Grenada LBS Awareness & Implementation Workshop

6 – 7 April 2009, St. Georges, Grenada

Watershed Management Planning

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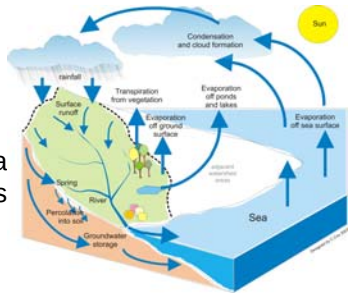
What is a watershed?

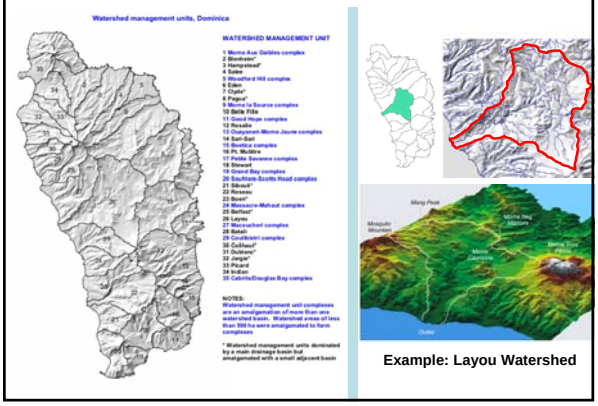
- A watershed is the land area over which water (from rainfall) drains <u>down-slope</u>, either over the land surface, within streams or within the sub-soil to the lowest point (usually the sea)

The water cycle

- Water flows in our environment within watersheds in a cyclical process



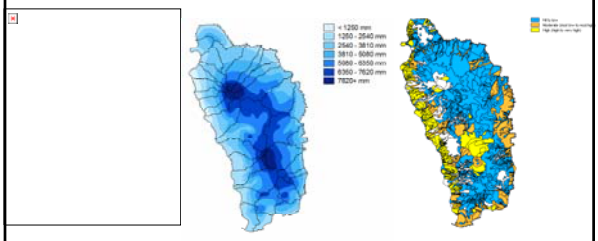
Dominica's watersheds



Example: Layou Watershed

Why are our watersheds fragile?

(a) Steep slopes (b) High rainfall (c) Fragile soils

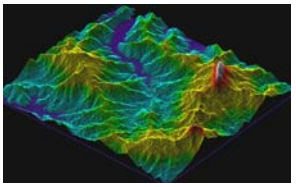


Slope steepness
(very steep slopes!!!)

Mean annual rainfall
(very high!!!!...interior areas in particular)

Soil erodibility
(how rapidly soil might be degraded once the vegetation ins removed)

A Framework for Rural Watershed Management Planning



Land zoning – sustainable land management regimes

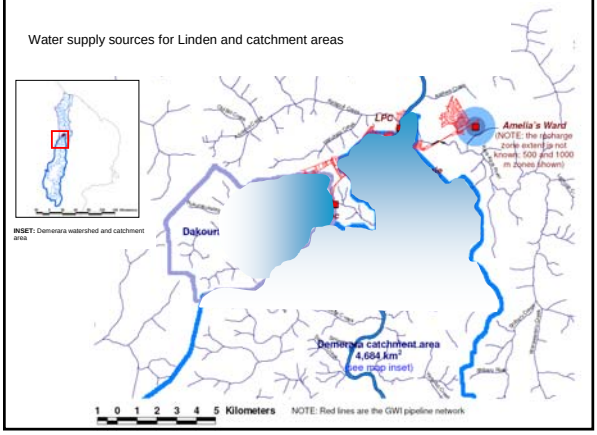
- ***Treatment-Oriented Approach*** (N. Ahmad, UWI)
- Specifies broad sustainable rural land management regimes based on land capability.
- Applied in rural zoning exercises over the past several years in St. Lucia
- 2-step process executed using GIS tools
  - 1st step: define land capability classes
  - 2nd step: assign recommended land management regimes to capability classes
    - Integrate special management areas or Environmental Protection Areas
- Two core criteria for land capability
  - Slope
  - Soil stability to erosion processes

