

Conference Topic: Watershed Management

Development of a Watershed Management Plan for the Demerara Sub-Watershed in Guyana

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Introduction

The impact of climate variability (unpredictable rainfall patterns) and anthropogenic climate change and the resultant change in temperature and rainfall (for the Caribbean 7-8% decline for the rainy season, a 6-8% increase for the dry season, and a projected increase in frequency of intense rainfall by 20%¹) has drawn attention of Caribbean policy makers, water managers and civil society to water scarcity and water security issues. Moreover, water resources in the region are under constant threats due to factors such as limited size, geology and topography, plus changes and variation in climate, especially rainfall. This situation is exacerbated by the rapid rate of population growth and urbanization, growth of tourism, pollution caused by waste disposal and agrichemical, watershed degradation and bad land-use practices².

In Guyana, the urgent need for Watershed³ Management Plans in Guyana is derived from two principal factors: global climate change threats to water security identified above; and conflicting objectives of the various land-uses which already exist within the watershed. Table 1 highlights the principal threats to watersheds as perceived by key institutions.

A very crude way of establishing the level of national concern is the frequency of articulation of a particular threat by key institutions. Therefore, information provided in Table 1 seems to suggest that the threats that are of primary concern to 50 % or more of the institutions (with direct or indirect responsibility for watershed management) are:

¹ Trotz, U., 2008. The Impact of Climate Change on Water Resources in the Caribbean. Paper presented at Impact of Climate Change on Water Resources for Water Managers Workshop, September 26-28, 2009, Trinidad.

² GWP-Caribbean (2008) Impact of Climate Change on Water Resources for Water Managers Workshop Report, September 26-28, 2009, Trinidad

³ A "watershed" is defined as "the region draining into a river, river system, or other body of water above a particular point.

- Poor waste management practices by industries (sawmills, lumberyards and manufacturing firms);
- Unregulated sand, gold and bauxite mining;
- Climate Change and associated impacts such as temperature increase and flooding;
- Unplanned Expansion of human settlements (forest clearance for housing and livelihood activities, plus drilling of wells); and
- Agriculture (farming and livestock rearing) and wastes generation.

In many instances the threats that are highlighted are rooted in the existing policy and legislative framework which is currently being reviewed.

Threat 1	Climate Change and associated impacts such as temperature increase and flooding
Threat 2	Forest Fires
Threat 3	Agriculture (farming and livestock rearing) and wastes generation
Threat 4	Illegal and legal clearance of vegetation
Threat 5	Tourism
Threat 6	Unplanned Expansion of human settlements (forest clearance for housing and livelihood activities, plus drilling of wells)
Threat 7	Unregulated sand, gold and bauxite mining
Threat 8	Poor waste management practices by households
Threat 9	Poor waste management practices by industries (sawmills, lumberyards and manufacturing firms)
Threat 10	Inadequate policy and regulatory framework for proper management
Threat 11	Public misconception of and attitude towards water resources

Table I : Principal Threats to Watershed as perceived by Institutions

Threats to Watershed	Threat 1	Threat 2	Threat 3	Threat 4	Threat 5	Threat 6	Threat 7	Threat 8	Threat 9	Threat 10	Threat 11
Institutions											
OP			✓			✓			✓	✓	
EPA	✓	✓	✓	✓		✓	✓	✓	✓		
GFC	✓			✓				✓	✓	✓	✓
GSLC			✓	✓			✓		✓		
Guyana Climate Unit	✓				✓	✓		✓	✓		
Hydromet Office						✓		✓	✓		
GWI	✓						✓		✓	✓	✓
GGMC							✓		✓		
CI-Guyana			✓			✓	✓		✓		

WWF-The Guianas	✓		✓			✓	✓				
Iwokrama Centre			✓				✓				
Citizen's Initiative	✓			✓			✓				

Source: Bynoe, P. and Opadeyi, J. (2009)

Undoubtedly, there is need for a culture of prudent watershed management practices at all levels of society and the involvement of all stakeholders (civil society, farming communities, public utility companies, households etc.). Thus, a Watershed Management Plan provides a comprehensive plan for protecting and improving the watershed conditions of the delineated area, while recognising the importance of involving stakeholders. Further, the purpose of the Plan is twofold: it assesses the existing situation and provides a course of action to preserve the environment and minimize the adverse impacts of future development; as well as protects the ecosystem service which has both scared and instrumental values.

