Annexes

Annex I
List of contributing authors and organisations involved

Lead authors

Name	Institutional affiliation	Country	Field of work
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Prof. Micheni Ntiba	Department of Zoology, University of Nairobi	Kenya	Fisheries biology
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Contributing authors

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Dr. George M Wamukoya	Centre for Research and Education on Environmental Law (CREEL), Nairobi	Kenya	Environmental policy
Mr. Peter G Ambenje	Drought Monitoring Centre, Nairobi	Kenya	Climate change

Annex II
Detailed scoring tables: Lake Turkana

I: Freshwater shortage

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
1. Modification of stream flow	2	80	Freshwater shortage	1.8
2. Pollution of existing supplies	1	20		
3. Changes in the water table	0	0		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	2	60
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Economic impacts		**1.8**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	40
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Health impacts		**1.6**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	2	35
Degree of severity	Minimum – Severe 0 1 2 3	2	45
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	20
Weight average score for Other social and community impacts		**1.8**	

II: Pollution

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
4. Microbiological	0	0	Pollution	1.6
5. Eutrophication	1	40		
6. Chemical	0	0		
7. Suspended solids	2	60		
8. Solid wastes	0	0		
9. Thermal	0	0		
10. Radionuclide	0	0		
11. Spills	0	0		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	20
Weight average score for Economic impacts		**1.0**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	40
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	10
Weight average score for Health impacts		**1.0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	1	30
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	20
Weight average score for Other social and community impacts		**1.0**	

III: Habitat and community modification

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
12. Loss of ecosystems	1	50	Habitat and community modification	1.5
13.Modification of ecosystems or ecotones, including community structure and/or species composition	2	50		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	2	40
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Economic impacts		**2.6**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	3	55
Degree of severity	Minimum – Severe 0 1 2 3	1	35
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Health impacts		**2.3**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	40
Degree of severity	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Other social and community impacts		**2.5**	

IV: Unsustainable exploitation of fish

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
14. Overexploitation	1	20	Unsustainable exploitation of fish	0.7
15. Excessive by-catch and discards	1	30		
16. Destructive fishing practices	0	20		
17. Decreased viability of stock through pollution and disease	0	10		
18. Impact on biological and genetic diversity	1	20		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	0	60
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	0	10
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	0	30
Weight average score for Economic impacts		**0**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	0	55
Degree of severity	Minimum – Severe 0 1 2 3	0	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	0	15
Weight average score for Health impacts		**0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	0	40
Degree of severity	Minimum – Severe 0 1 2 3	0	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	0	10
Weight average score for Other social and community impacts		**0**	

V: Global change

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
19. Changes in the hydrological cycle	2	45	Global change	1.4
20. Sea level change	1	45		
21. Increased UV-B radiation as a result of ozone depletion	0	0		
22. Changes in ocean CO_2 source/sink function	0	10		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	20
Weight average score for Economic impacts		**2.0**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	40
Degree of severity	Minimum – Severe 0 1 2 3	3	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	10
Weight average score for Health impacts		**2.4**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	50
Degree of severity	Minimum – Severe 0 1 2 3	3	45
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	5
Weight average score for Other social and community impacts		**3.0**	

Comparative environmental and socio-economic impacts of each GIWA concern

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	1.8	3	1.8	3	1.6	2	1.8	2	**2.1**
Pollution	1.6	3	1.0	2	2.0	2	2.0	2	**2.0**
Habitat and community modification	1.5	3	2.6	3	2.3	3	2.5	3	**2.6**
Unsustainable exploitation of fish and other living resources	0.7	2	0	1	0	1	0	1	**0.7**
Global change	1.4	2	2.0	2	2.4	2	3.0	3	**2.2**

If the results in this table were not giving a clear prioritisation, the scores were weighted by assigning different relative importance to present/future and environmental/socio-economic impacts in the following way:

Weight averaged environmental and socio-economic impacts of each GIWA concern

Present (%) (i)	Future (%) (j)	Total (%)
50	50	100

Environmental (k)	Economic (l)	Health (m)	Other social and community impacts (n)	Total (%)
40	20	20	20	100

Concern	Types of impacts					Rank
	Time weight averaged Environmental score (o)	Time weight averaged Economic score (p)	Time weight averaged Human health score (q)	Time weight averaged Social and community score (r)	Time weight averaged overall score	
	(a)x(i)+(b)x(j)	(c)x(i)+(d)x(j)	(e)x(i)+(f)x(j)	(g)x(i)+(h)x(j)	(o)x(k)+(p)x(l)+(q)x(m)+(r)x(n)	
Freshwater shortage	2.4	2.4	1.8	1.9	**2.2**	**2**
Pollution	2.3	1.5	2.0	2.0	**2.0**	**3**
Habitat and community modification	2.3	2.8	2.7	2.8	**2.6**	**1**
Unsustainable exploitation of fish and other living resources	1.4	0.5	0.5	0.5	**0.9**	**5**
Global change	1.7	2.0	2.2	3.0	**2.1**	**4**

Annex II
Detailed scoring tables: Lake Victoria

I: Freshwater shortage

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
1. Modification of stream flow	1	30	Freshwater shortage	1.7
2. Pollution of existing supplies	2	40		
3. Changes in the water table	2	30		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	0	35
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	0	55
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	10
Weight average score for Economic impacts		**0.1**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	0	40
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	10
Weight average score for Health impacts		**0.6**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	35	35
Degree of severity	Minimum – Severe 0 1 2 3	45	45
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	20	20
Weight average score for Other social and community impacts		**1.0**	

II: Pollution

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
4. Microbiological	3	20	Pollution	2.6
5. Eutrophication	3	25		
6. Chemical	2	20		
7. Suspended solids	3	25		
8. Solid wastes	1	5		
9. Thermal	0	0		
10. Radionuclide	0	0		
11. Spills	0	5		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	2	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	20
Weight average score for Economic impacts		**2.0**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	40
Degree of severity	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	10
Weight average score for Health impacts		**2.0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	30
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	20
Weight average score for Other social and community impacts		**2.0**	

III: Habitat and community modification

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
12. Loss of ecosystems	2	50	Habitat and community modification	2.5
13.Modification of ecosystems or ecotones, including community structure and/or species composition	3	50		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	40
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	10
Weight average score for Economic impacts		**1.1**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	55
Degree of severity	Minimum – Severe 0 1 2 3	1	35
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Health impacts		**1.2**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	1	40
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	10
Weight average score for Other social and community impacts		**1.0**	

