using techniques that enhance permeability. This would slow runoff water in urban areas and reduce laminar sheet flow. Less water would enter the drainage system	M	M to H	L	M	M	15-17
Install Asan River Sediment Basin	A sediment basin at the mouth of the Asan River would slow water movement and collect sediment. Basin would need continual maintenance dredging that should be conducted at the end of the dry season. Finding a suitable area to create the basin might be problematic.	H	H	M	M	L to M	13-15
Re-channel storm drainage on Rte. 1	The drainage system on Rte 1 near Adelup Pt. should be re-designed so that water does not cascade down the cliff and directly into the ocean. Water should be channeled in a permeable canal to a sediment basin. Basin would need continual maintenance dredging that should be conducted at the end of the dry season.	L	M to H	L to M	M	M	11-15

Table 7-1. (continued)

BMP	What it is/What it does	Environ. Effect	Cost	Difficulty	Political Will	Public Will	Total Score
Green Roof	Installing environmentally friendly green roofs slow runoff waters in urban areas and reduces laminar sheet flow. Less water enters the drainage system from Asan Village	L	L to M	L	L	L	11-13
Ponding basins	Ponding basins are essentially sediment basins but they would be installed at various locations within the watershed, where ever topography is appropriate. These slow the movement and collect sediments. These would require maintenance dredging	H	H	M	L	L to M	11-13
Remove impermeable channels	Rip-rap and concrete lined drainage ditches should be replaced with permeable (e.g., green) surfaces. Storm drains should be replaces with green filters systems to slow the transport of rainwater. Systems should be developed to be effective with large storm events	M	H	H	L	L	9
Create wanders in Asan River to slow water flow	Engineer additional bends in the Asan River to slow water movement and allow sediment to settle before reaching ocean. Needs to be used in combination with the sediment basin which would need continual maintenance dredging that should be conducted at the end of the dry season.	M	H	H	L	L	9

acquisition of private land, and would require continued, probably yearly, maintenance. In the island's current economic state, these BMPs are unlikely to occur.

Erosion BMPs

This research has shown that addressing erosion rates in badland areas can reduce the watershed sediment loss by as much as 17% and that by restoring badlands and stopping anthropogenic fire, the soil loss rates can be reduced by 25% (Chapter 6).

Several techniques exist to address badland erosion, but few viable long-term options exist for War in the Pacific NHP. While short-term solutions, such as coconut fiber mats and anti-erosion cloth, have been used in the past by other agencies, but the National Park Service and the island are seeking a long-term solution to badland erosion. The Guam Division of Forestry is currently undertaking a large forest restoration project focused in the Ugum watershed. However, their use of invasive exotic *Acacia* trees runs counter to the ideals of the National Park Service, which would rather see native vegetation returned to the park's and the island's badland areas. While GFD has had some success transforming the exotic *Acacias* to native forest, the results of their efforts will not be known for many years. The National Park Service will endeavor to develop a more appropriate long-term solution that fits better with its mission.

Without addressing the ultimate causes of badlands, long-term solutions will remain illusive. This project has shown that wildland fire contributes to increased soil erosion and may be responsible for savanna conversion to badland. While other factors (e.g. soil characteristics, mass wasting events, etc.) contribute to badland formation and/or increased erosion, wildland fire is an anthropogenic disturbance that can be addressed. However, this highlights the importance in having viable, affordable options to restore badland areas when they development by natural mechanism.

Reducing anthropogenic fire on Guam will be a long and difficult process. Fire has become an integral part of the local culture, particularly among game hunters, and while local laws exists criminalizing wildland arson (9 GCA §34.20), fire use has not slowed. Enforcement and prosecution are sporadic at best.

While the widespread application of fire is probably the most significant, chronic anthropogenic impact in Asan – and will be the focus of these BMPs – other anthropogenic activities, including off-road vehicle use and poor construction practices, also contribute to soil erosion and should be addressed. Eleven BMPs (Table 7-2) were developed to address fire and erosion issues in the Asan watershed. These BMPs could be generalized to other locations on Guam.