	Capability classes / Recommended land management regimes		
Slope range	**Stable** Erosion hazard classes: • Nil • None • Low to very low • Low	**Moderately stable** Erosion hazard classes: • Moderately low • Moderate • Moderately high	**Fragile** Erosion hazard classes: • High or moderately high • High • High if cultivated • Very high
0 – 5°	**A1** Intensive agriculture	**B1** Intensive agriculture	**C1** Intensive agriculture
5 – 10 °			**C2** Agro-forestry/forestry
10 – 15 °		**B2** Agro-forestry	**C3** Production / protection forestry
15 – 20 °			
20 – 25 °	**A2** Agriculture/agro-forestry	**B3** Production / protection forestry	
25 - 30 °			
30 - 35 °	**A3** Production / protection forestry		
35 - 40 °			
40 - 45 °			
45 ° +			

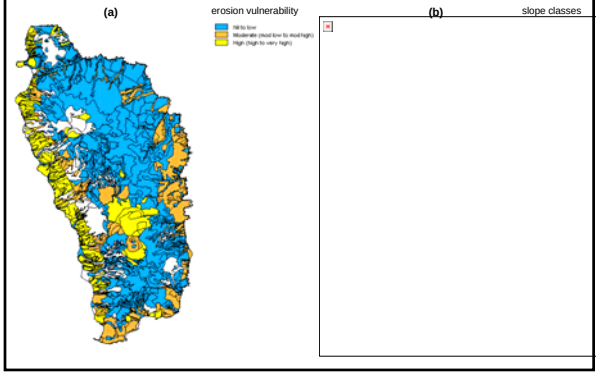
Environmental Protection Areas

EPA category	Locational attributes	Management regime and description
Forest reserve / National Park buffer	200 metre along periphery of boundary lines of the Northern and Central Forest Reserves, Morne Diablotins NP and Cabrits NP	**Agro-forestry/forestry** Tree crops with high crown cover in shelter wood system over annual crops; tree orchard, natural or plantation forest; eco-touristic activity
World Heritage Site buffer	1,000 metre buffer along periphery of boundary lines of MTPNP	
Riparian (stream) buffer	•50 metre buffer along all major watercourses at elevations below 250 m. •150 metre buffer along all watercourses above 250 m elevation.	
Water (catchment) areas	Drainage areas upstream of water intakes	
National Parks and Forest Reserves	•Morne Trois Pitons National Park •Cabrits National Park	**Protection forestry** Minimal intervention in National Parks; eco-tourism
	•Northern Forest Reserve •Central Forest Reserve	**Production forestry** Commercial operation where permissible; eco-tourism

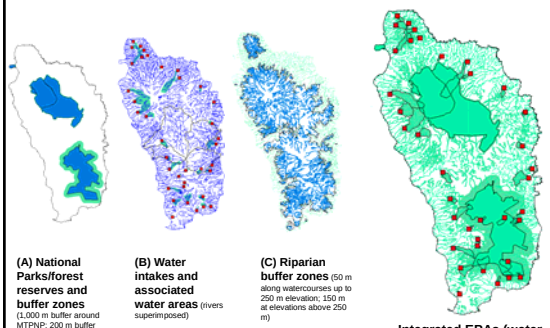
Water supply sources for Linden and catchment areas



(a) Soil erosion vulnerability and (b) slope steepness classification.



Environmental Protection Areas

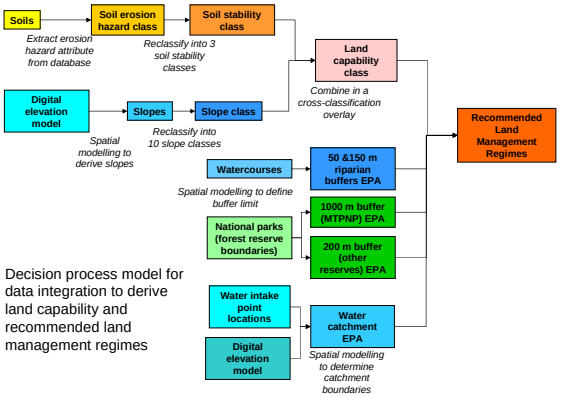


(A) National Parks/forest reserves and buffer zones (1,000 m buffer around MTPNP; 200 m buffer around others)