IV: Unsustainable exploitation of fish

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
14. Overexploitation	3	30	Unsustainable exploitation of fish	2.6
15. Excessive by-catch and discards	2	20		
16. Destructive fishing practices	3	30		
17. Decreased viability of stock through pollution and disease	2	10		
18. Impact on biological and genetic diversity	2	10		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	2	60
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	10
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	30
Weight average score for Economic impacts		**2.4**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	55
Degree of severity	Minimum – Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	15
Weight average score for Health impacts		**2.2**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	2	40
Degree of severity	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Other social and community impacts		**2.1**	

V: Global change

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
19. Changes in the hydrological cycle	1	50	Global change	0.7
20. Sea level change	1	20		
21. Increased UV-B radiation as a result of ozone depletion	0	20		
22. Changes in ocean CO_2 source/sink function	0	10		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small Very large 0 1 2 3	1	30
Degree of impact (cost, output changes etc.)	Minimum Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	0	20
Weight average score for Economic impacts		**1.3**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small Very large 0 1 2 3	1	40
Degree of severity	Minimum Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	0	10
Weight average score for Health impacts		**1.4**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small Very large 0 1 2 3	1	50
Degree of severity	Minimum Severe 0 1 2 3	1	45
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	1	5
Weight average score for Other social and community impacts		**1.0**	

Comparative environmental and socio-economic impacts of each GIWA concern

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	1.7	3	0.1	1	0.6	0	1.0	1	**1.1**
Pollution	2.6	3	2.0	2	2.0	1	2.0	1	**2.0**
Habitat and community modification	2.5	3	1.1	0	1.2	0	1.0	1	**1.2**
Unsustainable exploitation of fish and other living resources	2.6	2	2.4	1	2.2	1	2.1	1	**1.8**
Global change	0.7	2	1.3	2	1.4	1	1.0	1	**1.3**

If the results in this table were not giving a clear prioritisation, the scores were weighted by assigning different relative importance to present/future and environmental/socio-economic impacts in the following way:

Weight averaged environmental and socio-economic impacts of each GIWA concern

Present (%) (i)	Future (%) (j)	Total (%)
50	50	100

Environmental (k)	Economic (l)	Health (m)	Other social and community impacts (n)	Total (%)
40	20	20	20	100

Concern	Types of impacts					Rank
	Time weight averaged Environmental score (o)	Time weight averaged Economic score (p)	Time weight averaged Human health score (q)	Time weight averaged Social and community score (r)	Time weight averaged overall score	
	(a)x(i)+(b)x(j)	(c)x(i)+(d)x(j)	(e)x(i)+(f)x(j)	(g)x(i)+(h)x(j)	(o)x(k)+(p)x(l)+(q)x(m)+(r)x(n)	
Freshwater shortage	2.4	0.6	0.3	0.5	**1.3**	**5**
Pollution	2.8	2.0	1.5	1.5	**2.1**	**1**
Habitat and community modification	2.8	0.6	0.6	1.0	**1.5**	**3**
Unsustainable exploitation of fish and other living resources	2.3	1.7	1.6	2.1	**1.9**	**2**
Global change	1.4	1.7	1.2	1.0	**1.3**	**4**

Annex II
Detailed scoring tables: Lake Tanganyika

I: Freshwater shortage

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
1. Modification of stream flow	1	50	Freshwater shortage	1.0
2. Pollution of existing supplies	1	50		
3. Changes in the water table	0	0		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	0	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	0	60
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	10
Weight average score for Economic impacts		**0.2**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	0	40
Degree of severity	Minimum – Severe 0 1 2 3	0	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	10
Weight average score for Health impacts		**0.2**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	0	35
Degree of severity	Minimum – Severe 0 1 2 3	0	45
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	20
Weight average score for Other social and community impacts		**0.2**	

II: Pollution

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
4. Microbiological	1	10	Pollution	2.4
5. Eutrophication	1	20		
6. Chemical	2	20		
7. Suspended solids	3	40		
8. Solid wastes	0	5		
9. Thermal	0	0		
10. Radionuclide	0	0		
11. Spills	1	5		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	20
Weight average score for Economic impacts		**1.4**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	40
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	10
Weight average score for Health impacts		**1.0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	2	30
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	20
Weight average score for Other social and community impacts		**1.3**	

III: Habitat and community modification

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
12. Loss of ecosystems	2	50	Habitat and community modification	2.0
13.Modification of ecosystems or ecotones, including community structure and/or species composition	2	50		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	2	40
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Economic impacts		**2.6**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	55
Degree of severity	Minimum – Severe 0 1 2 3	1	35
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	0	10
Weight average score for Health impacts		**0.9**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	40
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Other social and community impacts		**2.0**	

IV: Unsustainable exploitation of fish

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
14. Overexploitation	3	40	Unsustainable exploitation of fish	2.1
15. Excessive by-catch and discards	0	5		
16. Destructive fishing practices	2	40		
17. Decreased viability of stock through pollution and disease	0	5		
18. Impact on biological and genetic diversity	1	10		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	3	60
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	2	10
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	30
Weight average score for Economic impacts		**2.9**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	55
Degree of severity	Minimum – Severe 0 1 2 3	1	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	15
Weight average score for Health impacts		**1.3**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	40
Degree of severity	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Other social and community impacts		**2.5**	

V: Global change

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
19. Changes in the hydrological cycle	1	45	Global change	1
20. Sea level change	1	45		
21. Increase UV-B radiation as a result of ozone depletion	0	0		
22. Changes in ocean CO_2 source/sink function	0	10		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small — Very large 0 1 2 3	1	30
Degree of impact (cost, output changes etc.)	Minimum — Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	0	20
Weight average score for Economic impacts		**1.3**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small — Very large 0 1 2 3	1	40
Degree of severity	Minimum — Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	1	10
Weight average score for Health impacts		**1.0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small — Very large 0 1 2 3	1	50
Degree of severity	Minimum — Severe 0 1 2 3	1	45
Frequency/Duration	Occasion/Short — Continuous 0 1 2 3	1	5
Weight average score for Other social and community impacts		**1.0**	

Comparative environmental and socio-economic impacts of each GIWA concern

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	1.0	2	0.2	1	0.2	1	0.2	1	**0.8**
Pollution	2.4	3	1.4	2	1.0	2	1.3	3	**2.0**
Habitat and community modification	2.0	3	2.6	3	0.9	2	2.0	3	**2.3**
Unsustainable exploitation of fish and other living resources	2.1	3	2.9	3	1.3	2	2.5	3	**2.5**
Global change	0.9	2	1.3	2	1.0	2	1.0	2	**1.5**