The purpose of this paper is to present a Watershed Management Plan for a pilot study area in the Demerara Sub-Watershed in Guyana. The process of developing the Plan comprised several inter-related steps, including a situational analysis of the institutional framework for water resources and watershed management in Guyana; a computer aided assessment of the water quantity and water quality of Demerara sub-watershed, and stakeholders' engagement by means of interviews and workshops. The paper will conclude with recommendations for creating the enabling framework to guarantee successful implementation of the Watershed Management Plan.

The Institutional Framework for Water Resources and Watershed Management in Guyana

Currently, there is no single policy to address effectively watershed management in Guyana. At best, a National Water Policy is being prepared; however, a cursory glance at the proposed contents of the document suggests that watershed management will not be addressed in any detailed manner. Those policies and legislation that support watershed major national documents include the following.

Table 1

Policies	Summary
National Development Strategy (NDS) (2001-2010)	The National Development Strategy includes a Chapter on Water Management and Flood Control Policies which focus primarily on structural approaches (sea defences, drainage and irrigation, Hydrometeorological Services, and the improvement of the functioning of institutions). It advocates the establishment of Water Users Associations as a means of empowering farmers to manage secondary drainage and irrigation systems in their various localities.
Poverty Reduction Strategy Paper (2005)	The PRSP focuses on several areas related to water management in an effort to reduce poverty <i>Specifically, the objectives of the Water Sector will include (i) provision of access to safe water to 95 percent of the population; (ii) establishment of a Guyana Water Company to provide economies of scale; (iii) streamlining of the activities in the Coastal Zone with emphasis on treatment of raw water.</i>
Guyana National Environmental Action Plan (2001-2005)	The NEAP states that "in order to conserve and improve the environment, the Government of Guyana will endeavour, among other things, to: <ul style="list-style-type: none"> • Conserve and use the environment and natural resources of Guyana for the benefit of both present and future generations, based on the principle of the exercise of sovereignty. • Maintain ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity and to observe the principle of optimum sustainable yield in the use of renewable natural resources and ecosystems, both on land and the sea."
National Mangrove Management Plan (2001)	In recognition of the important hydrological and other functions performed by mangrove vegetation as wetland ecosystems on Guyana's coast, the National Mangrove Management Action Plan (2001) which, among other things: i) proposes specific actions, including review of policy and legislation, as well as zonation of mangrove forest to ensure protection; (ii) identifies main facilitators of the process; and (iii) outlines indicators and establishes time-lines. The ultimate objective of this Plan is to foster a more coordinated approach in planning, policy formation, institutional cooperation and implementation of action.

Integrated Coastal Zone Management Plan (2000)	The Integrated Coastal Zone Management Plan (2000) aims at fostering a more coordinated and integrated approach to management of the coastal zone. One of the key objectives of the Plan is to promote and support sustainable development of coastal resources.
National Forest Plan (1997 and 2000)	The overall objective of the National Forest Policy is to promote conservation, protection, management and utilization of the nation's forest resources, while ensuring that the productive capacity of the forests is maintained or enhanced.
National Biodiversity Action Plan (NBAP) II (2007-2011)	The National Biodiversity Action Plan (NBAP) II (2007-2011) builds upon NBAP I, which has as its overall goal <i>“to promote and achieve the conservation of Guyana's biodiversity, to use its components in a sustainable way, and to encourage the fair and equitable sharing of benefits arising out of the use of Guyana's biodiversity.”</i> The NBAP calls for the preparation of watershed management plans, either independently or part of current required plans, such as forest management plans.
National Action Plan for Combating Land Degradation (2006)	The National Action Plan for Combating Land Degradation (2006) outlines the following actions: promote and support sustainable management in forest and mining; restoration and protection of biodiversity and watersheds in collaboration with relevant agencies; undertake a groundwater situation analysis including an assessment of salt water intrusion; undertake a study and situation analysis of both coastal and hinterland surface water systems; expand the Water User's Association and their role in management; among other things.
Guyana Climate Change Action Plan (2001)	The Guyana Climate Change Action Plan outlines strategic measures to be taken to respond to the threat of climate change on water resources. These water conservation measures are expressed as metering, the use of time-runs where the water supply may be staggered according to regions or sectors in the domestic/industrial sector; cautious development of new artesian wells in the interior regions for anticipated population migration from the coast; introduction of efficient control and management practice for water reservoirs network

Overlaps and duplications are common characteristics of the existing policies that relate, to some extent, to watershed management. The overlaps and duplications, coupled with inadequate institutional capacity, have affected the implementation process. Moreover, watershed management is best considered as an ‘add’ on’ issue to many of the policies.

