



HOKKAIDO UNIVERSITY

GRADUATE SCHOOL OF ENGINEERING

DEPARTMENT OF ENVIRONMENTAL ENGINEERING

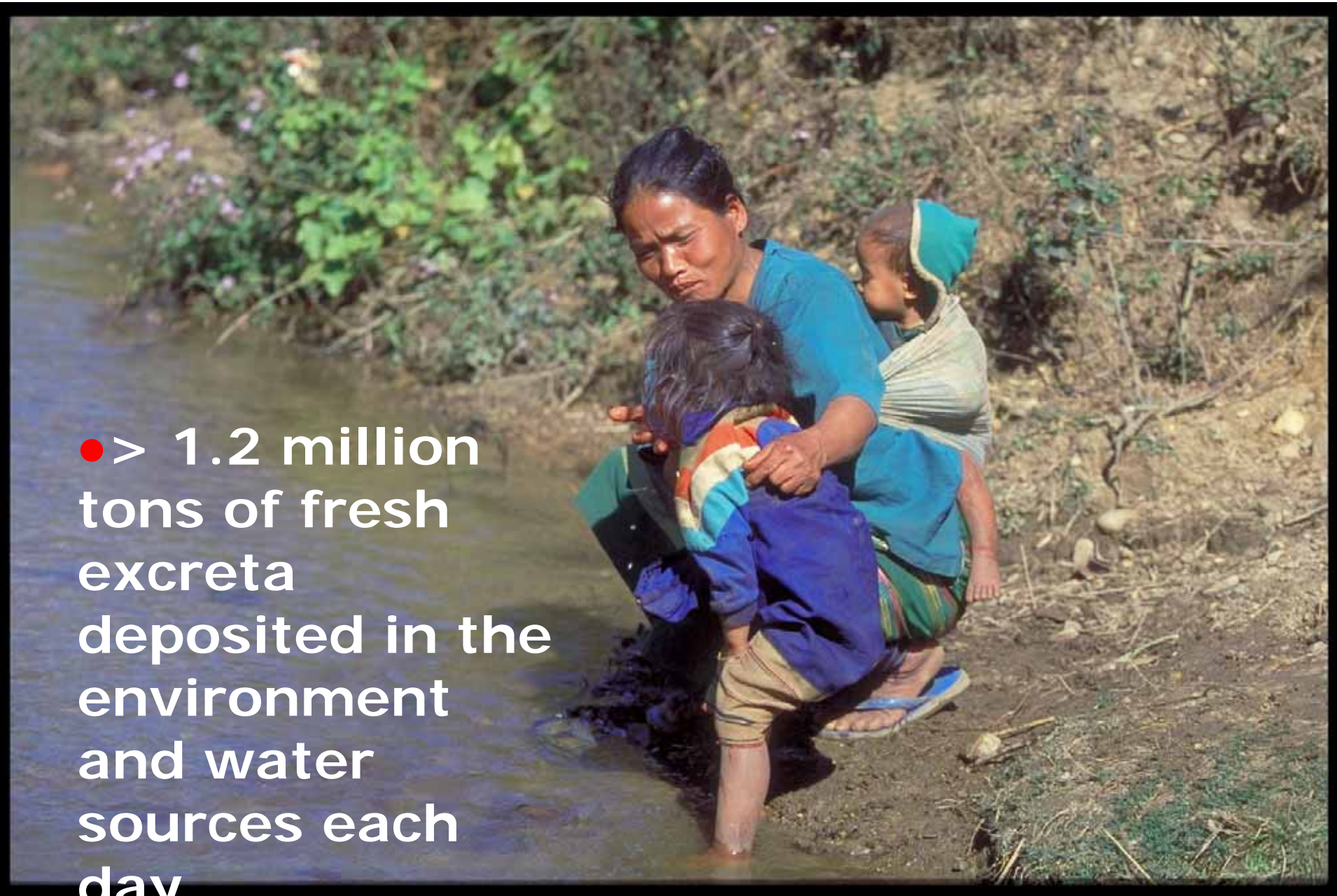
**Sustainable Sanitation System
based on the concept:
“don’t collect” and “don’t mix”
wastewater**

