

# Life Cycle Check as a decision support tool for medical waste management in underdeveloped areas of Africa

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# Summary of presentation

- ◆ **Why develop a another decision support tool**
- ◆ **Life Cycle Check: Description of decision support tool to optimize waste management systems - “WasteOpt”**
  - ▮ **Goal and scope of tool**
  - ▮ **Specifications**
  - ▮ **Process assessment: quantities, mass flow, resource flow, equipment and manpower**
  - ▮ **Impact assessment: identification and ranking relative to guidelines**
- ◆ **Fitness for purpose**
  - ▮ **Fitness for purpose: case of one country assessment**
  - ▮ **Quality control**
  - ▮ **Accuracy**
  - ▮ **Implementation**



# Why develop a decision support tool



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# Summary: Why develop another decision support tool

- ◆ **Difficulties with making decisions**
- ◆ **Where we are coming from in setting up the tool**
  - ▢ **What about other tools**
    - **Review of tools used for waste management decision support**



# Difficulties with making decisions for waste management systems



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# Summary: Difficulties with making decisions

- ◆ **Developing country shift in focus from district curative facilities to local preventative services, e.g. immunization, mother and child programmes**
- ◆ **There is more waste at preventative health service facilities**
  - ▮ **Due to poor quality control on sterilization, 1 million people are estimated to die each year (next slide), and to for this reason WHO and UNICEF have recommended the adoption of single use devices in place of reusable devices**
  - ▮ **The waste is hazardous**
- ◆ **The responsible authorities do not have waste management infrastructure**
- ◆ **In Africa where donor funds play a large role in providing health care, the aid will be tied to compliance with national regulations and international protocols**



# Costs of poor infection control in developing countries

Estimated global annual incidence of cross infection, future deaths, years of life lost, and cost resulting from cross infection in unsafe injections\*

	Hep B	Hep C	HIV	Total
<b>Infections</b> (millions)	8.2	2.3	0.1	10.6
<b>Deaths</b> (millions)	1	0.2	0.1	1.3
<b>Years of life lost</b> (millions)	19.7	3.6	2.7	26
<b>Direct medical cost</b> (USD millions)	327	59	149	535

(\*WHO Bulletin 1999, 77 (10) Miller and Pisani)



# Hazards from waste at developing country health care facilities

<b>Disease</b>	<b>% of population in sub-Saharan Africa infected</b>	<b>Infection risk based on one needle prick</b>
Hepatitis B	10.0 %	20-40 %
Hepatitis C	2.6 %	6.0 %
HIV/AIDS	> 3.5 %	0.3 %





Where are we coming from in  
setting up the tool?



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# Summary: Where are we coming from in setting up the tool?

- ◆ **Experiences to date**
- ◆ **Review of other decision support tools**
  - ▢ **BPEO**
  - ▢ **Decision makers guides**
  - ▢ **Decision trees**
  - ▢ **Practical technical guidance documents**
  - ▢ **Environmental life cycle assessment**



# Experiences to date

- ◆ **Several years experience with identifying waste management problems with health care waste and assisting industry, and government, development agencies, and their financiers to come up with rapid, effective decisions for long and short terms**
  - ▮ **Found problems with a lack of integrated vision, understanding, and commitment**
    - **General levels of frustration by decision makers, and ad-hoc and lack of integrated planning**
  - ▮ **Results are: slow decision making, and loss of focus on the overall problems, e.g. training, equipment performance, what can be achieved with available resources**
  - ▮ **A number of tools were implemented to support decision makers**



# Review of WM tools: BPEO

- ◆ **Best Practicable Environmental Option (BPEO)**
  - ◆ **The selection of options for each step in the process that provides the most benefit or least damage to the environment as a whole, at a cost that is acceptable to the community (NEMA 1998)**
    - ▮ **Enables identification of options**
    - ▮ **cost and impact assessment and**
    - ▮ **Rational ranking**
- But**
- ▮ **Ability of uneducated and inexperienced communities to assess impacts and costs may be low**



# Review of WM tools: Decision makers guides

- ◆ **Guideline document for national assessment (policies, regulations, economics and facilities), development of a national plan, using key stakeholders, and recommendations for pilot projects and implementation plans (WHO 2002)**

- ▣ **Enables comprehensive planning for short and long term**

**But**

- ▣ **Can be drawn out and take many years to complete**



# Review of WM tools: Decision trees

- ◆ **Flow chart of operations, accompanied by a list of parameters that should be assessed before using the decision tree (WHO 2001)**