Table 2

Legislation	Summary
Water and Sewerage Act (2002)	The Water and Sewerage Act (2002) allows for the introduction of national water standards and a National Water Council to spearhead the water resource management policy. Specific issues covered are water supply and connection, water regulations, wastewater and sewerage matters, drought orders and 1

	hydrometeorological matters.
The Environmental Protection Act (1996)	The Environmental Protection Act (1996) is an umbrella legislation that mandates the undertaking of a number of measures to safeguard the environment and its resources, including water resources.
Mining (Amendment) Regulations (2005)	The Mining (Amendment) Regulations (2005) seek to prevent actions that lead to the contamination of rivers, creeks and other waterways affecting various life-forms. These actions encompass mercury use, mine reclamation, mine effluents, contingency planning, mine waste and tailings management.
East Demerara Water Conservancy Act (1998)	The East Demerara Water Conservancy Act (1998) seeks to establish the East Demerara Conservancy Board for the purpose of making better provision for the supply of water, and to provide for the management of the Conservancy through the establishment of a Board of Commissioners.

There is definitely a need to harmonise the various pieces of legislation that govern the extraction, use, conservation of water resources. The current fragmented approach to the enactment of legislation undermines the effectiveness of enforcement measures. A clear example is the Environmental Protection Act of 1996 which overlaps with other pieces of legislation that existed before.

The key challenges posed to watershed management in the study area may be highlighted as:

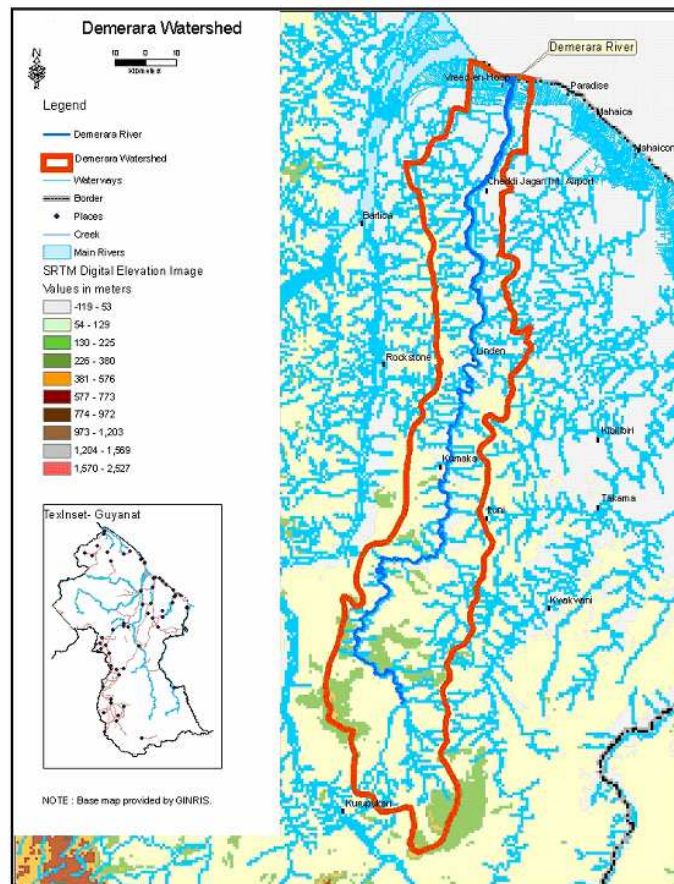
- Harmonisation of Policy and Legislation;
- Establishment of technical scientific body and NOT create another institution;
- Capability building in terms of human, financial and material resources;
- Enforcement of Legislation/Compliance;
- Internal Migration;
- Livelihood Activities; and
- Change of Public Perception and Attitudinal and Behavioural Change

The Context: Demerara Sub-Watershed

The pilot study area (referred to as the Demerara Sub- Watershed) extends on both sides of the Soesdyke/Linden Highway; its northern boundary extends from Kuru Kururu to its southern boundary at the right bank of Moblissa Creek, its western boundary lies on the right bank of the Demerara River and the eastern boundary is the boundary of the watershed of the Mahaica River.