(B) Water intakes and associated water areas (rivers superimposed)

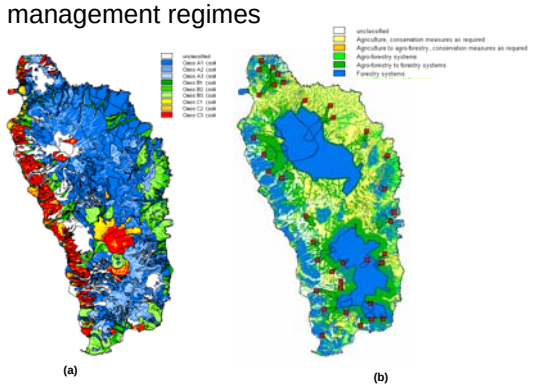
(C) Riparian buffer zones (50 m along watercourses up to 250 m elevation; 150 m at elevations above 250 m)

Integrated EPAs (water intakes and parks boundaries shown)

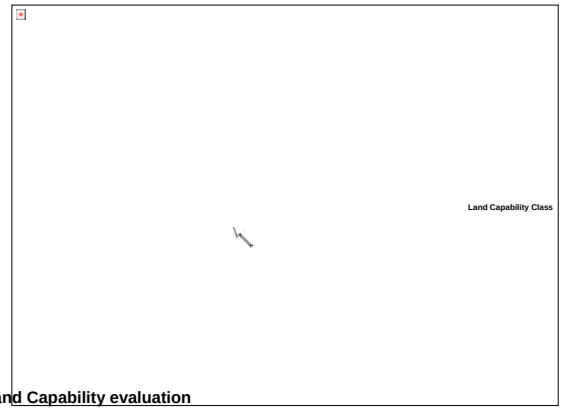


Decision process model for data integration to derive land capability and recommended land management regimes

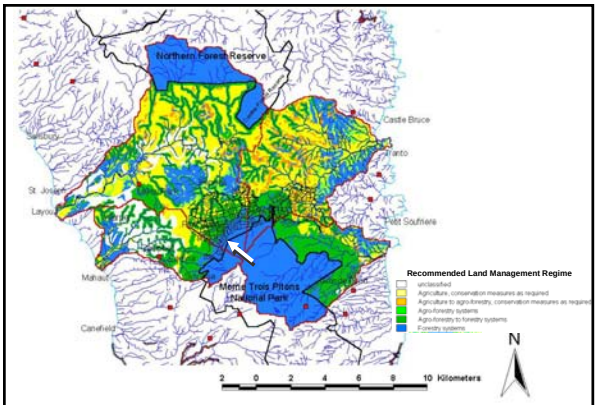
Land capability and recommended land management regimes



(a) (b)



Land Capability evaluation



Recommended land management regime evaluation

Hot spot mapping/assessment

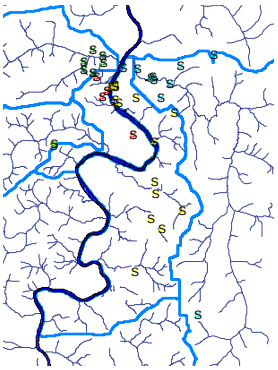
- Go to Word doc

West bank – Demerara

Silvertown, Wismar, Christianburg, Dakoura

Pollution hazard locations

- 30 pollution hazards were identified across the study area
- Majority were point-source
- Non-point sources noted

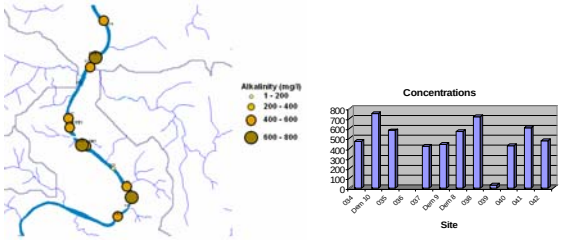


Water quality assessment

- Sampling March 2008
  - 15 water samples within watershed areas (incl. main river)
  - Tests were limited to:
    - microbiological and organics (enterococci, e-coli, total organic carbon),
    - physical (turbidity, total suspended solids)
    - Chemical (nitrates) parameters
  - testing for metals was not replicated