NAOYUKI FUNAMIZU

My topic today is

- **Why do we have to develop a new sanitation system?**
- **Our interdisciplinary research project supported by Japan Science and Technology Agency**

International Symposium on Sustainable Sanitation
2003 Nanjing University
2004 Northeast Normal University



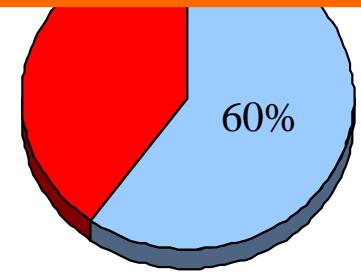
- > 1.2 million tons of fresh excreta deposited in the environment and water sources each day



To achieve the Millennium Development Goals Water Supply and Sanitation 2000

Up to 5.5 billion people will be without sanitation by the year 2035, if sanitation provisions continue to be installed based on the current standards.

Sanitary
means for
excreta
disposal



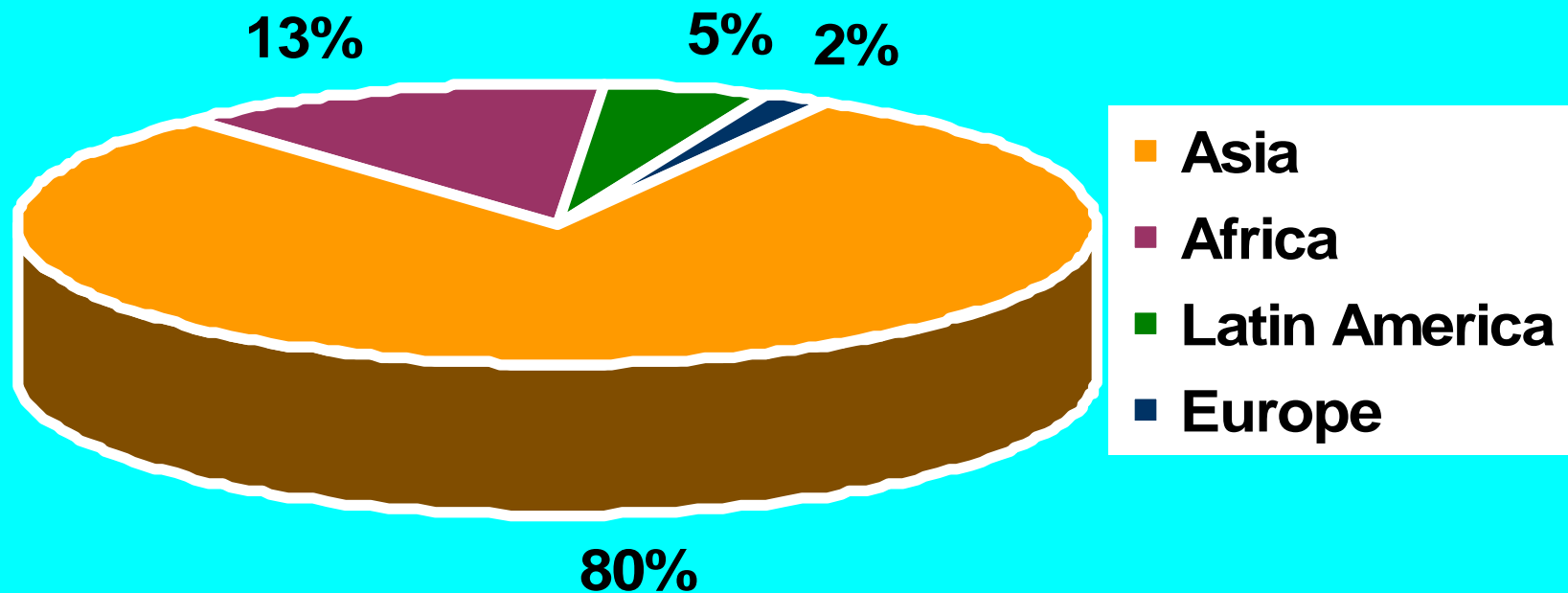
Sanitation





Sanitation Issues in Asia

Distribution of the global population not served with improved sanitation (WHO, 2001)