If the results in this table were not giving a clear prioritisation, the scores were weighted by assigning different relative importance to present/future and environmental/socio-economic impacts in the following way:

Weight averaged environmental and socio-economic impacts of each GIWA concern

Present (%) (i)	Future (%) (j)	Total (%)
50	50	100

Environmental (k)	Economic (l)	Health (m)	Other social and community impacts (n)	Total (%)
40	20	20	20	100

Concern	Types of impacts					Rank
	Time weight averaged Environmental score (o)	Time weight averaged Economic score (p)	Time weight averaged Human health score (q)	Time weight averaged Social and community score (r)	Time weight averaged overall score	
	(a)x(i)+(b)x(j)	(c)x(i)+(d)x(j)	(e)x(i)+(f)x(j)	(g)x(i)+(h)x(j)	(o)x(k)+(p)x(l)+(q)x(m)+(r)x(n)	
Freshwater shortage	1.5	0.6	0.6	0.6	**1.0**	**5**
Pollution	2.7	1.7	1.5	2.2	**2.2**	**3**
Habitat and community modification	2.5	2.8	1.5	2.5	**2.4**	**1**
Unsustainable exploitation of fish and other living resources	2.6	3.0	1.7	2.8	**2.5**	**2**
Global change	1.5	1.7	1.5	1.5	**1.5**	**4**

Annex II
Detailed scoring tables: Lake Malawi

I: Freshwater shortage

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
1. Modification of stream flow	2	80	Freshwater shortage	2.0
2. Pollution of existing supplies	2	20		
3. Changes in the water table	0	0		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	1	60
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	10
Weight average score for Economic impacts		**1.1**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	40
Degree of severity	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	10
Weight average score for Health impacts		**2.0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	1	35
Degree of severity	Minimum – Severe 0 1 2 3	0	45
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	20
Weight average score for Other social and community impacts		**0.8**	

II: Pollution

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
4. Microbiological	2	20	Pollution	2
5. Eutrophication	2	20		
6. Chemical	1	20		
7. Suspended solids	3	30		
8. Solid wastes	0	5		
9. Thermal	0	0		
10. Radionuclide	0	0		
11. Spills	1	5		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	20
Weight average score for Economic impacts		**1.2**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	40
Degree of severity	Minimum – Severe 0 1 2 3	0	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	10
Weight average score for Health impacts		**0.6**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	2	30
Degree of severity	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	20
Weight average score for Other social and community impacts		**2.0**	

III: Habitat and community modification

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
12. Loss of ecosystems	2	50	Habitat and community modification	2.0
13.Modification of ecosystems or ecotones, including community structure and/or species composition	2	50		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	40
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Economic impacts		**1.7**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	3	55
Degree of severity	Minimum – Severe 0 1 2 3	1	35
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Health impacts		**2.3**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	40
Degree of severity	Minimum – Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Other social and community impacts		**2.5**	

IV: Unsustainable exploitation of fish

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
14. Overexploitation	3	60	Unsustainable exploitation of fish	2.6
15. Excessive by-catch and discards	0	0		
16. Destructive fishing practices	2	40		
17. Decreased viability of stock through pollution and disease	0	0		
18. Impact on biological and genetic diversity	1	0		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	1	60
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	2	10
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	30
Weight average score for Economic impacts		**1.7**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	55
Degree of severity	Minimum – Severe 0 1 2 3	1	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	15
Weight average score for Health impacts		**1.6**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	40
Degree of severity	Minimum – Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	10
Weight average score for Other social and community impacts		**2.0**	

V: Global change

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
19. Changes in the hydrological cycle	1	50	Global Change	1.0
20. Sea level change	1	50		
21. Increased UV-B radiation as a result of ozone depletion	0	0		
22. Changes in ocean CO_2 source/sink function	0	0		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small Very large 0 1 2 3	3	30
Degree of impact (cost, output changes etc.)	Minimum Severe 0 1 2 3	2	50
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	0	20
Weight average score for Economic impacts		**1.9**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small Very large 0 1 2 3	2	40
Degree of severity	Minimum Severe 0 1 2 3	1	50
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	0	10
Weight average score for Health impacts		**1.3**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small Very large 0 1 2 3	1	50
Degree of severity	Minimum Severe 0 1 2 3	2	45
Frequency/Duration	Occasion/Short Continuous 0 1 2 3	0	5
Weight average score for Other social and community impacts		**1.4**	

Comparative environmental and socio-economic impacts of each GIWA concern

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	2.0	2	1.1	2	2.0	2	0.8	2	**1.7**
Pollution	2.0	3	1.2	2	0.6	2	2.0	2	**1.9**
Habitat and community modification	2.0	3	1.7	2	2.3	3	2.5	3	**2.4**
Unsustainable exploitation of fish and other living resources	2.6	3	1.7	3	1.6	3	2.0	2	**2.4**
Global change	1.0	2	1.9	1	1.3	1	1.4	1	**1.3**

If the results in this table were not giving a clear prioritisation, the scores were weighted by assigning different relative importance to present/future and environmental/socio-economic impacts in the following way:

Weight averaged environmental and socio-economic impacts of each GIWA concern

Present (%) (i)	Future (%) (j)	Total (%)
50	50	100

Environmental (k)	Economic (l)	Health (m)	Other social and community impacts (n))	Total (%)
40	20	20	20	100

Concern	Types of impacts					Rank
	Time weight averaged Environmental score (o)	Time weight averaged Economic score (p)	Time weight averaged Human health score (q)	Time weight averaged Social and community score (r)	Time weight averaged overall score	
	(a)x(i)+(b)x(j)	(c)x(i)+(d)x(j)	(e)x(i)+(f)x(j)	(g)x(i)+(h)x(j)	(o)x(k)+(p)x(l)+(q)x(m)+(r)x(n)	
Freshwater shortage	.20	1.6	2.0	1.4	**1.8**	**4**
Pollution	2.5	1.6	1.3	2.0	**2.0**	**3**
Habitat and community modification	2.5	1.9	2.7	2.8	**2.5**	**2**
Unsustainable exploitation of fish and other living resources	2.8	2.4	2.3	2.0	**2.5**	**1**
Global change	1.5	1.5	1.2	1.2	**1.4**	**5**