Alkalinity

Oct 2007 and Mar 2008



Parameter	Target (MCL)	Rationale for MCL target
Enterococci count	*Recreational waters target:* 35 CFU/100ml	**animal fecal waste. These organisms cause gastrointestinal infections following ingestion or infections of the upper respiratory tract, ears, eyes, nasal cavity and skin (WHO, 2008) The Class 1 Receiving waters targets are recommended given the fact that the waters are used for drinking water abstraction.**
Escherichia coli count	*Recreational waters target:* 126 CFU/100ml	
Total Suspended Solids	*Recreational waters target* 30 mg/L	**TSS affect aquatic life as the suspended solids can clog fish gills, reduce light penetration that affects productivity of aquatic plant life. Excessive siltation can smother riverbeds and organisms within. Suspended solids have the effect of absorbing solar radiation thereby raising the water temperatures.**
Total organic carbon	*Drinking water target for ambient (raw) water:* 4 mg/L	**TOC is contributed by decaying natural organic matter and is of concern when raw water high in TOC is chlorinated. The disinfection process will create chlorination by-products (haloforms) that have been linked to the presence of carcinogens.**
Chloride	*Drinking water target for ambient (raw) water:* 250 mg/L	**Nuisance pollutant; contributes salty taste to water; taste thresholds for sodium chloride and calcium chloride in water are in the range 200–300 mg/L (WHO, 2003)**
Nitrate	10 mg/L	**Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.**
Phosphorous	*Drinking water target for ambient (raw) water:* 0.1 mg/L	**Encourages the proliferation of macro-algal growth that leads to oxygen depletion. Total phosphorous in excess of 100 µg/L may interfere with coagulation in water treatment.**
Aluminum	*Drinking water target for ambient (raw) water:* 200 µg/L *Note: this is target for finished water also*	**This is also considered a nuisance pollutant that results in coloured water.**
Iron	*Drinking water target for ambient (raw) water:* 300 µg/L *Note: this is target for finished water also*	**Promotes undesirable bacterial growth ("iron bacteria") within a waterworks and distribution system, resulting in the deposition of a slimy coating on the piping (WHO, 2003). Also contributes a rusty colour, sediment, metallic taste and reddish or orange staining**
Mercury	*Drinking water target for ambient (raw) water:* 2 µg/L	**Mercury bio-accumulates in aquatic organisms and is associated with kidney damage in humans.**

Comparative analysis

- Mean values used in analysis **(sample shown)**

Location ID	Location	Microbiological		Phys.	Chemical							
		Enterococci count	E-coli count	Total Suspended Solids	Total organic carbon	Chloride	Nitrate	Phosphorous	Aluminum	Copper	Iron	Mercury
		CFU/100ml	CFU/100ml	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L
		35*	126*	30*	4**	250*	10*	0.1**	200*	1,000*	300*	2*
Demerara River												
34	Dallawalla	186	614%	40%	208%	-98%	-90%	80%	125%	-100%	144%	-99%
DEM 10	EPA Point: Below Kara-Kara Creek	186%	138%	80%	196%	-98%	-97%	420%	125%	-100%	12%	-78%
D: 35	Mouth Kara-Kara Creek	99%	289%	82%	404%	-96%	-96%	4140%	185%	-100%	23%	-65%
F	Demerara River at Alumina Plant intake (LPC)	23%	203%	-77%			-100%					
36	Close to discharge outfall from bauxite plant	186%	297%	-76%	186%	-98%	-90%	5060%	-14%	-100%	184%	-95%
DEM 9	EPA Point: Bauxite Plant	186%	-21%	-78%	181%	-98%	-97%	620%	125%	-99%	210%	-18%
37	Mouth of surface drain from bauxite plant	43%	58%	-80%	175%	-99%	-75%		214%	-100%	-97%	-92%
G	Demerara River at bauxite plant main outfall	11%	138%	-80%	2205%		-100%	380%				
38; H; DEM 8	EPA Point: Watooka Boat House	64%	7%	-77%	175%	-97%	-96%	3280%	135%	-100%	128%	-99%

* The percentages were derived from average values from the observed data. It must be noted that some data points were single observations. In addition, given the small number of data points, the full range of variability in pollutant loads is not known. Pollutant loadings under high runoff or flood conditions may be significantly higher than that in the data available for this study.