K.USHIJIMA, M. IRIE, N.SINTAWARDANI, J.TRIASTUTI, T.ISHIKAWA: The 5th International Symposium on Sustainable Sanitation Tokyo, Japan(2007)





Economical Issues (Peter Wildere, 2002).

- It becomes evident that the capacity of the global money market would not be sufficient to cover the need for investment capital for centralized system **Don't collect**
- The **rehabilitation** cost for the **pipng system** in Germany is estimated to be in the range of **100 billion** euros
- The cost of the installation of **the pipe system** is almost one order of magnitude higher than the cost of building the treatment facilities



Watershed Management

Don't collect

- Taking water from a discrete location and discharging it to a distant surface water body may have a negative effect on the water cycle in that area.
- sewers and water mains are leaking





Water Resource

Don't collect

- A significant amount of the drinking water is used as a means to transport the pollutants
- Reuse wastewater by retaining water near the point of origin

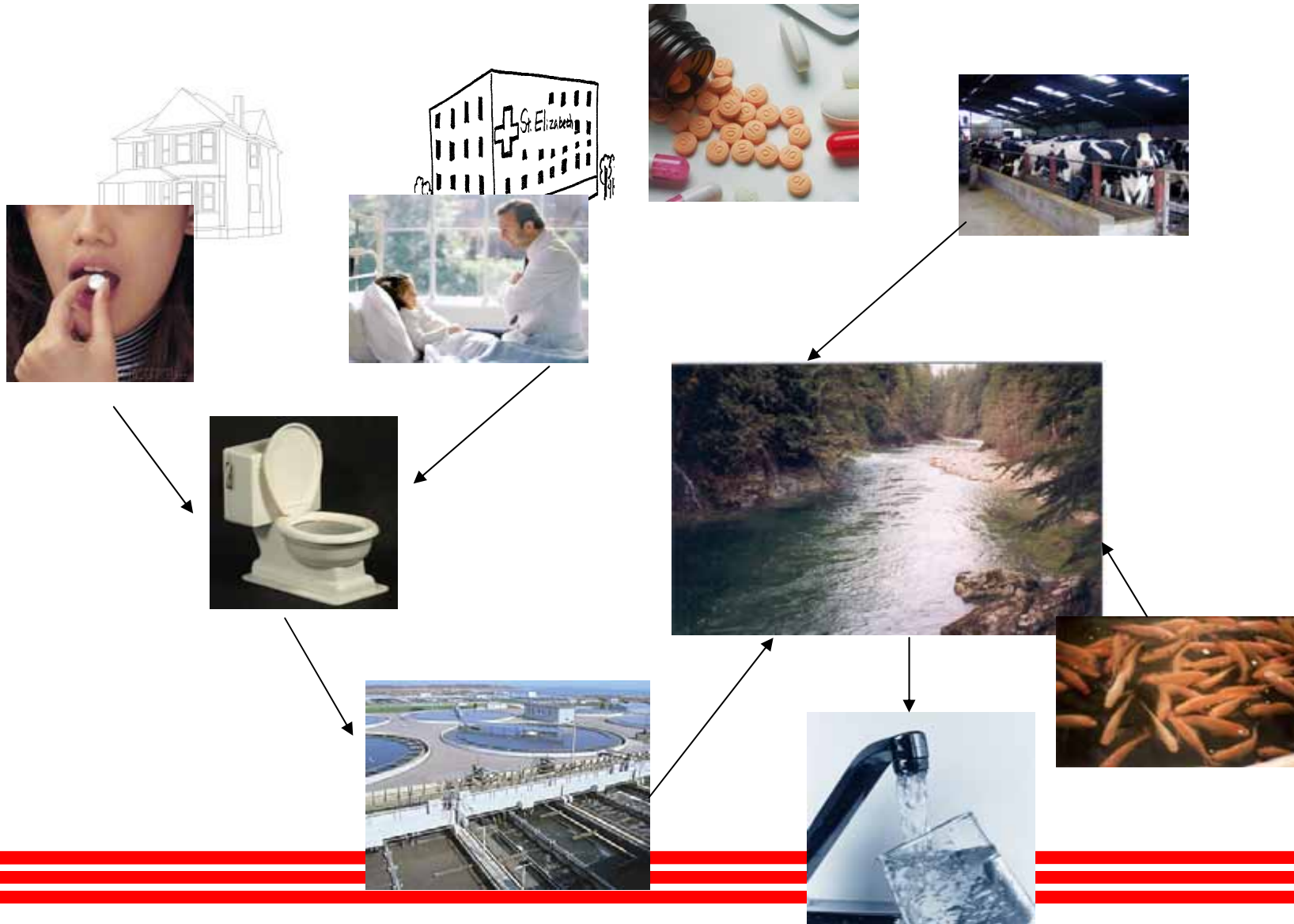
Managing raw wastewater quality to recycle nutrients and to use simple treatment process