The Area encompasses seven (7) major settlements (Soesdyke, Waikabra, Kuru Kururu, Timehri, Yarrowkabra, Kuru Kuru, Long Creek, and Moblissa) and 18 small communities (Hauraruni, Low Wood, Sans Souci, Jalousie, Susannah Rust, Teddington, Endeavour, Warida, Vryheid, Uitspa, Loolands, Dora, Clem Wood, York, Elizabeth, Kairuni, Adventure and Dalgin) with a total area of one hundred and sixty-six thousand, seven hundred and twenty acres (166,720 acres) or sixty seven thousand, four hundred and sixty-nine hectares (67,469 hectares); occupied by approximately 10,000 people.

Figure 1: The Demerara Watershed

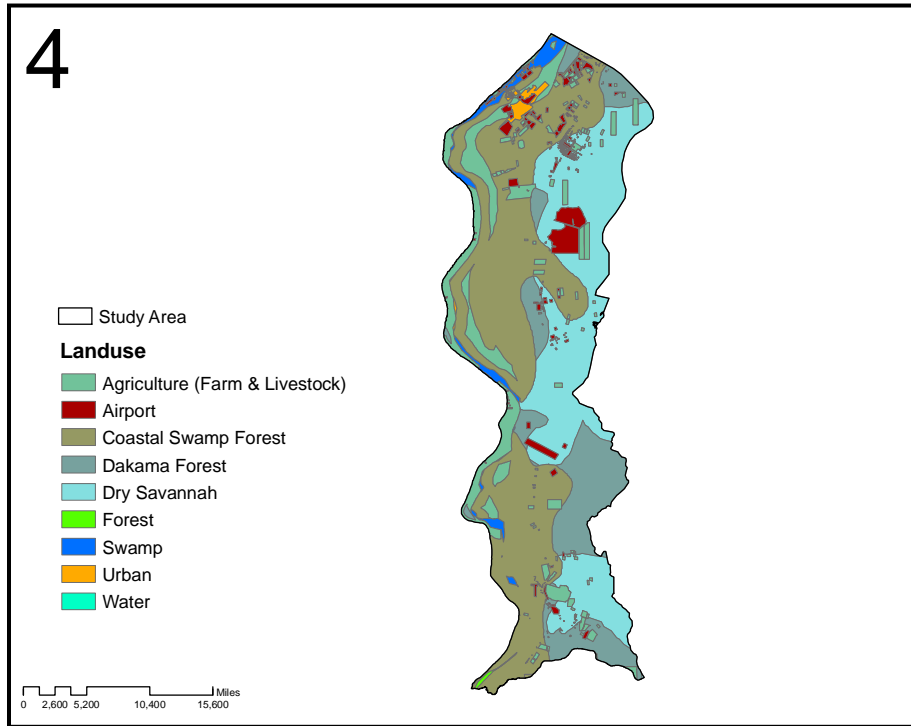


The land cover of the Soesdyke/ Linden Highway Area is dominated by dakama forests, muri scrub/ white sand savannah, open swamps and swamp forests. The land tenure of the Planning Area comprises of eighty four percent (84%) state lands and sixteen (16) percent private lands.

The main land uses were observed as: forestry, sand mining, and farmsteads and homesteads, eco-tourism facilities and timber extraction. Agriculture is characterized by diversified crops

cultivated in small and medium scale, with some large scale operations. Intensive livestock rearing consists mainly of cattle and pigs for meat, and poultry for meat and eggs.

Figure .2: Land Cover of the Pilot Site



The main settlements are designated as homesteads and farmsteads in order to facilitate farming and living in proximity to farm areas. Residential lots are used for primarily residential purposes and the likewise the same with agriculture. Some residents use the residential lot for their homes and farming practices with poultry, pig farming or cattle, while some farm crops and fruits. This organized arrangement is consistent throughout the Planning Area with the exception of areas where squatting has disrupted the pattern. Notably, an increase in the settlement of residents over the years has been the result of the development of physical and social infrastructural, ease of transportation, and the desire to practise farming.

Ecotourism activity (water-based tourist resort and tourist facilities) is quite established in the sub-watershed area, particularly in the northern section of the sub-watershed. It is fair to say that this part of the country has a dense pattern of ecotourism resorts, due partly to the ease of access from the city and the presence of creeks and natural vegetation.

Sand mining or extraction is more predominant than loam, being utilized for building and other infrastructure construction, while forestry land use is of two kinds, extraction concessions and natural reserves.