- ▢ **Graphically illustrates a wide range of options and highlights the risks associated with each step**

**But**

- ▢ **Not user friendly at practical level, owing to intricate nature of flow-charts; best used for awareness building**



# Review of WM tools: Practical technical guidance documents

- ◆ **Technical problems are identified and recommended practices are provided. (eg SABS 1993/200X codes of practice, and WHO Guides 2002 )**

- ▮ **Practical advice on management involvement, and examples of equipment to use for collection, segregation, transport, treatment and disposal**

**But**

- ▮ **Limited information on costs and availability of equipment in developing countries**



# Review of WM tools: Rapid Assessment Tools (RAT)

- ◆ **Questionnaire based quantification, qualification of waste amounts, locations**

- ▮ **Standard format for use at many locations, and many types of personnel**

**But**

- ▮ **No data on environmental or health impacts, or costs. Requires expert interpretation to provide data required by decision makers**





# Review of WM tools: Environmental Life Cycle Assessment

- ◆ **LCA studies environmental aspects through a product or process life, typically from raw material acquisition, production, use, to disposal. (ISO 14040:1997)**



# Review of WM tools: Environmental Life Cycle Assessment (2)

- ◆ **Potential uses in health care waste management:**
  - ▣ **Process assessment, equipment and training specifications, operation guidelines for equipment and manpower**
  - ▣ **Enables a mass balance for waste. Quantifies flow of material (inputs, and outputs), resources, and pollutants.**
  - ▣ **Enables integrated planning and Decision making for industry and government (strategic planning, priority setting, product and process design)**

**But**

- ▣ **Can be subjective if impact data is not available, e.g. time and space range is broad and varied, e.g. impact of pollution over many years and many regions.**



# Review of WM tools: Environmental Life Cycle Assessment (3)

- ◆ **Solution 1: focus on the purpose and available resources (manpower and time), e.g.,**
  - ▮ Cradle to grave: can be relevant for product and health care system design
  - ▮ End of useful life to grave: main relevance for waste management
- ◆ **Solution 2: use semi-quantitative ranking criteria, e.g.**
  - ▮ Acceptable/ unacceptable impacts, e.g. WHO, Centre of Disease Control, World Bank



# Example of the use of life cycle to improve decision making

- ◆ **Ineffective Approach: Optimize task efficiency: unit operation improvement**
  - ▮ In the interests of infection control in the preventative health care system, disposable devices are introduced. This results in more infectious waste being produced.
- ◆ **More effective approach: Optimize system efficiency: LCA assessment and risk/risk tradeoff**
  - ▮ By comparing the risk of infection in the waste disposal more rational decisions can be made about investment in infection control technologies



# Life Cycle Check: Description of decision support tool "WasteOpt"



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# Summary: Description of the decision support tool "WasteOpt"

- ◆ **Goal and scope of WasteOpt**
- ◆ **Process assessment: quantities, mass flow, resource flow, equipment and manpower**
- ◆ **Impact assessment: identification and ranking relative to guidelines**



# Goal and Scope of WasteOpt

## ◆ Application

- Quantify masses and classes of waste in the system
- Quantify key resource usage, and key impacts from the use of the
- Available options for unit operations used in
- the collection, treatment and disposal of the waste, at
- Rural health care facilities, in
- Under-serviced and developing country areas; limited resources and infrastructures



# Goal and Scope of WasteOpt (2)

## ◆ To be used by decision makers

- ▮ Policy and budgets at national level (DoH-Environmental Health; DEAT/DWAF: Waste management and Environment protection; standards and control for infection and pollution; Occupational training institutions)
- ▮ Implementation and prioritizing expenditures at regional level (DoH-Environmental Health, District Hospital management)

## ◆ Reasons

- ▮ To provide a coherent and integrated framework for both health care professionals and managers to rank and prioritize alternative waste management processes, and
- ▮ To optimize waste management systems, taking into account environmental/health effectiveness and economic affordability