Annex III
Causal chain analysis – Outline of the process

Unsustainable exploitation of fish and other living resources: Issue 1 – Overfishing			
Questions asked	**Hypotheses**	**Assumptions**	**Evidence**
Why is there increased effort?	There are increasing numbers of fishermen. There are increased number of nets per fisherman.	Poverty is driving more people to the fishing industry. Agriculture has failed, so more people are turning to fishing. More people are involved in fishing as a result of increased urban settlements along the Lakeshore. Fishing methods requiring more nets are used as a result of declining fish catch per net.	Fishermen are normally hired or employed and will change fishing grounds depending on the catches (Katunzi 1996). People with few options for employment were drawn to a lucrative industry (Cohen et al. 1996). The heaviest populations (both urban and rural) are concentrated within a short distance of the Lake (Bootsma & Hecky 1993). "Multiple hanging" of nets emerged in late 1994 (Gibbon 1997, Kulindwa 2001).
	Increasing efforts by fishermen (e.g. increased gear and greed).	Increased fishing is not driven by greed. Increased fishing is not driven by increased access to gear.	
	The government is deliberately trying to increase the number of fishermen.	The government is encouraging fishing among local populations for economic returns and food security.	
	Price of fish has been increasing.	The price of fish per unit effort has increased over the last few years.	
	There is increased demand for fisheries export (regionally and internationally).	The demand for fish is not offset by increasing fish landings from other inland lakes.	
	There is more demand for inland fish than marine fish.	For socio-cultural reasons the regional population insist on inland fish.	
	There is no alternative cheap source of protein.	Animal and plant protein costs more than fish protein. There is increasing lack of land for subsistence farming due to increasing population.	Fish is the least expensive form of animal protein available. Fish comprises over 50% of the animal protein consumed in the intralacustrine region of eastern Africa (Hecky & Bugenyi 1992).
	There are reduced taxes and subsidies in the fishing industry.	More people are able to purchase fishing gear etc. at reduced cost.	
	There are credits/support available to fishermen.	More people are turning to fisheries as a result.	
	Current fishing efforts are still way below the maximum sustainable yield.	The maximum sustainable yield is known.	The resource base (MSY) still needs to be identified (Katunzi 1996). Lack of information on the size of the Nile perch stock has strongly limited the planning and development of the fishery (Katunzi 1996). The average size of fish caught in the gill-net fishery has decreased over the years (Katunzi 1996).
How is technological change contributing to overfishing?	Reduced taxes and subsidies on nets have enabled more fishermen to purchase nets, leading to higher catch per unit effort. Beach seining as a large scale technique of fishing for the market provides opportunities for employment but also destroys the habitat, enhances indiscriminate harvesting of fish (juvenile and adults) etc.	Proper net sizes are used to catch the target fish. Proper net size not used. The number of fishermen has not increased significantly.	Gill-nets and beach seines are still in use (Katunzi 1996). The use of hooks is encouraged since the required investment is low and the gear is highly selective, but still only few fishermen use them (Katunzi 1996). Beach seines are still in use though they are officially banned. (Mbuga et al. 1998, Kulindwa 2001).
	Processing industries have increased in number.	There is a higher demand for fish as the capacity for processing fish has increased.	There has been rapid expansion of the fish processing factories on the Tanzania side of the Lake (Katunzi 1996).
	Processing industries are geared to export markets.	Demand for fish in the world market is high and increasing. There is more demand for fish as a result.	The transformation of the Victoria from a locally based fishery to a commercial fishery has been the result of the strong demand from the global markets (Abila & Jansen 1997).
	Trawling has increased to meet demand for fish.	No fish quotas are in place.	Use of trawlers expanded greatly during the 1970s with the original targets being abundant benthic haplochromine cichlids (Cohen et al. 1996). With the collapse of the indigenous fauna in Lake Victoria (Barel et al. 1991), a new open-lake trawl fishery developed for the Nile perch with heavy foreign subsidy (Cohen et al. 1996).
	Improvements have been made in fish storage and transport.	Capacity for storage and transport has increased.	
	There is lack of fish storage facilities at fish landing sites.	Fresh fish tends to spoil if not taken immediately to processing factories or markets.	Fishermen are exploited by middlemen who buy at throw-away prices, forcing the fishermen to intensify their fishing. *Rastrineobola argentia* (80%) is sold dry after sun-drying on the beaches (Katunzi 1996).
	There is improper use of technology (e.g. nets) leading to overfishing.	Fine mesh sizes are used.	Nets are produced for various industries, e.g. horticultural industry where fine mesh nets are used to guard against birds. These are now being used in the fishing industry.
	There are no refrigeration facilities and infrastructure for fish transport at the coast.	There is more reliance on inland fisheries on a regional scale.	