Colour code key:

% Below guideline			% Above guideline				
-100 to 50%	-50 to -25%	-25 to 0%	0 to 25%	25 to 50%	50 to 100%	100 to 200%	200 to 500%	>500%

Guideline sources:

* Cartagena Convention LBS Protocol for Class 1 Receiving Waters

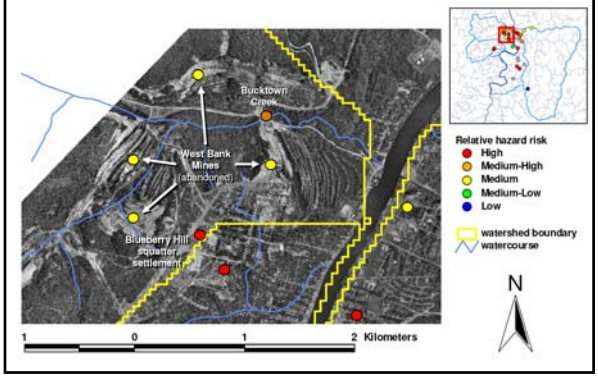
** US-EPA Primary drinking water regulations

*** US-EPA Secondary drinking water regulations

**** British Columbia Ambient Water Quality Guidelines – raw water

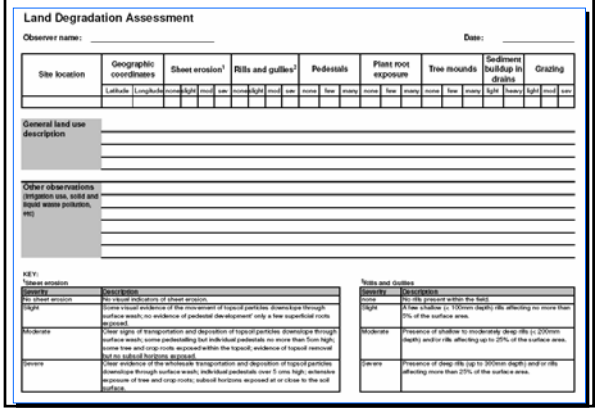
***** US EPA (1986): no more than 0.1 mg/L for streams which do not empty into reservoirs

Hotspots – hazard to human health and ecosystem (in terms of impairment)



Control measures - actions

Data capture



Land Degradation Assessment

Observer name: _____ Date: _____

Site location	Geographic coordinates		Sheet erosion[1]			Rills and gullies[2]			Pedestals			Plant root exposure			Tree mounds			Sediment buildup in drains		Grazing		
	Latitude	Longitude	none	light	mod	sev	none	light	mod	sev	none	few	many	none	few	many	none	few	many	light	heavy	light	mod	sev

General land use description _____

Other observations (irrigation use, solid and liquid waste pollution, etc) _____

KEY:

[1]Sheet erosion

Severity	Description
No sheet erosion	No visual indicators of sheet erosion.
Slight	Some visual evidence of the movement of topsoil particles downslope through surface wash; no evidence of pedestal development' only a few superficial roots exposed.
Moderate	Clear signs of transportation and deposition of topsoil particles downslope through surface wash; some pedestalling but individual pedestals no more than 5cm high; some tree and crop roots exposed within the topsoil; evidence of topsoil removal but no subsoil horizons exposed.
Severe	Clear evidence of the wholesale transportation and deposition of topsoil particles downslope through surface wash; individual pedestals over 5 cms high; extensive exposure of tree and crop roots; subsoil horizons exposed at or close to the soil surface.