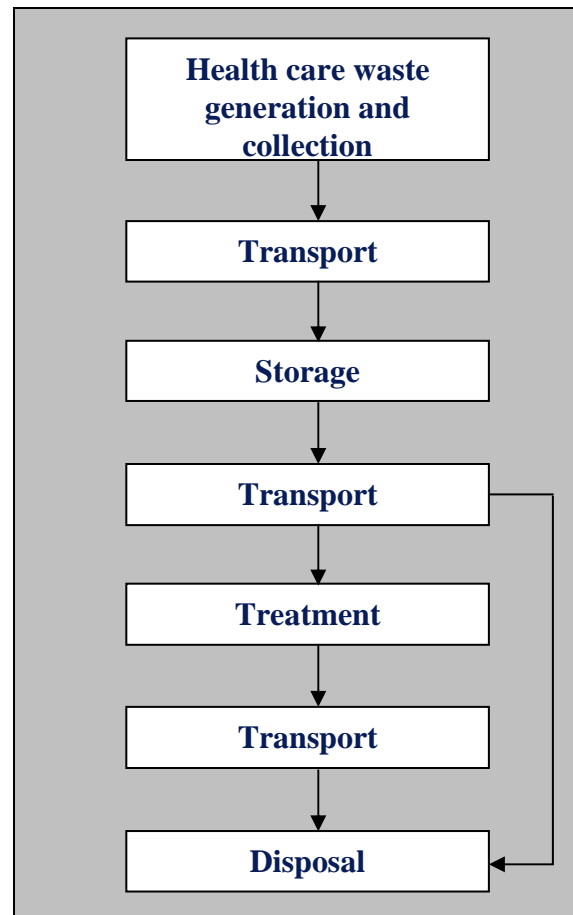




# Process assessment: Life cycle of health care waste

- ◆ Consists of unit operations that require equipment and manpower components:

- ▢ Segregation/collection
- ▢ Storage
- ▢ Transport
- ▢ Treatment
- ▢ Disposal

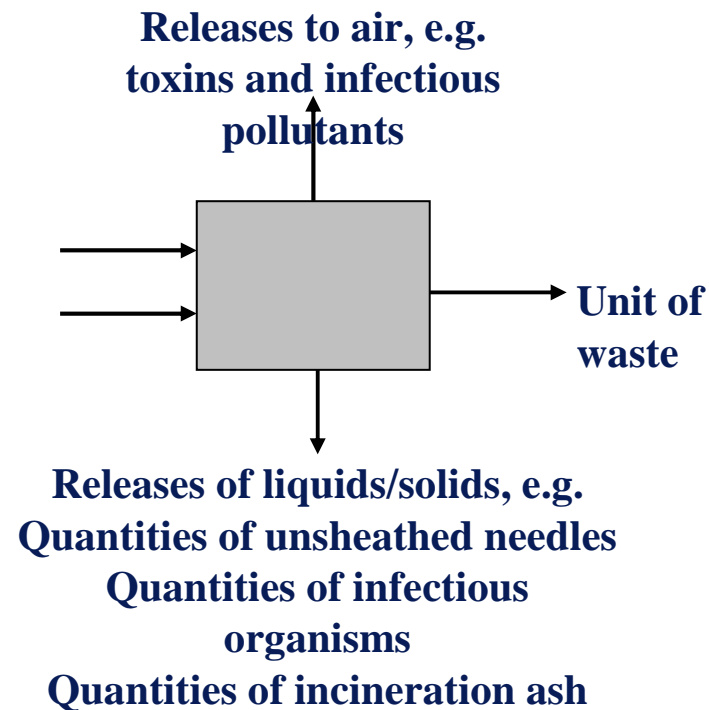


# Process assessment: Unit operations within the life cycle

- ◆ Different unit operations require specific input and output flows to function properly:

- ▣ Segregation/collection
- ▣ Storage
- ▣ Transport
- ▣ Treatment
- ▣ Disposal

Resources, e.g.  
energy Unit of  
waste



# Impacts associated with measured parameters

- ◆ Typical examples of how measurable parameters relate to potential risks of impacts:

Measurable parameters	Cause of potential impacts	Mid-impacts	End-impacts
Best practices / guidelines for equipment and manpower operations	Best practices are not followed	Unprotected sharps in contact with people	HIV infection of person
		Out of order or incorrectly operated incinerator	Inhalation of hazardous emissions



# WasteOpt: Identification of impacts and ranking

- ◆ **Identify main potential impacts**
- ◆ **Identify potential cause of impacts by comparison of current practice with best practice**
- ◆ **Ranking using fault tree with severity of deviation determined by expert ranking relative to guidelines**



# WasteOpt: Interface - measurable parameters and impacts

## ◆ Example of the treatment unit operation:

WasteOpt Life Cycle Check Tool for Health Care Waste Management: Treatment Phase



The preferable treatment is destruction in a maintained, specced incinerator with regularly available fuel, by a fully qualified operator using comprehensive PPE. This corresponds to option 1 below.