Unsustainable exploitation of fish and other living resources: Issue 2 – Destructive fishing practices			
Questions asked	**Hypotheses**	**Assumptions**	**Evidence**
Why is there increased effort?	Recommended fishing gear is not used – smaller size nets are used to capture target fish.	There is a decline in catch per unit effort.	A progressive decrease in mesh size of gill nets (Nile perch) has been noted (Ligtvoet & Mkumbo, 1992), increasing the likelihood of overexploitation (Katunzi 1996). Evidence shows that the availability of all type of fish and particularly Nile Perch is declining (Kulindwa 2001). Beach seining catches a lot of juvenile fish and destroys breeding sites and eggs (Katunzi 1996).
	Higher demand for fish leads to a scramble for limited resources by increasing numbers of fishermen.	There exists high demand of Nile Perch in the regional and world market.	Export of Nile Perch increased over time from 1996 (Kulindwa & Mbelle 2002, Kulindwa, 2001, Abila, 2002).
	There are credits/support available to fishermen.	More people are turning to fisheries as a result.	
	Lack of adequate enforcement.		Gill-nets have had a devastating effect impact around river mouths during spawning migrations of potadromous fishes (Ogutu-Ohwayo 1990).
	Failure of agricultural production due to adverse weather conditions and inadequate markets for cotton, coffee etc.	Lack of alternative livelihoods.	The change of occupation coincided with the decline of cotton and coffee price declines (Kulindwa 2001) and decline in food production due to bad weather conditions (Abila 2002).
Why is rent-seeking behaviour prominent?	There are windfall profits for those dealing with the export market.	Profit maximisation is a major motivating force. More commercial fishermen are setting up in the region. Lack of regulation, enforcement and monitoring capacity. Dwindling fish stocks are leading to use of unconventional fishing methods to meet market demand.	Number of fish processing industries and trawlers has increased. With the collapse of the indigenous fauna in Lake Victoria (Barel et al. 1991), a new open-lake trawl fishery developed for the Nile perch with heavy foreign subsidy (Cohen et al 1996). Pesticides have been used to kill fish (leading to EU ban on fish from LVB). Illegal fishing practices such as the use of beach seine, poison or smuggling continue despite the efforts made by the government (Kulindwa 2001, Mbuga et al. 1998)
	There is lack of fishing quotas, or fishing quotas are not enforced.	Over fishing is occurring in main fishing grounds due to free access.	Fish exports increasing due to increased world market demand (Abila 2002) despite efforts to limit exports by limiting the number of cargo planes per week (Kulindwa 2001).
	There are no clear-cut property rights or entitlements.	There are scuffles in fishing grounds among fishermen competing for fishing territory.	In some areas, the large number of new fishing operations, particularly large-scale operations, has undermined traditional paths of authority which governed fishing rights (Yongo 1991). Fishing camps by processing plants create havoc between the company fishermen and small-scale fishermen (Kulindwa 2001)
	There are no legal or institutional arrangements between governments and resource users.		The existing fisheries regulation regarding mesh sizes needs revision because they are outdated and are no longer binding (Katunzi 1996).
	Political patronage and corruption protects commercial fishermen when they flout regulations.	Regulations exist but are not being enforced.	Although trawling in bays, gulfs, and inlets at depths of 20m or less is prohibited, most of the trawling and beach seining operations are made in these places without permission (Katunzi 1996). Those assigned duties of enforcing regulations at the village level have been accused of accepting bribes (Bwathondi et al. 2001).
How does failure of monitoring and enforcement mechanisms contribute to destructive fishing practices?	Issuing of licences for fishing is not enforced. Inadequate monitoring and enforcement capacity results in destructive fishing practices.	Excess fishing licences results into excessive fishing effort. Use of small sized fishnets, beach seines, multiple hanging and poison exists.	Licences used for tax collection and fund raising (Owino 1999). Illegal fishing practices continue despite efforts by government to curb them (URT/JICA 2002, Kulindwa 2001, Abila 2002).
	Corruption is rampant.		
	There is no regional integration of institutions, laws and enforcement.		The proposal to ban beach seining in the Lake has met with partial success in Uganda and Kenya, but is yet to be implemented in Tanzania (Katunzi 1996).
	Lack of resources in government to police the Lake.		

Pollution: Issue 1 – Microbiological			
Questions asked	**Hypotheses**	**Assumptions**	**Evidence**
Why is there increased animal waste?	There are larger populations of livestock and wildlife in the catchment.	Increase in animal waste is directly proportional to increases in livestock and wildlife populations. Efforts to manage livestock waste are minimal and insignificant.	The dense rural human population of LVD (>100/km^2) (Cohen et al., 1996), is matched by an equally high cattle population (Bootsma & Hecky 1993).
Why is there enhanced municipal effluent discharge that contributes to microbiological pollution?	The number and size of urban settlements and agro-industries are growing.	Increase in municipal effluent discharge is directly proportional to increases in human population and industry.	Human population density in LVB is >100km^2 and rapidly growing (Cohen et al. 1996).
	Untreated municipal effluents are largely discharged directly into the Lake.	There is no provision made to manage the existing and increasing effluents. Current effluent treatment technologies are outdated or non-functioning.	The highest population concentrations (both urban and rural) are within a short distance of the Lake (Bootsma & Hecky 1993). Except for Mwanza Tanneries, all the industries in Mwanza discharged their raw effluent into the Lake (Kishimba & Amkenda 1995).
	Rules and regulations for managing effluent from industry are not adhered to.	There is no enforcement of rules and regulations.	

How do runoff and stormwater contribute to microbiological pollution?	Land clearance for agriculture and settlements has led to increased run-off and stormwater.	There has not been a significant change in rainfall patterns and amount. There is increased erosion due to lack of soil conservation measures.	The highest population concentrations (both urban and rural) are within a short distance of the Lake (Bootsma & Hecky 1993). Rapid population growth has resulted in rapid conversion of forest and savannah woodland habitats to agricultural and range land (Cohen et al. 1996). Terracing is practiced by only about 25% of farmers in western Kenya today and this is probably a maximum for the region (Cohen et al. 1996).
	Poor urban planning has enhanced runoff and stormwater.	There has not been a significant change in rainfall patterns and amount.	The highest population concentrations (both urban and rural) are within a short distance of the Lake (Bootsma & Hecky 1993).
How does maritime waste contribute to microbiological pollution?	There are no regulations on over-board dumping of wastes.	There are a large number of craft that in total make a significant contribution to microbiological pollution in the Lake.	

Pollution: Issue 2 – Eutrophication			
Questions asked	**Hypotheses**	**Assumptions**	**Evidence**
Why is there enhanced effluent discharge?	The number and size of urban settlements and agro-industries are growing.	There is no provision made to manage the existing and increasing effluents. Current effluent treatment technologies are outdated or non- functioning.	The highest population concentrations (both urban and rural) are within a short distance of the Lake (Bootsma & Hecky 1993).
Why is there enhanced discharge of solids?	Land clearance for agriculture and settlements, poor waste disposal mechanisms or practices, and lack of soil conservation measures have led to increased discharge of solids.	There has not been a significant change in rainfall patterns and amount.	Rapid population growth has resulted in rapid conversion of forest and savannah woodland habitats to agricultural and range land (Cohen et al. 1996).
How do runoff and stormwater contribute to eutrophication?	Land clearance for agriculture and settlements has led to increased load of nutrient elements in run-off and stormwater.	There has not been a significant change in rainfall patterns and amount. There is increased erosion due to lack of soil conservation measures.	Rapid population growth has resulted in rapid conversion of forest and savannah woodland habitats to agricultural and range land (Cohen et al. 1996). The highest population concentrations (both urban and rural) are within a short distance of the Lake (Bootsma & Hecky 1993). The most densely populated (human and livestock) Lake margins are also areas where eutrophication problems are most serious (Cohen et al. 1996). Terracing is practiced by only about 25% of farmers in western Kenya today and this is probably a maximum for the region (Cohen et al. 1996).
	Poor urban planning has enhanced amounts of nutrient elements in runoff and stormwater.	There has not been a significant change in rainfall patterns and amount.	
	Widespread biomass burning has contributed to the total nutrient flux to the Lake.	Atmospheric dry and wet deposition is significant to the nutrient budget of the Lake.	The use of fuel wood among rural populations has accelerated deforestation and has enhanced nutrient load to the Lake (via particles carried by wind (Hecky & Bugenyi 1992, Bootsma & Hecky 1993, Cohen et al. 1996).