Once again education ranked out as one of the top priority BMPs. Successfully implementing this BMP is crucial to the success of other BMPs. Several enforcement BMPs ranked high. Guam has many environmental regulations in place, but these are poorly enforced primarily because of the lack of political will and funding for a sufficient number of appropriately trained enforcement officers. On Guam, enforcement fails at many levels, but most significantly, failure occurs at the prosecutorial and judicial level. Environmental crimes are not considered as important as other crimes and are often not prosecuted or are dismissed. This attitude can only change with education.

Table 7-2. BMPs to reduce erosion and soil loss in the Asan sub-watershed. All BMPs have been ranked as a High, Medium, or Low for environmental effectiveness, cost, difficulty to install and maintain, political will to support, and public will to support. Total score is derived from assigning a rank to each of the five categories as follows: For the Environmental effectiveness, Political will to support, and Public will to support H=5, M=3, and L=1; For Cost and Difficulty to install and maintain H=1, M=3, and L=5.

BMP	What it is/What it does	Environ. Effect	Cost	Difficulty	Political Will	Public Will	Total Score
Fire Education	Educate on the impacts of fire, highlighting the environmental damage in a way meaningful to the public and lawmakers. This may convince the public to stop setting fires, to support other BMPs, or to seek legal action against those that burn. Eliminating all fires would lower erosion by ~7%.	M	M	H	L	L	17
Reforestation	Convert badlands to forest. GFD is currently attempting this in the Ugum watershed. This is a long-term project. Converting to Acacia trees is not a viable option for the National Park. Restoration of all badlands in the Asan sub-watershed would lower soil loss by ~18%. This is a long-term solution to badland erosion.	H	M	M	M	M	17
Enforcement of construction Regulations	Developer and contractors are required to use environmentally sound practices, such installation of sediment fences. These regulations are often ignored and are poorly enforced. Enforcement to ensure compliance would reduce erosion associated with construction sites.	L	L	L	L	H	17
Restore Burned Savanna	Using well-established, fire rehabilitation techniques, burned areas can be treated to reduce erosion rates and restore vegetation. While not a long-term solution to burning, this BMP would lower erosion rates associated with the burned savanna.	M	M	L	L	H	17
Coconut fiber/Erosion cloth	Install erosion cloth over burned and badland areas to reduce soil erosion. This technique has been used with limited success to reduce erosion in the Fena Watershed. This is not a long-term solution to badland erosion	L	L	L	L to M	L to M	13-17

Figure 7-2. (continued)

BMP	What it is/What it does	Environ. Effect	Cost	Difficulty	Political Will	Public Will	Total Score
No wet season building	Erosion is highest during the wet season. Activities that remove vegetation or break ground should not be permitted to occur during the wet season. Construction permits should not be issued for any project that disturbs soil with a start between June and December.	L to M	L	L	L	L to M	13-17
Put out all fires	All fires will be aggressively pursued and extinguished. This will reduce the area of burned savanna and lower watershed soil loss by ~7%.	M	L	L	L to M	H	11-13
Ponding basins	Ponding basins are essentially sediment basins installed at various locations within the watershed – where ever topography is appropriate. These slow water movement and reduce the likelihood of stream bank erosion.	H	H	M	L	L to M	11-13
Install Anti-erosion Vegetation	Revegetate badlands with anti-erosion plants such as vetiver grass. Restoration of all badlands in the Asan sub-watershed would lower soil loss by ~18%. This may be a long-term solution to badland erosion.	M	M	M	L	L	11
Ban Off-Road Vehicles/Enforce	Off road vehicles contribute to erosion by destroying vegetation. Restricting the use o off road vehicles to appropriate areas would reduce their environmental impacts. Off-roading is not a significant issue in the Asan sub-watershed but it is in other areas.	L	M	M	L	L to M	9-11
Badland Restoration	Convert badlands to native savanna vegetation. Methods do not currently exist. Restoration of all badlands in the Asan sub-watershed would lower soil loss by ~18%. This is a long-term solution to badland erosion	M	M to H	H	L	L	7-9