[2]Rills and Gullies

Severity	Description
None	No rills present within the field.
Slight	A few shallow (< 100mm depth) rills affecting no more than 5% of the surface area.
Moderate	Presence of shallow to moderately deep rills (< 200mm depth) and/or rills affecting up to 25% of the surface area.
Severe	Presence of deep rills (up to 300mm depth) and/or rills affecting more than 25% of the surface area.

Watershed Plan of Action

Control measures

- Example from Guyana

Hazard characterization	Hazard Type M (microbial) C (chemical) P (physical)	Risk* * H (High) M (Medium) L (Low)	Existing Control Measures and/or Proposed Measures
KD1: Abandoned mines: West Bank mines (bauxite) **Waste stream code:** n/a **Risk factors:** **Human health:** • Low direct risk to human health, although the increased turbidity can result in an environment that favours the proliferation of potentially harmful bacteria **Ecosystem:** • Risk to aquatic flora and fauna through physical smothering. Ambient water temperatures may be higher on account of high sediment loads. • The mining operation itself would have severely compromised the natural forest ecosystems that existed in the areas before operations commenced.	P	M	1. **Existing control measures:** a. No measures 2. **Proposed control measures:** a. Identify the most appropriate mechanism to coordinate and raise financing for a land reclamation effort. A likely entry point may be the "Forest Landscape Restoration Project" which seeks to restore mined-out and degraded areas in Guyana. Financing for this project is being sought. Lead agency responsibilities will also need to be considered b. Re-vegetate the spoil heaps, with priority attention paid to rapidly eroding areas. c. Commission a feasibility study to evaluate the possibility of conversion of these mined-out areas to sanitary landfills (for waste from Linden and possibly Georgetown) in a manner that will eventually result in landscape reclamation. The revenue generated from tipping fees could be recycled into landscape restoration efforts.

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Watershed Plan of Action

Control measures – targets/indicators

- Example from Guyana

Point source Hazard	Recommended Control Measures (cross-cutting measures that can fall within amalgamated programme areas are flagged as follows: [CB]: capacity-building for env mgmt [LPS]: legislative, policy strengthening [SWM]: solid waste management [WQM]: water quality monitoring [WWM]: waste water management	Outputs/Targets and Indicators P – process indicator S – stress reduction indicator E – environmental status indicator	Lead agency responsibility for implementation	Timeframe (estimated from commencement of component implementation)
KK8: Forestry concessions at Chikabaru along Ituni Trail	Closer collaboration between RDC and Town Council and the Forestry Commission to ensure environmental compliance	Environmental audit report **(P)**	Guyana Forestry Commission (GFC); RDC; LTC	Short-long term; ongoing
		No evidence of waste (oils, other residues, etc) **(E)**	GFC;	Short-long term; ongoing
KK9: Urban encroachment around Amelia's Ward wellhead	Establish a statutory zoning regulation (spatially-based) to define no-build restrictions within the wellhead area	Zoning protocol for drinking water supply wells **(P)**	GWI; LTCEHD (supported by the CH&PA)	Medium-term
	Implement a specific monitoring regime (inclusive of test sample wells) for detection of pollutant contamination within the aquifer [WQM]	Test monitoring wells installed **(P)** WQ testing; minimal to zero microbial detection in raw water **(E)**	GWI; LTCEHD	Short-long term; ongoing

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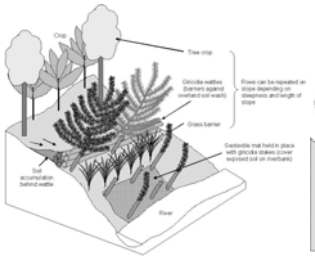
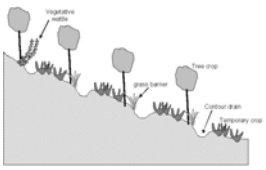
Land degradation control measures

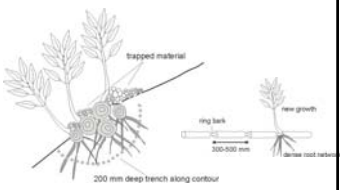


Riverbank soil conservation



Contour farming

Gliricidia **wattle** installed under banana cultivation in alignment with the river bank.



Check-dams installed within drainage ways