If your treatment practices show any of the shortcomings listed below, select the appropriate boxes by marking them "1"

OPTION	DESCRIPTION	APPLICABLE?	WEIGHTS		LINE STATUS
			AUTOMATIC	MANUAL	
1	Treatment according to preferred procedure	1	1.0		Automatic only
2	Highest form of training is course				Not selected
3	Highest form of training is in-house				Not selected
4	No training				Not selected
5	Apron not available				Not selected
6	Goggles not available				Not selected
7	Surgical gloves not available				Not selected
8	Thermal gloves not available				Not selected
9	Direct manipulation of waste				Not selected
10	Fuel available irregularly				Not selected
11	Problems with loading, reloading, heating				Not selected
12	Problems with ash removal				Not selected
13	Inferior fuel quality (e.g. smoke, too cool)				Not selected
14	Problems with burn duration				Not selected
15	Problems with burn temperature				Not selected
16	No maintenance plan for incinerator				Not selected
17	Only a drum available for burning				Not selected
18	Only an open pit available for burning				Not selected
19	Fuel or burner not available				Not selected
20					Not selected

STATUS OF MANUAL WEIGHTS:	
Weights ascending?	OK
Weights between 1 and 10?	Error



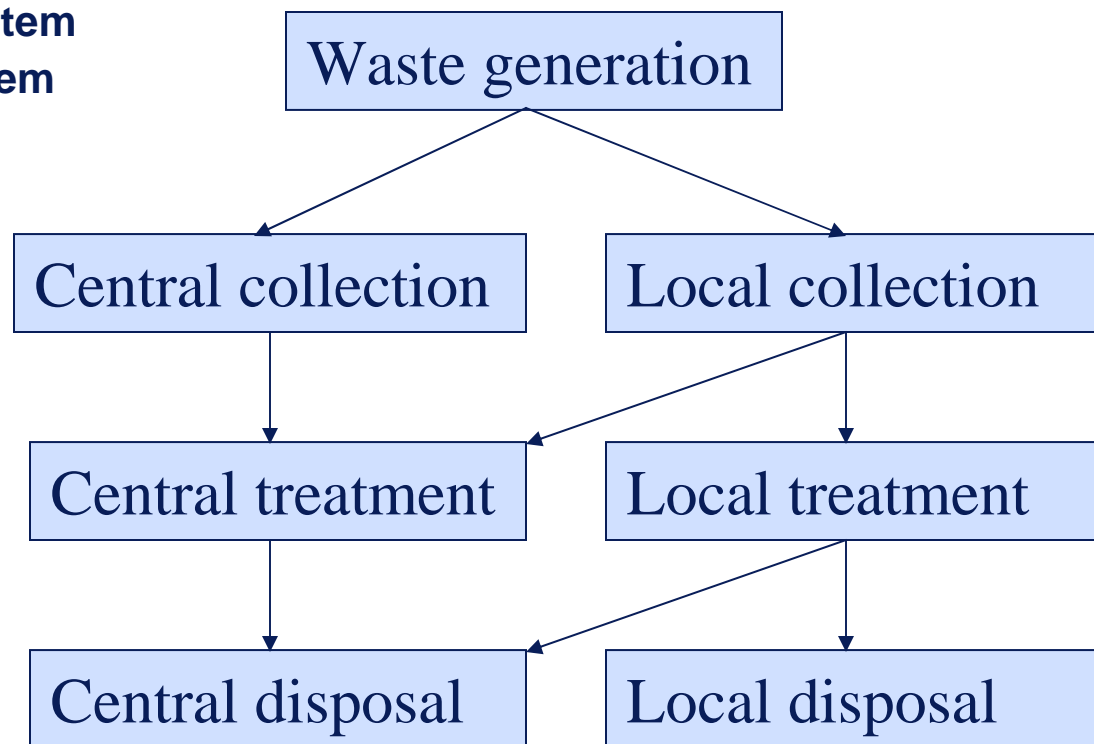
# WasteOpt: Select life cycle options to determine least risk

- ◆ **Centralized collection system, transport and storage**  
Central treatment system  
Central disposal system