Industries are mainly wood based processing, poultry processing and juice processing. The wood based industries are lumberyards and sawmills.

Results of the computer aided assessment (SWAT Model)⁴ of the water quantity and water quality of Demerara sub-watershed revealed that the Demerara sub-watershed has produced some very interesting results as detailed in earlier subsections. Whereas the majority of the watersheds have very little human interaction, the significant sediment flow in some of the watershed should be of concern.

The hydrology of the Demerara sub-watershed is relatively stable over the period of assessment 2003-2008. Water percolation showed no significant difference in all the basins. Surface runoff that contributes to stream flow ranges between 28 and 954 mm H₂O in all the basins. Groundwater contribution to stream flow is relatively stable and so is water yield. The average daily stream flows is balance between the in-flow and out-flow of all the basins.

In terms of water quality, the following basins show notably high sediment yield: Madewini, Haurauni, Haia, and Warida. Warida has the highest sediment yield. Organic nitrogen yield is significant in the following basins in increasing order of magnitude: Kairuni, Haurauni, Madewini, Warida, Moblissa, and Loo. Organic phosphorus is relatively high in Warida and Moblissa basins. With the exception of Warida basin which showed significantly high sediment retention, the in-flow and out-flow of sediments is relatively balanced in all the basins.

The assessment of the Demerara sub-watershed has revealed that there are four main issues:

- Maintaining water percolation (PERC) ;
- Managing surface runoff contribution to stream-flow (SURQ);
- Decreasing sediment flow (SYLD); and
- Deceasing nutrient loads (Organic Nitrogen (ORGN) and Organic Phosphorous (ORGP)).

Development of a Watershed Management Plan for Demerara Sub-Watershed

The Watershed Management Plan can be described as the most logical ‘blueprint’ for planning optimal development of water resources at various levels, and essentially, involves interventions at five levels, namely: rainwater harvesting, ground water recharge, maintenance of water balance, preventing water pollution, and economically rational use of water resource. It adopts a holistic approach and underscores the need for integration between land, water and biomass, and importantly, the participation and collective action of local people.

⁴ SWAT is an hydrology model that assesses weather, surface runoff, percolation, evapo-transpiration, transmission losses, ground water flow, nutrient and pesticide loading, water transfer etc. etc it can be used to: (i) predict long term impacts in large basin,; (ii) time agricultural practices within a year; and (iii) simulate at basin scale water and nutrient cycle in landscapes whose dominant land use is agriculture. .

The process of developing a WMP for the Demerara Sub-watershed area can be described as inclusive and involved the hosting of a two day training workshop on watershed management and a follow-up stakeholder consultation meeting. Participants were drawn from the seventeen (17) institutions listed below.

- Civil Defence Commission;
- Environmental Health Unit, Ministry of Health;
- Environmental Protection Agency;
- Guyana Forestry Commission ;
- Guyana Geology and Mines Commission;
- Guyana Lands and Survey Commission;
- Guyana Shields Initiative;
- Guyana Water Incorporated;
- Hydrometeorological Division, Ministry of Agriculture;
- Iwokrama International Centre for Forest Conservation and Development;
- Ministry of Local Government;
- National Agriculture Research Institute;
- National Drainage and Irrigation Authority;
- Regional Democratic Council, Region #4;
- School of Earth and Environmental Sciences, University of Guyana;
- United Nations Development Programme (Georgetown Office); and
- Wildlife Division, office of the President.

These events allowed for meaningful exchange of views, ideas and experiences between various stakeholders at different levels and collective decision making on the specificities of the WMP. The results are outlined briefly below.

Vision Statement

Fostering water secure community development through the sustainable and integrated management of watershed resources by the year 2020.

Improvement Goals and Management Objectives and Principles

The following watershed goals were developed during the Watershed Modelling and Management Training Workshop held in April 2009. The goals are identified under four major

headings: hydrology; physical habitat, water quality; and biological communities. The table below specifies each goal and identifies a number of related objectives. The objectives are regarded as those desired changes in the watershed conditions and functions and are based on the information provided in Section 2 of this Report, in conjunction with feedback from the key stakeholders.