Appliance	Volume	COD	NH ₄ -N	NO ₃ -N	PO ₄ -P	TSS
WC	31%	44%	97%	3.8%	80%	77%
Kitchen sink	13%	23%	0.3%	38%	9.4%	10%
Wash Basin	13%	1.7%	0.1%	11%	1.3%	2.1%
Bath	16%	2.5%	0.6%	15%	1.1%	1.3%
Shower	12%	6.4%	0.7%	25%	4.1%	5.1%
Washing machine	16%	22%	1.2%	7.6%	4.3%	4.0%

Don't Mix

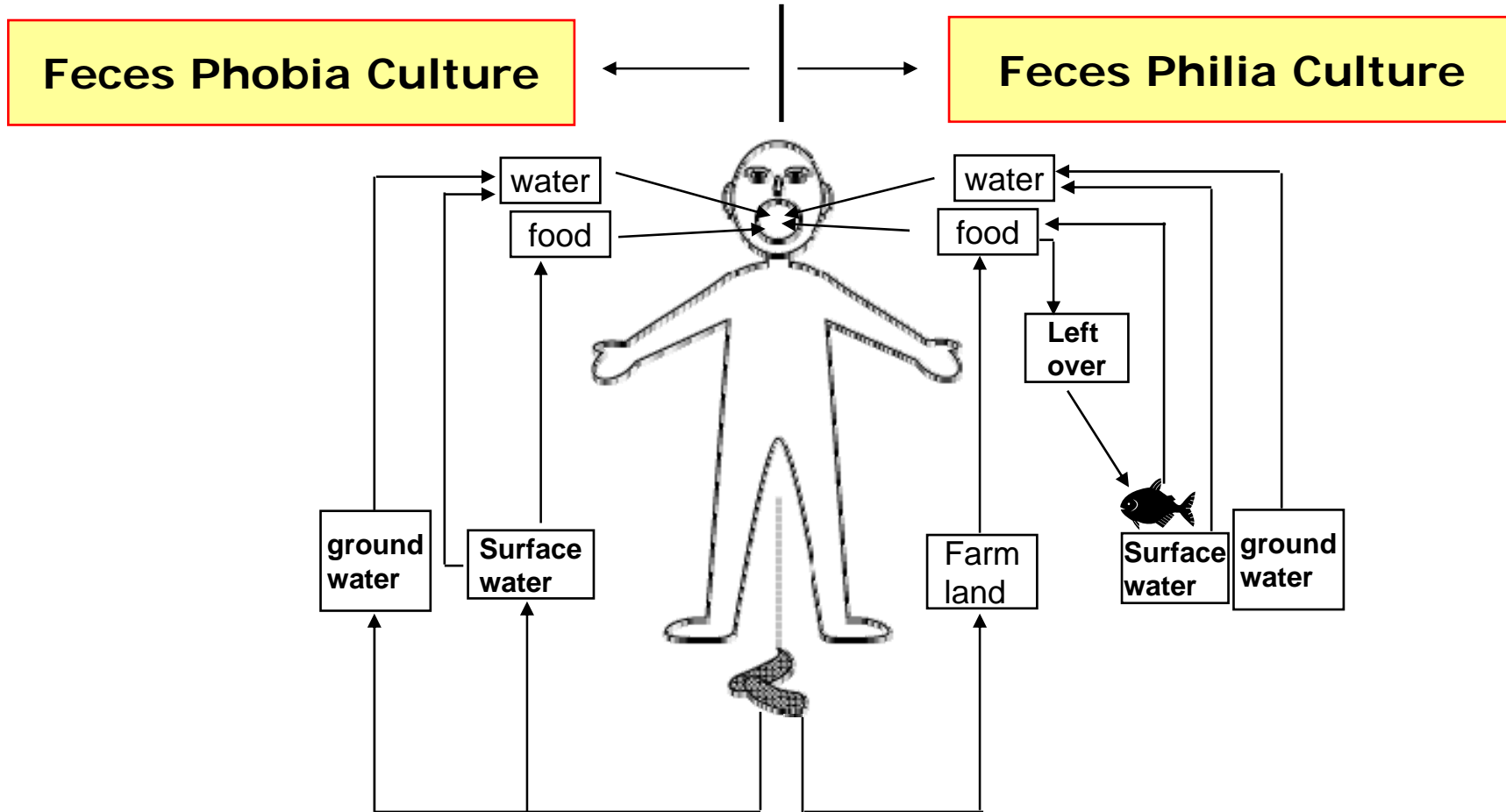


Controlling micro-pollutants



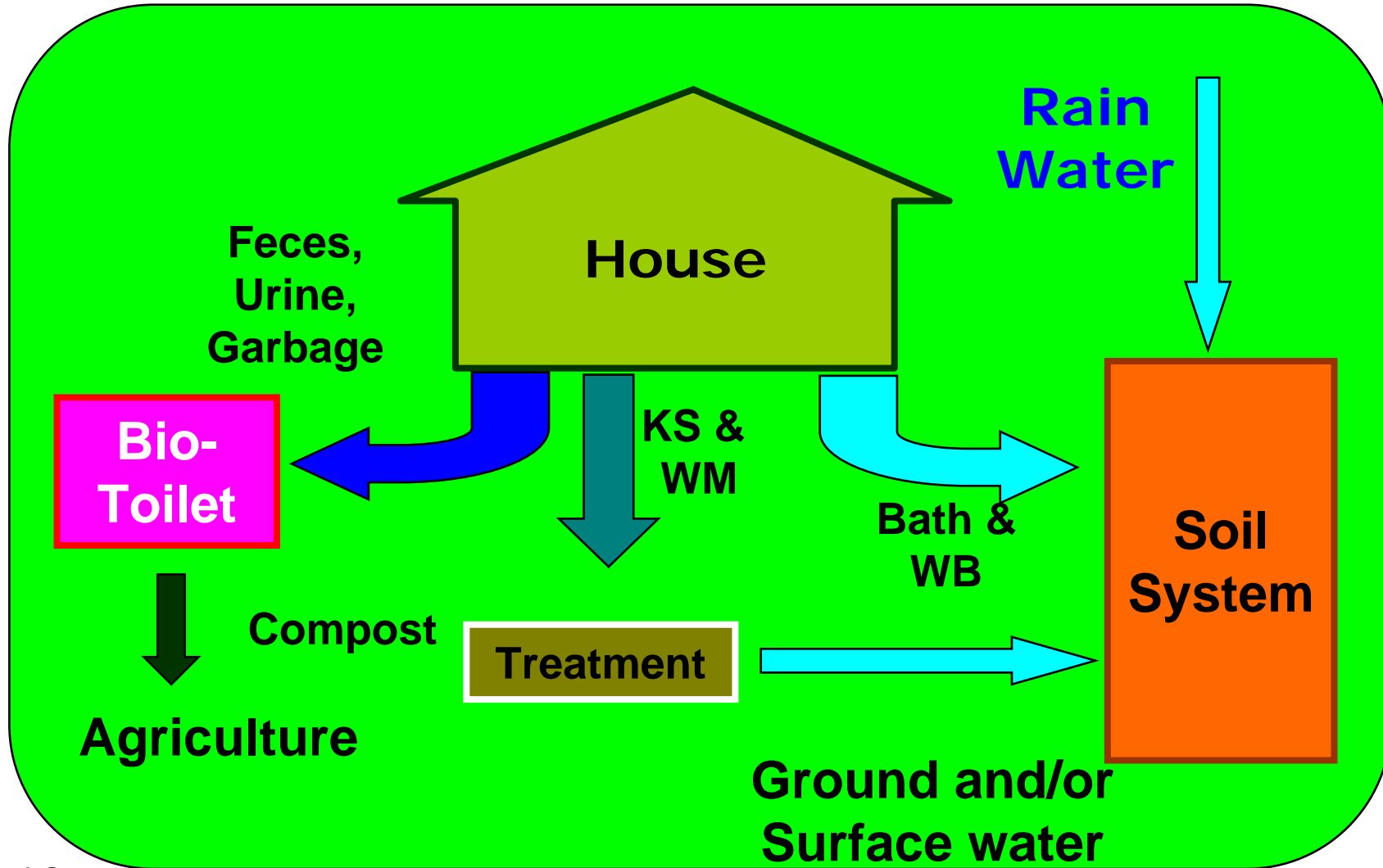


Feces Philia Culture vs Feces Phobia Culture