Pollution: Issue 3 – Chemical			
Questions asked	**Hypotheses**	**Assumptions**	**Evidence**
What has caused enhanced effluent discharge to the rivers and Lake?	Increase in industrial processing, mining, and use of agro-chemicals.	Inadequate or non-existent treatment of effluents prior to discharge in the rivers and Lake.	Manufacturing industries in Mwanza discharge their raw effluent direct into streams, rivers and into the Lake (Kishimba & Mkenda 1995). Kisumu effluent treatment facilities dysfunctional (actual observation) and effluent discharge from industrial areas flow into the Lake through black river (actual observation).
	Lack of monitoring and enforcement of regulations, hence non-compliance by industry.	Sufficient regulations exists which if adhered to would greatly minimise the chemical load in industrial and agro-chemical effluents.	
	Use of inadequate or outdated technologies.	Incentives exist for incorporation of clean technologies in industrial processes.	
Why is there enhanced discharge of solids?	Lack of regulations governing dumping of chemical waste	Solids are dumped close or into rivers and the Lake. Sufficient regulations exist and if adhered to would greatly minimise the chemical load in industrial and agro-chemical effluents.	Mining dumps.
How do runoff and stormwater contribute to chemical pollution?	Excessive use of agro-chemicals in agriculture.	There has not been a significant change in rainfall patterns and amount. There is increased erosion due to lack of soil conservation measures.	Terracing is practiced by only about 25% of farmers in western Kenya today and this is probably a maximum for the region (Cohen et al. 1996).
	Poor waste management leads to enhanced chemical load in stormwater drains.	There has not been a significant change in rainfall patterns and amount.	

Annex IV
List of important water-related programmes and assessments in the region

Programme	Aims / Objectives
East African Community Secretariat : Lake Victoria Development Programme (LVDP)	Puts emphasis on activities which lead to strengthening and consolidation of its role in promoting, coordinating and harmonising the various programmes and projects in the Lake Victoria Basin. The LVDP has already established and operationalised National Focal Points in the Partner States' Ministries, responsible for Lake Victoria development.
Lake Victoria Regional Authorities Cooperation (LVRLAC)	Socio-economic concerns.
Kenya Agricultural Research Institute (KARI)	Introduction of weevils from Australia, South Africa and Uganda to control water hyacinth.
Lake Victoria Environmental Management Programme (LVEMP)	Programme to monitor water quality, control water hyacinth, and manage fisheries, wetlands and land use
East African Communities Organisation for Management of Lake Victoria (ECOVIC)	Clean productive Lake with a healthy and productive community.
Urban Management Programme of the World Bank, in partnership with the Municipal Development Programme (MDP) of East and Southern Africa, and the Swedish International Development Agency (Sida)	Mobilising city/municipal governments along Lake Victoria to develop a programme on environmental management/improvement for poverty reduction in the lake region.
Lake Victoria Fisheries Organisation (LVFO)	Protect and restore the Lake: foster cooperation among the three East African countries on Lake issues, coordinate and harmonise national measures for the sustainable utilisation of the living resources of the Lake, develop and adopt conservation and management measures.
Lake Victoria Fisheries Research Project (LVFRP)	Status of fish stocks in the Lake, and socio-economics of the fisheries sector.
Lake Victoria Water Research Project (LVWRP)	Addressing issues of Lake water balances.
Kenya Marine Fisheries Research Institute (KMFRI)	
Tanzania Fisheries Research Institute (TAFIRI)	
Fisheries Research Institute of Uganda (FIRI)	
Kenya Medical Research Institute (KEMRI)	
Lake Basin Development Authority (LBDA)	
The Nile Perch Fishery Project, IUCN	
The Vulnerability Assessment of Lake Victoria basin to Environmental Change, UNEP-DEWA	
National Environment Action Plans (NEAP) for Kenya, Uganda and Tanzania	Regional cooperation to address problems such as water pollution, biodiversity loss, land degradation, deforestation, damage to wetlands.

Annex V
List of conventions and specific laws that affect water use in the region

East African Community Treaty

LVFO Convention

RAMSAR Convention

CITES Convention

Biological Diversity Convention of Agenda 21

Persistent Organic Pollutants (POPs) Convention

BASEL Convention

National Environmental Coordination Acts

National Fisheries Acts

National Water Acts

Nile Basin Treaty

SADC Protocols on Fisheries, Shared Watercourse Systems, Mining, Wildlife Conservation, and Law Enforcement

Annex VI
Addendum: A Journalists Diary for a Lake Victoria Tour

Lake Victoria Basin: So Rich Yet So Poor

By Parsellelo Kantai

The East African, Magazine, Monday, January 14, 2002

The Lake Victoria Basin is, potentially, the richest region in East Africa. So why are its people so poor, its environment in such deep crisis? Special Correspondent PARSELELO KANTAI toured the region, looking for answers.

Of the 320 odd fish species native to Lake Victoria 40 years ago, only eight remain. Their disappearance from the lake has been described as "the greatest mass extinction of modem times.

Its problems begin in bulging middle-age. At its source near Londiani, the River Nyando bubbles with the clarity and rebelliousness of youth. But age quickly thickens and corrupts it; travel darkens it. The Nyando's winding course down the Rift Valley and into Lake Victoria is a grim study in waste mismanagement. Municipalities, farms - large and small, industries and markets - all empty their waste into the river, so that by the time it nears the lake, the Nyando shows none of the purity of its youth. It has, in fact, become the filthiest of all the rivers flowing into Lake Victoria. Old and drunk - a sampling of its
waters some time ago revealed they were actually alcoholic - the Nyando is a danger to itself and to all those that use it or dwell within it. At Ahero Bridge, some 20 kilometres from the lakeshore, it is impossible to see more than an inch or two into the murk.