Table 3

IMPROVEMENT GOALS	MANAGEMENT OBJECTIVES
Hydrology	
Maintain water percolation	To protect rainfall interception areas and reduce areas to reduce surface run off To sustain high rates of infiltration into the soil. To maintain relatively slow stream flow response to precipitation
IMPROVEMENT GOALS	MANAGEMENT OBJECTIVES
Maintain the integrity of the aquatic ecosystems	To reduce unplanned land use activities and excessive and inappropriate development in the watershed To maintain the linkages among the aquatic ecological systems (for the basins) within the watershed
Preserve the quantity at levels compatible with demand and supply regarding the multiple uses	To maintain natural drainage patterns and local ground water recharge conditions To manage surface run off contribution to stream flow
Manage surface run off contribution to stream flow	To reduce slash and burn activities within the watershed To ensure that sedimentation of aquatic systems (particularly from mining activities) is kept to a minimum.
Bio-Physical Habitats	
Restore the environment	To encourage and support reforestation and backfilling of mined out areas To reduce sediment load from upland sources; improve riparian vegetation, and limit livestock access to stabilize stream banks
Reduce land degradation ⁵	To manage agricultural, mining and forestry practices
Protect, enhance, manage and restore aquatic and terrestrial species and biological communities	To improve and maintain biodiversity in the watershed To maintain forest cover

⁵ Land degradation generally signifies the temporary or permanent decline in the productive capacity of the land (UN/FAO definition). Another definition describes it as, "the aggregate diminution of the productive potential of the land, including its major uses (rain-fed, arable, irrigated, rangeland, forest), its farming systems (for example smallholder subsistence) and its value as an economic resource." The emphasis on land, rather than soil, broadens the focus to include natural resources, such as climate, water, landforms and vegetation.
Source: http://www.unu.edu/env/plec/l-degrade/D-Ch_2.pdf

	To maintain the health of wetland ecosystems for example mangrove forests
Water Quality	
Preserve the water quality of source waters within the watershed	<p>To identify legal constraints and possibilities</p> <p>To reduce sedimentation runoff into watershed from human activities such as mining and agriculture</p> <p>To reduce phosphate runoff into watershed from human domestic activities</p> <p>To prevent aquatic ecosystem disturbance from tourism related activities</p> <p>To prevent wastes generated by chicken farms from entering into watershed</p>
Minimize or mitigate non-point source pollution of both surface and groundwater in the watershed	<p>To manage the sources and transport of untreated waste water , hazardous or other industrial wastes, as well as nutrients to limit ground and surface water contamination</p> <p>To reduce erosion and sedimentation from human activities</p> <p>To manage/decrease nutrient load to receiving waters</p>
IMPROVEMENT GOALS	MANAGEMENT OBJECTIVES
Protect and improve surface water and groundwater quality to protect public health and support biological communities.	<p>To reduce sediment loads from upland sources</p> <p>To improve vegetative cover</p> <p>To ensure plant and animal communities are kept within their carrying capacities</p>
Conserve and protect critical habitats within the watershed	<p>To maintain or improve critical habitats through conservation easements and other land protection measures</p> <p>To maintain buffer zones</p> <p>To implement actions to maximise the persistence of aquatic organisms and assist with potential population productivity</p> <p>To protect and restore the composition and structure of native vegetation communities.</p>
Local Communities and Other Stakeholders	
Protect human health and safety	<p>To maintain/improve the quality⁶ of water that is consumed by local populations.</p> <p>To limit human activities that cause pollution</p> <p>To identify major categories of uses of watershed area</p> <p>To enhance public awareness of the importance of improving water quality</p>
Enhance communication and collaboration between local and national institutions (agencies and ministries)	<p>To identify key stakeholders and their roles and responsibilities with respect to watershed management</p> <p>To promote stakeholders' dialogue and coordinated programmes</p>

⁶ Water quality is threatened by public practices and industrial activities.

Improve public education to promote stewardship of watershed resources	To raise awareness of and educate public on the importance of watershed and the consequences of their actions
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In addition to the above- mentioned improvement goals and management objectives, there following guiding principles which focused on community health and safety, sustainability, cost effectiveness, partnerships and shared responsibility and public education. These were followed by the developed of strategies action and broad action plans.

Strategies-a synopsis

STRATEGY 1 Pollution Management

Major activities that should be involved in pollution management of watersheds include:

- Testing the organic and inorganic content within the watershed;
- Checking the biological richness and species composition of indicator plant and animal ; and
- Observing physical changes for example colour and taste of the water along the watershed over time.