ONSITE WASTEWATER DIFFERENTIABLE TREATMENT SYSTEM

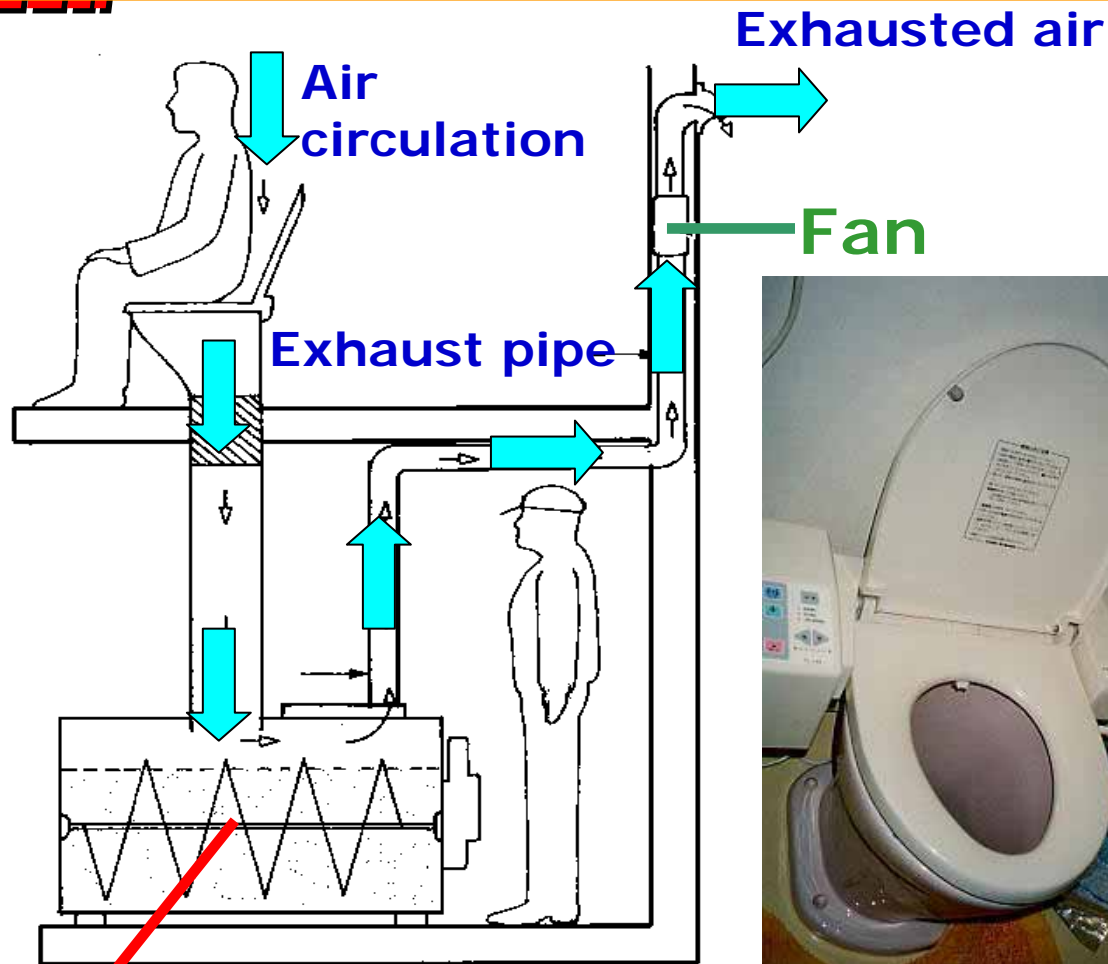




Benefits

- **Separating black water gives**
 - Recovery and recycle of nutrients
 - Elimination of micro-pollutants in urine
 - Elimination of sources of pathogens
 - Reduction of wastewater flow
 - Conservation of water resources
- **On-site treatment gives**
 - No requirement of pipes
- **The system creates**
 - Material cycle (organic matter and nutrients)
 - New social system such as M&O NPO or company.

