Identification and evaluation of reuse-oriented sanitation concepts for Massawa, Eritrea

Pre-feasibility Study

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Objectives

To initiate the inception phase for ecological sanitation activities in the town of Massawa

- **Specific objectives:**
  - To assess the actual sanitation and hygiene situation in the town.
  - To identify a series of suitable reuse-oriented sanitation concepts for the town.
  - To evaluate the feasibility of the different concepts considering the economic, environmental, social and technical context.

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Methodology

1. Determination of local officials's interest
2. Presentation of Terms of Reference
3. Informal presentation of the study (to national and local authorities)
4. Stakeholder analysis
5. Rapid assessment of the actual situation
6. First workshop presenting the results on the rapid assessment and receiving the official input (expectations on the project)

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Methodology (2)

7. Information gathering, consulting and survey
8. Identification and evaluation of different ecological sanitation concepts
9. Discussion with supervisors and counter-parts
10. Second workshop presenting results of the study
11. Redefinition of concepts
12. Final Report

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Information sources

- Secondary data
- Interviews with key stakeholders
- Observatory walks
- Field visits
- Household-based interviews
- Group discussions
- Workshops

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Eritrea

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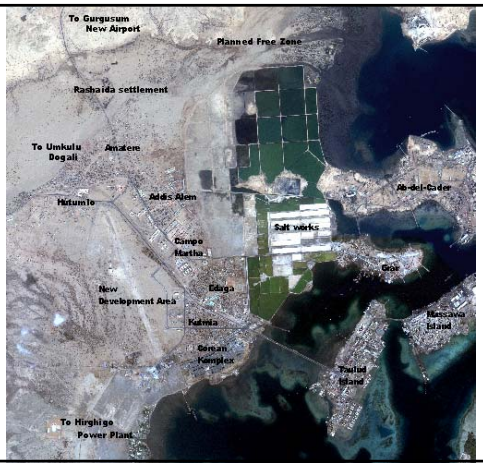
Massawa

- Temperature: 29,5°C (maximum 46,5°C)
- Rainfall: less than 200 mm (nov – feb)
- Soil: sand dunes, coral dunes and evaporites (permeable soil)
- Groundwater level: 5-13 m.
- Population: 36,700 (census 2004)
- Main industries: Port, salt works, cement factory, quarry
- Agricultural activities: maize, sorghum, millet, watermelon, tomato (spate-irrigation)
- Energy sources: electricity, wood and coal



Major problems in Massawa

- Water shortage
- Lack of adequate sanitation
- Health effects of poor sanitation
- Groundwater and seawater pollution
- Food insecurity
- Increase of the urban population

Water shortage

- Depletion of actual groundwater sources due to overexploitation
- Salt water intrusion
- Constant droughts
- Increase of the water demand

Lack of adequate sanitation

- Lack of sanitation facilities in some areas.
- Sometimes toilets have to be shared by different households.
- Flush toilets do not work properly due to the shortage of water.
- All schools in Massawa lack of adequate sanitation infrastructure.
- Traditionally people in Eritrea do not care about sanitation aspects.

Sanitation (2)

Health effects of poor sanitation

- Eventhough the diarrhoea incidents have decreased in the last few years, it is still the second most common water-related disease in Massawa.
- 20% of the outpatients of Massawa hospital suffer diarrhoea.
- Many cases of malnutrition may be caused by a badly treated diarrhoea.

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Water pollution

•Infiltration pits (called septic tanks)
•Discharges into the sea

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Food insecurity

- Agricultural activites in coastal areas dependant on rainfall.
- 80% of food requirements comes from the highlands.
- Dependancy on food aid.
- Loss of valuable nutrients in human wastes and organic wastes.

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Increase of urban population

- Population in Massawa has increased in 55% from 1994 to 2004, which represents 4.5% annually.
- New development areas and industries will generate more jobs and therefore more migration to Massawa town during the next years.

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General considerations

- Reduce groundwater and sea water pollution
- Low water consumption
- Prefered decentralized systems
- Low costs
- Offer reuse options and nutrients recycling
- Adequate to climatic conditions of Massawa
- Accepted by the population

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General considerations (2)

- Reliable, stable and robust (simple) process
- Simple operation and maintenance
- Low technical knowledge
- No need of external energy supply
- No chemicals are needed
- Availability of spares

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Type of proposals

1. Hut areas

2. Concrete-constructed houses and buildings

3. New development areas

Technical proposals (Category I)

Category	Option	Flows to be treated	Sanitation facility and treatment	Treatment	Resource recovery
Hut areas (Category I)	I-A Fossa alterna	- Blackwater - Greywater	Fossa alterna with separated greywater collection and treatment	- Soil composting of faeces and urine - Sand filter for greywater	- Composted material as a soil conditioner - Greywater for irrigation
	I-B Dehydration with urine diversion	- Yellowwater - Brownwater - Greywater	Deydration toilet with urine diversion	- Storage tank for yellowwater - Faeces co-composted with organic waste after dehydration - Storage tank for greywater with filter or sand filter	- Urine as a fertiliser - Compost as a soil conditioner - Greywater for irrigation
	I-C Biogas	- Blackwater - Greywater	Low-flush toilet	- Blackwater in anaerobic digester for biogas production - Sand filter for greywater - Sludge handled centralized in drying beds	- Biogas for electricity or cooking - Greywater for irrigation - Sludge as soil conditioner