The River Nyando is also an important spawning ground for some of the lake's native fish species. At the start of the mating season they swim upriver, their course determined by a remarkable sensitivity to the quality of water. Today, many of them are either endangered or extinct, unable or unwilling to breed in the Nyando's foul waters. *Synodontis victorianus*, Okoko in Dholuo: rare. *Barbus* spp., Adel: rare. The Eel, *Mastecebelus* spp.: extinct. Of the 320 odd fish species native to Lake Victoria 40 years ago, only eight remain. Their disappearance from the lake has been described as "the greatest mass extinction of modem times."

Many blame the introduction of the Nile Perch, that voracious carnivore, for the disappearance of the native fish species. "That's garbage," says Okoth Mireri, a chemist by training and an environmentalist by profession, working with Osienala (Dholuo for 'Friends of Lake Victoria'). "What destroyed those species? Our poor environmental practices, our agricultural practices that have resulted in chemicals entering the lake through the rivers; our land use patterns that have brought a lot of silt into the lake. The fish have disappeared because the water quality in the Winam Gulf and around the shoreline has changed. We have destroyed the sub-ecosystems of the shoreline where most of the fish, like Tilapia, would breed in the littoral zone. The riverine fish species are threatened because their breeding grounds are polluted."

The Nyando is one of 10 rivers that drain into Lake Victoria from the Kenya side. Another 10 feed the lake, four from Uganda and six from Tanzania. The Nyando is a dirty mirror image of them all. They may not be as polluted, but they all suffer, in varying degrees, from the same disease: untreated sewage from municipalities and rural towns, toxic effluent from industries and, above all else, sediment - the biggest contributor of pollution in the lake basin.

"The sheer magnitude of soil and land degradation is phenomenal," says Markus Walsh, an ecologist researching land degradation in the lake basin. "This sort of destruction is, I think, unparalleled in Africa."

The state of the Nvando illustrates a widelvheld view: of the three East African countries that share this resource, Kenya's impact on the lake's ecological health is by tar the most severe, "All the East African countries contribute to the pollution of the lake basin in general and Lake Victoria in particular," says Tom Anyonge of SIDA, the Swedish development agency which funds much of the research into the environmental problems of the lake basin. "75 per cent of the lake's recharge comes from Kenya. Kenya is also the biggest polluter of the lake, and it is doing the least about it."

A 1998 SIDA-funded report. The Lake Victoria Basin Hot Spots Study, paints a terrifying picture of pollution from all sides of the lake basin: broke and broken-down municipalities - Kisumu's sewer treatment works, for instance, stopped functioning 10 years ago; largely unregulated, agro-industries dump untreated or partially treated effluent into rivers or directly into the lake; fertilisers, herbicides and pesticides all find their way into river systems and the lake.

On the banks of" the Nyando, at the junction of the new Kisii road and the main Nakuru -Kisumu road, Ahero town is alive with activity. The market centre, located close to the river and flush against the road, is crammed with hotels, lodgings and hundreds of hawkers selling anything from those noisy alarm clocks on offer along Nairobi's Uhuru Highway to vegetables, dried fish, fried and smoked fish, nyama choma and mitumba of all kinds. Music in three languages fills the market place, competing with shouted offers for clothes, shoes, trinkets and toys, and motor vehicle spare parts. Itinerant photographers hover. Two-man welding operations squeeze between the kiosks and hotels. quick-servicing the vehicles that ply the various Nyanza routes. Matatus enter the market, hooting like there's a medical emergency. Touts holler. Everybody's doing roaring, raucous business. The age of trinkets and second-hand clothes has arrived. Liberalisation and rural poverty are a heady mix.

Behind the market and across the road, on the banks of the river, are scenes of people living the sort of semi-rural existence that is repeated a thousand times throughout East Africa. Scores of mabati shanties interspersed with jua kali workshops; tiny shambas line the banks. The entire weight of Ahero's waste rolls down into River Nyando, transported by rainwash or dumped directly into the river.

In towns like these, whose existence is incidental to the larger aims of cross-country trade, the need to connect towns and cities located hundreds of kilometres apart by tarmac, the presence of a river is frequently disastrous. For all of its chequered upstream history of human activity and rural waste, the Nyando is also Ahero's only source of drinking water.

"This water is used directly for domestic consumption. That is the sad part of it. There is no sewage trealment at Ahero, no sewer works." explains Okoth Mireri, who is also our guide during our Nyanza tour. "The toilets of Ahero are the banks of the river. Everybody shits into the river."

For all of its problems, however, the Lake Victoria Basin also contains immense natural wealth. "The lake is this region's IMF and World Bank," says Okoth Mireri. "But only if we manage it correctly."

The lake sustains the largest freshwater fisheries in the world. In the 1990s, and, paradoxically, thanks to the introduction of the Nile Perch and the Nile Tilapia, total fish catches in Lake Victoria accounted for 25 per cent of all the fish caught in Africa's inland fisheries. In 1999 at the height of the EU fish ban and water hyacinth infestation, Kenyan fishermen still managed to catch and sell fish worth about Ksh 8 billion($100 million).

Water hyacinth

The lake's resource wealth is further increased by the fact that its soils are among the most fertile in East Africa. The varied and rich cultures of its peoples, its breathtaking scenery and abundant wildlife as well as the sheer vastness of the lake make it, potentially, a prime tourism destination. Factor in the region's capacity for industry, its potential for hydro-electricity, the gold and other mineral deposits in such places as Geita in Tanzania and Macalder in Kenya, and you are looking at, again potentially, the richest region in East Africa.

And yet the people of the lake basin are among the poorest in the world. On the Uganda side. 55 per cent of the population is classified as absolutely poor. In Kenya and Tanzania, official statistics suggest poverty levels of 42 per cent and 52 per cent respectively. Malnutrition is rife. Child mortality high, protein deficiency, in this richest of protein-rich zones, acute. Add to this the economic, social and environmental cost of HIV/Aids, whose incidence in the lake basin is, once again, among the highest in the world, and a grim picture begins to appear tragic.

Why?

There are clues, but no easy answers. The dreams for the lake basin's development were as grand as the area's size and potential; fisheries, sugar production, irrigation schemes for rice and cotton. In Kenya, however, where much of the early development look place, many of the dreams' monuments are either unfinished or rusting from disuse, giant jokes wilt painfully farcical punch-lines. A molasses plant that never look off; the new offices of the Lake Basin Development Authority, which cost a reported Ksh900 million ($11.25 million) but never got past the foundation stage; limping sugar factories, an empty cotton mill, disused fish-ponds; a rice-plantation scheme now filled with maize; an abandoned irrigation scheme at Yala Swamp. The road between Homa Bay and Mbita Point is officially tarmacked, the contractor paid, but it remains a dirt road, bone-shaking when it's dry, nearly impassable when it rains.