Composting Toilet



Mixing Device



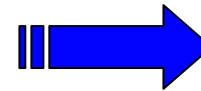
Sawdust Matrix

Mixing mechanism

SAWDUST MATRIX: Key element of the composting reactor

o Sawdust properties:

⇒ High porosity
⇒ High water and air retention
⇒ High drainage



Aerobic biodegradation (without odor)

⇒ High bacterial tolerance



Use of sawdust for long time

⇒ Low apparent density



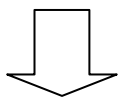
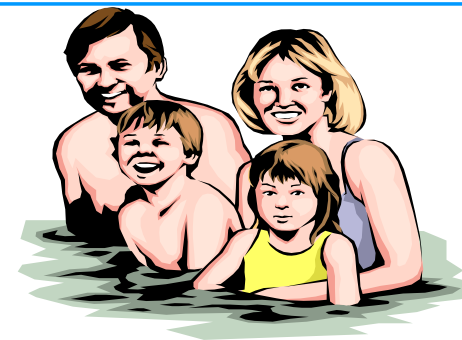
Energy saving when mixing

⇒ Biodegradability

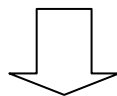


Reuse as a fertilizer or soil conditioner

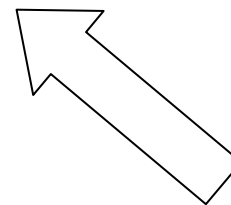
BIODEGRADATION OF ORGANIC MATTER



130 g feces/day
(wet basis)

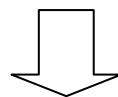


**Bio-
degradation**
Remaining TS:
44%

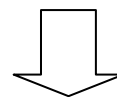


**Design and
operation**

**Accumulation:
15 kg TS/year**



23.5 g feces/day
(dry basis)