STRATEGY 2 Revegetation

Revegetation is crucial to watersheds that have significantly been affected by human activities. Non-native species must be removed then replaced by native or adaptive ones.

STRATEGY 3 Aquatic and Terrestrial Enhancement

Focus must be given to both terrestrial and aquatic areas and processes that connect them within watersheds since one ecosystem will impact on another. It is therefore necessary to maintain the integrity of both terrestrial and aquatic ecosystems through enhancement.

STRATEGY 4 Protection and Policy

This involves the protection of important watershed functions and the application of policies to improve development and redevelopment practices which are important to the maintenance of the integrity of watersheds. The protection of existing vegetation, stream channels and wetlands reduces water runoff, stabilizes peak stream flows, maintains flow levels and enhances wildlife habitat. Additionally, vegetated savannahs, forests and stream corridors serve to filter pollutants and improve water quality.

STRATEGY 5 Information, Education and Stakeholder Involvement and Stewardship

This is a very crucial strategy since it involves all stakeholders that use the watershed. Bearing in mind that watersheds need to be protected, these stakeholders, must not only be aware of this necessity, but should be working together to ensure that this goal is achieved. In order for this to happen, information must always be available so that a mindset of ownership and responsibility is present all times. Further, all levels of community education must involve the necessity to protect aquatic ecosystems.

Table 5 below links each strategy with a set of actions and general goals.

Strategies	Actions	Goals			
		Hydrology	Bio-physical habitats	Water Quality	Local Communities and Other Stakeholders
Pollution Management	Review and update legislation and regulation	✓	✓	✓	
	Manage mining and agricultural activities	✓	✓	✓	✓
	Reduce forest cover clearing	✓	✓	✓	✓
	Manage industrial run off	✓	✓	✓	✓
	Manage domestic waste water runoff, example, from laundry.			✓	✓
	Manage tourism activities in waterways	✓	✓	✓	
	Reduce pollutant availability (for example reducing phosphates and nitrates)		✓	✓	✓
	Prevent wastes generated by chicken farms from entering into watershed		✓	✓	✓
	Avoidance of pollutants or treating the pollutant before and after it is delivered to the water resource through chemical or biological transformation		✓	✓	
Revegetation	Enforce mining regulations regarding deforestation and backfilling, where practicable		✓	✓	
	Manage invasion of exotic species, for example, algae in waterways		✓	✓	
	Reduce erosion of upper watershed areas	✓		✓	
	Identify specific areas for livestock grazing away from waterways		✓		
	Replant mangrove vegetation		✓	✓	
	Prevent saltwater intrusion into fresh water wetlands, by maintaining the cross section of the coastline		✓	✓	

Aquatic and Terrestrial Enhancement	Rehabilitation to the topography of the original landscape for example by backfilling, where practicable		✓		✓
	Provide adequate solid waste disposal facilities		✓		✓
	Ensure compliance with current WHO water quality standards			✓	✓
	Monitor population changes of bio-indicators such as native plant and animal species		✓		
Strategies	Actions	Goals			
Protection and Policy	Implement management of erosion, sediment, and pollutant discharge from mining, agriculture, forestry and tourism activities	✓	✓	✓	
	Implement management of pollutant discharges for industrial and residential sites			✓	✓
	Identify and protect sites and features with high watershed values and functions	✓	✓		
Information, Education and Stakeholder Involvement and stewardship	Promote watershed awareness among stakeholders, including local communities, businesses and students				✓
	Provide pollution prevention education to water users associations, households and businesses.				✓
	Promote corporate social responsibilities among businesses				✓
	Provide information on environmentally friendly technologies to industries and businesses				✓
	Execute workshops and seminars on watershed management among local communities to build human resource capacity				✓
	Integrate watershed management into the school's curriculum				✓

This was followed by the identification of short terms, medium term and long term actions, plus key partners for the implementation of the actions. Partners include community organisations, local businesses, natural resource sector agencies/ministries (agriculture, tourism mining, forestry) Environmental Protection Agency (EPA); Guyana Bureau of Standards; educational institutions and the National Water Council.

Monitoring Plan

In addition, a monitoring plan was developed based on what key concepts and the identification of specific indicators:

- **Cause and Effect Monitoring:** this focuses on the effects of specific actions on the water quality constituents, for example, timber harvesting and suspended sediments concentrations or sediment loads.
- **Base-line Monitoring:** this focuses on the continuous or periodic measurements and recording of existing and changing conditions of a particular environmental parameter within the watershed; for example, changes in water quality parameters over time.
- **Compliance Monitoring:** this will ensure that businesses and other activities are in compliance with specific regulations and standards, for example, water turbidity.
- **Inventory Monitoring:** this will observe and record the existing conditions of environmental components of the watershed, for example, the biodiversity or the nutrient loads of the waterway.