Waste in the lake basin is a two-lane highway: flowing down into the lake is the waste and pollution generated upstream. In the opposite direction, leaving the basin, flows the region's wealth. Few other places display such a lack of re-investment in the midst of such riches.

Take Mbita Point, for instance. Facing the open lake, with its back to the Winam Gulf, its waters are rich fishing grounds. So rich. in fact, that the brokers and agents of various, mostly foreign-owned fish processing companies, riding in fleets of two-Ion Isuzu trucks, make up to three round-trips a day from Mbita to Homa Ray, a 40 km, 90-minute trip over the barest excuse for a road.

On each departure, their trucks are laden with the lake's harvest, belching smoke and the fumes of dead fish. *Lates niloticus*, Nile Perch. At the beach landing sites on an especially desperate day, the fishermen will sell a kilo of Nile Perch for Ksh20 (25 US cents). On a good day, it may go for Ksh9O, just over $l. A mature Nile Perch weighs between 30 and 180 kg, the heaviest ever recorded. The brokers, who sell to the processors, claim to make a paltry five shillings on every kilo; "These are bad times. After fuel and maintenance, there's nothing left." said Ali, a broker we met at a fish banda in Mbita, supervising the weighing and lugging of a 52 kg Nile Perch into his van.

The Nile Perch has been a blessing and a curse. To paraphrase the findings of a study by International Union for Conservation of Nalure (IUCN), "Rich Fisheries, Poor Fisherfolk," over the past two decades its presence has dramatically increased the total fish harvest from Lake Victoria. It has commercialised fishing and created employment; it has also left itinerant fishermen at the mercy of wealthy industrial fish exporters, and is rapidly pushing local fish traders out of existence. Along the Mbita Causeway, fish mamas sell the dried skeletons of small, immature Nile Perch, or dried Tilapia from distant Lake Turkana. Of the huge tonnage caught from the waters off Mbila Point, this is what remains for local consumption. Small fry. The big fish have been loaded onto the trucks, headed for Nairobi, Mombasa, the export market.

"One problem we have here is the middleman. There is a lot of money going out but the fishermen remain poor." explains Malachi Magero, the finance manager of the Suba District Co-operative Union. "At times they will bid down to less than Ksh20 per kilo. They sell the fish at throwaway prices because they can't store it," Once processed into fillet, a kilo will go for Ksh475 (S5.9) in Nairobi's supermarkets, and at least twice that on the international market.

There is little evidence of re-investment in Mbita - or any of the fishing towns and villages on the Kenya side of the lake. In 1992, Kenyan fishermen caught 219,000 tonnes offish. At an average ofKsh50 ($0.6)per kilo, this translates to nearly Ksh11 billion ($137.5 million). Where did it all go?

Whatever money left behind in Mbita is quickly frittered away, drained down the urinals of the many bars and hotels, testimony to the fisherman's firm belief that there is always more where that came from. Drink today, for tomorrow we fish. It's a trend that extends across the lake basin, beyond borders.

"A fisherman is a hard person to tame," says Magero. "He doesn't understand the idea of saving. We tried to implement a credit system, whereby we buy their fish and pay them after three days, or they could be paid in Homa Bay through a bank. They rejected that. They want to be paid directly and immediately."

The money left over has, presumably, helped construct the many semi-permanent structures, the mabati shops, the kiosks, hotelis and bars that populate this one-street township, but there is little if any evidence of long-term prosperity here.

The region's challenges remain enormous. Waste and poverty make awful bedfellows, and in the lake basin, they have spawned a demon child - a debilitating culture of dependency.

"If you ask fishermen on the Kenya side of the lake, 'Who owns the fish?', they will tell you that it belongs to the government," says Mireri. Such attitudes indicate the extent to which many feel that they have lost out or lack a stake in managing their own resources. It doesn't help either, that with the many disasters that have stalked the region in the recent past, have also come armies of aid agencies and NGOs, doing little more than taking the place of Mama na Baba, the government.

The region needs a lot more than fresh injections of funding. "Ultimately, the lake basin's problems can only be solved by the people of the lake themselves," says Tom Anyonge. Uganda seems to have taken this sentiment to heart in its campaign to protect and boost the wetland ecologies that fringe the lake and serve as a crucial natural filter.

Launched in 1989, the key to the Uganda National Wetlands Programme's success has been community involvement, and specifically women, because, as one observer put it, "the government recognises that they are the guardians of water and fire in the community. They know best how to manage those resources."

The programme also offers a five-week course in wetland management, trains communities in making a range of products from sustainably-harvested wetland plants such as papyrus, rattan cane and hyacinth, and is in the process of quantifying the economic contribution of the wetlands' natural services.

Pollution must also be aggressively tackled at its source. Before Okoth Mireri and Osienala began preaching the virtues of waste treatment to the managers at Muhoroni Sugar Factory and its molasses-producing counterpart, Agrochemicals and Foods Ltd, the two were among the worst industrial polluters in the lake basin. Effluent released from Agrochemicals had a BOD (biological oxygen demand, a measure of its pollutants) of 95 000 milligrammes per litre. The World Health Organisation recommended level is 100.

The giant mollasses plant in Kisumu has never taken off.

Like many other factories, they had taken advantage of weak environmental laws and opted to pay ridiculously small fines rather than improving their treatment plants. Osienala was faced with the choice of either exposing them, eventually getting them closed down and leaving thousands of people unemployed, or working with them to steadily reduce their pollution-levels. They chose the latter.

Working with the District Development Committee, they managed to get the government to offer them some tax breaks. Eventually, and at a huge cost to both companies - Ksh300 million for Agrochemicals and Kshl20 million for Muhoroni ($3.75 million/$1.5 million) - the two installed new treatment works and are
gradually reducing the toxicity of their effluents.

All of these opportunities, bright spots flickering on the horizon, are fragile, easily extinguished. And they won't amount to much overall if the fundamental problem of the lake basin is not addressed: resource ownership. It is not for lack of laws - whether old or new - that fishermen poison fish, that industries flush their untreated waste down rivers, that municipal councils endanger the lives of their citizens by emptying raw sewage directly into the lake. These acts of irresponsibility are nurtured in an environment where entire communities have been disenfranchised and the extraction and exportation of wealth have become the dominant trends. Until these basic issues are addressed, the region's economic potential will be something we'll be talking about forever.

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