Technical proposals (Category II)

Category	Option	Flows to be treated	Sanitation facility and treatment	Treatment	Resource recovery
Concrete-constructed houses and buildings (Category II)	II-A Baffled-septic tank	Mixed sewage	Low-flush toilet	- Baffled septic tank for mixed sewage - Sludge treated in drying beds	- Effluent for groundwater recharge - Sludge as a soil conditioner
	II-B Urine diversion and wetland	- Yellowwater - Brown and greywater	Low-flush toilet with urine diversion, wetland treatment plant	- Storage tank for yellowwater - Sedimentation of mixed brown and greywater in the old septic tank - Treatment of the effluent in a constructed wetland - Sludge treated in drying beds	- Urine as a fertiliser - Sludge of the septic tank as soil conditioner - Effluent of wetland for irrigation - Possible reuse of the plants from the wetland
	II-C Dehydration with urine diversion	- Yellowwater - Brownwater - Greywater	Dehydration toilet with urine diversion, wetland treatment plant	- Storage tank for yellowwater - Dehydration of faeces - Co-composting of pre-treated faeces with organic waste - Sedimentation of greywater in old septic tank - Constructed wetland for greywater - Sludge treated in drying beds	- Urine as a fertiliser - Composted faeces used as soil conditioner - Sludge from the septic tank as soil conditioner - Treated greywater for irrigation - Possible reuse of plants from the wetland

Technical proposals (Category III)

Category	Option	Flows to be treated	Sanitation facility and treatment	Treatment	Resource recovery
New development areas (Category III)	III-A Baffled-septic tank	- Mixed sewage	Low-flush toilet, baffled septic-tank and wetland treatment plant	- Baffled-septic tank - Constructed wetland for effluent of the baffled-septic tank - Sludge handled centralized in drying beds	- Treated greywater for irrigation - Possible reuse of plants from the wetland plant. - Sludge as soil conditioner
	III-B Vacuum and biogas	- Blackwater - Greywater	Vacuum toilet, anaerobic digester and wetland treatment plant	- Anaerobic digestion of blackwater - Sedimentation tank - Constructed wetland for greywater and effluent of digestor - Sludge handled centralized in drying beds	- Biogas for electricity or cooking - Treated greywater for irrigation - Possible reuse of plants from the wetland - Sludge as soil conditioner
	III-C Dehydration with urine diversion	- Yellowwater - Brownwater - Greywater	Double-vault dehydration toilet with urine diversion, wetland treatment plant	- Storage tank for yellowwater - Dehydration of faeces - Co-composting of pre-treated faeces with organic waste - Constructed wetland for greywater	- Urine as a fertiliser - Compost as soil conditioner - Treated greywater for irrigation - Possible reuse of plant from the wetland

Evaluation criteria

- Water required for operation
- Health and environmental impacts
- Climate and soil requirements
- Costs
- Technical capacity
- Operation and maintenance
- Flexibility
- Reuse potential
- Acceptance by users

Analysis

	Category I: Hut areas			Category II: Concrete-constructed houses and buildings			Category III: New development areas		
Indicator	I-A Fossa alterna	I-B Dehydration and urine diversion	I-C Biogas	II-A Baffled-septic tank	II-B Urine diversion and wetland	II-C Dehydration with urine diversion	III-A Baffled-septic tank	III-B Vacuum and biogas	III-C Dehydration and urine diversion
Water requirements	++	++	-	-	-	++	-	+	++
Health and environmental impacts	++	++	++	+	++	++	++	++	++
Climate and soil requirements	+	+	++	+	-	-	-	-	-
Costs	++	+	+	++	-	-	+	--	++
Technical capacity	++	+	+	++	+	+	+	--	++
Operation and maintenance	++	+	-	+	+	+	+	--	+
Flexibility	++	++	+	+	++	++	+	+	++
Reuse potential	+	++	+	-	+	++	+	++	++
Acceptance by users	++	+	++	++	+	-	++	+	-

Recommendations for follow-up

1. Select the department or area responsible for coordinating.
2. Select people from the administration to be responsible for the follow-up.
3. Developing technical proposal for pilot project(s).
4. Apply for financing of pilot project(s).
5. Installation of pilot project(s).
6. Feasibility study on specific alternatives considering the experiences from pilot projects.
7. Implementation of the feasibility study and construction of the new sanitation infrastructure.
8. Monitoring and redefinition of the systems should be done during the whole process.
9. Educational campaign should be considered during the whole process.

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