Conclusion and Recommendations

This paper has provided an insight into the issues, context and content in respect of the Demerara Sub-watershed Management Plan. There is a clear indication that a plethora of issues needs to be addressed; this underscores the need for greater collaboration and institutional linkages between the key stakeholders, and importantly, more meaningful participation of local communities in the management of the sub-watershed.

The Plan must be considered as evolving and adaptive; hence the need for necessary adjustments to be made as informed by research and monitoring activities within the watershed area, the use of the findings to revise management policies, strategies, and actions to achieve the desired results.

The general challenges to the management of Guyana's water resources can be overcome largely by the creation of an enabling framework for a sustainable WMP. Current existing opportunities to operationalise this goal are:

Development and Implementation of a National Water Policy

The recent establishment of a National Water Council in Guyana is a very positive step to promoting integrated watershed management and overall protection of water resources. It is noted that one of the key functions of the Council is to develop and/or review the national water policy and to oversee its management and coordination. Additionally, the goal of the Policy is to provide a framework to maximize the contribution of the water sector to sustainable economic, social and environmental development in an efficient and equitable manner.

Establishment of the National System of Protected Areas

The National System of Protected Areas in Guyana, which will ultimately see the establishment of a total of at least six Protected Areas: Kaieteur Falls Area, Kanuku Mountains, Mount Roraima, Orinduik Falls, Shell Beach, and South Eastern Forests⁷, will no doubt protect maintain forest cover, and by extension, will help to maintain constant supplies of good quality water. To date, Guyana has three legally protected areas: Kaieteur National Park, Iwokrama Rainforests, and Shell Beach.

Land Use Policy

When fully reviewed and implemented the Land Use Policy will provide an overarching framework for the development of a national Land Use Plan, which, among other things, will promote optimum land use and integration among the different uses (NBAP II, 2007-2011).

Public Education and Participation

A comprehensive public awareness and education programme is a critical tool for changing public perceptions, promoting awareness and concern and fostering more responsible attitudes among water users. More than likely, informed citizens will be encouraged to act responsibly individually and collectively to protect Guyana's water resources.

International Conventions

Guyana's obligations to major international Conventions such as the United Nations Convention on Biological Diversity (UNCBD), the United Nations Convention to Combat Desertification (UNCCD), and the United Nations Framework Convention on Climate Change provide excellent opportunities for the country to access much needed financial resources and technical assistance to respond to the various challenges to watershed management in Guyana. In particular, the global attention given to climate change, plus ecosystem services are excellent platforms to lobby for support for watershed management in Guyana.

⁷ <http://www.epaguyana.org/npas/proposed.htm>

In addition, if Guyana were to accede to the Cartagena Convention on land based pollution, point source pollution will be significantly reduced.

Information and Knowledge Sharing

Information and knowledge sharing of watershed conditions and management issues across jurisdictions and agencies with direct or indirect responsibility for water resources in Guyana is necessary for effective management. Moreover, the costs associated with geographic information systems, satellite imagery etc. and the effectiveness of these information systems to good decision making justifies the need for sharing.

Strategic Environmental Assessment

Strategic Environmental Assessments (SEAs), which originated from land use planning in the developed world, provide a useful and effective approach to formulating appropriate management policies for watersheds in Guyana, given the diverse uses of water resources and the possibility of conflicts. In essence, the SEA process will allow decision makers to focus on key issues: different spatial scales, multi-sectoral decision making, stakeholder participation, monitoring and evaluation, and broadening perspectives beyond immediate sectoral issues. These issues are vital to integrated watershed management.

Partnership and Collaborative Management

Effective management of water resources in Guyana requires public participation and collaboration between state entities, the private sector and local communities. The National Water Policy can create opportunities for the creation of partnerships among key stakeholders of water management, as well as specify specific roles that will demonstrate a genuine participatory process.

Watershed management must be seen as that critical link between water and improved quality of life. It is also essentially about seeing Guyana recognize and cherish their rich, natural heritage: water resources. The consequences are grave if all stakeholders fail to act now and responsibly.

Water is life!

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