- ◆ **Local collection**  
Central treatment  
Central disposal

- ◆ **Local collection**  
Local treatment  
Central disposal

- ◆ **Local collection**  
Local treatment  
Local disposal



# Fitness for purpose of WasteOpt



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# Summary: Fitness for purpose of WasteOpt

- ◆ **Case of one country assessment**
- ◆ **Quality control**
- ◆ **Accuracy and data inputs**
- ◆ **Decision making and communication**
- ◆ **Implementation**





# Case assessment: Example of the treatment unit operation

Measurable parameters	Main findings in a typical African country assessment	WasteOpt
Mass flow of fuel for equipment operations	Fuel not available	√
Training for manpower operations	No training system of waste management	√
Specifications for equipment operations (maintenance)	50% of incinerators are not in working condition	√
Control of manpower and equipment operations	No infrastructure or guidelines for best practices, e.g. 50% of waste disposed in open pits with burning	√



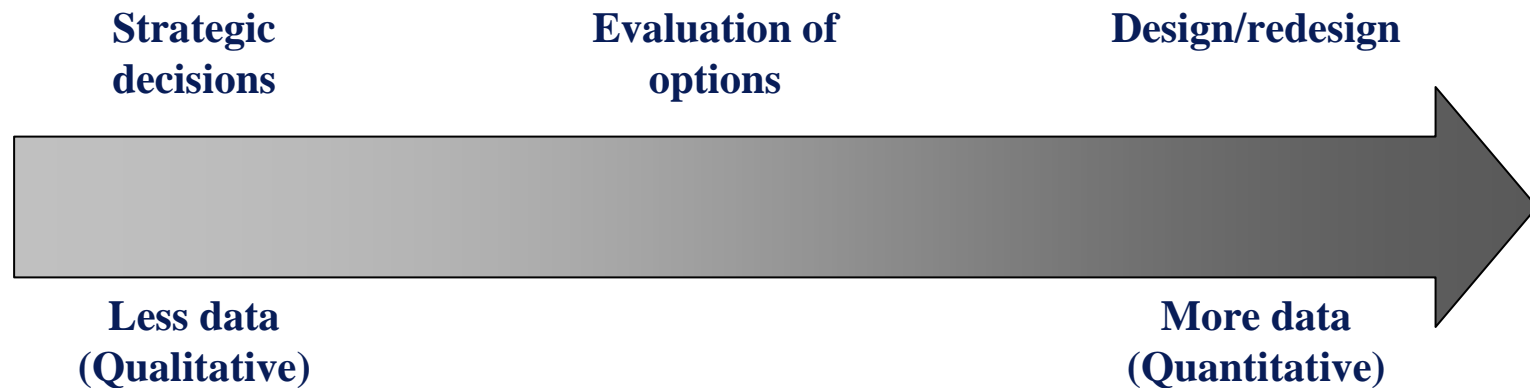
# WasteOpt: Quality control

- ◆ **Quality control of data to ensure reliability**

- ▢ ISO 14040

- ▢ Review

- ◆ **Data requirements:**



# WasteOpt: Accuracy and data inputs

## ◆ Strategic decisions

- ▢ Identification of optional waste management systems

## ◆ Implementation decisions

- ▢ Costs (capital and operating) and manpower (numbers and training)

## ◆ Accuracy of the data to ensure applicability

- ▢ Sample size
- ▢ Benchmarks



# WasteOpt: Decision making and communication

- ◆ **Practitioners aware of process and impacts**
- ◆ **Prioritisation**
  - ▢ Investment of scarce resources
  - ▢ Short and long term
- ◆ **Comparison with benchmarks**
  - ▢ Equipment
  - ▢ Training
  - ▢ Performance



# WasteOpt: Implementation modes

- ◆ **Self assessment in full**
- ◆ **Self assessment with support from external waste advisor**
- ◆ **Full external assessment**



# Decision support for integrated waste management systems

- ◆ **Software based expert system; paper based primary data acquisition**
  - ▮ **Model – collection, storage, transport, treatment, and disposal**
  - ▮ **Predicts impacts on human health primarily, and environmental burdens of health care waste systems**
  - ▮ **Includes parallel economic model**
- ◆ **Strategic and operational decisions**
  - ▮ **Underdeveloped areas**
  - ▮ **For waste managers in the health care system, primarily at Government/Financial support organizations**
  - ▮ **Who need to decide between various systems for waste management**