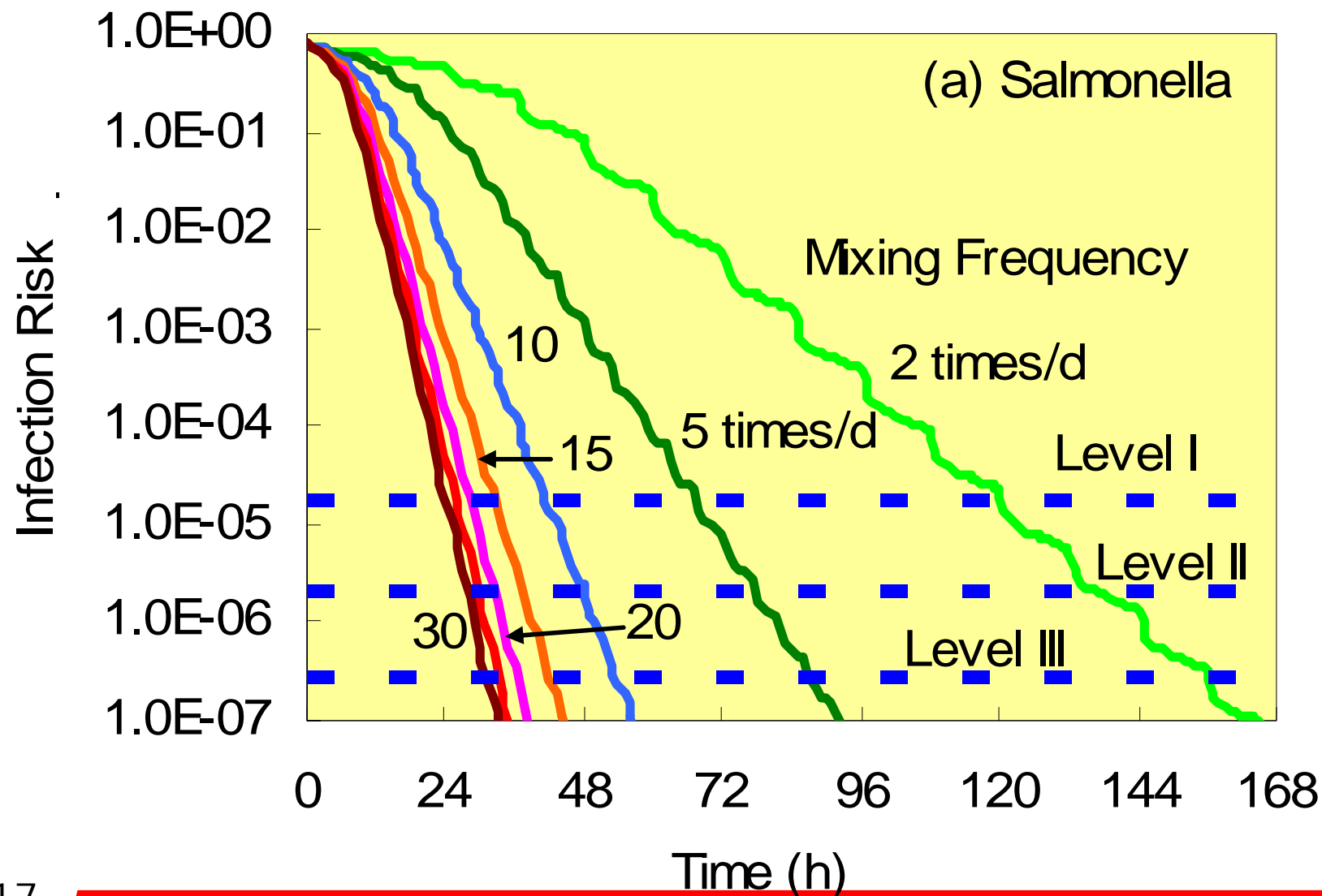
**Accumulation:
10.3 g TS/day**



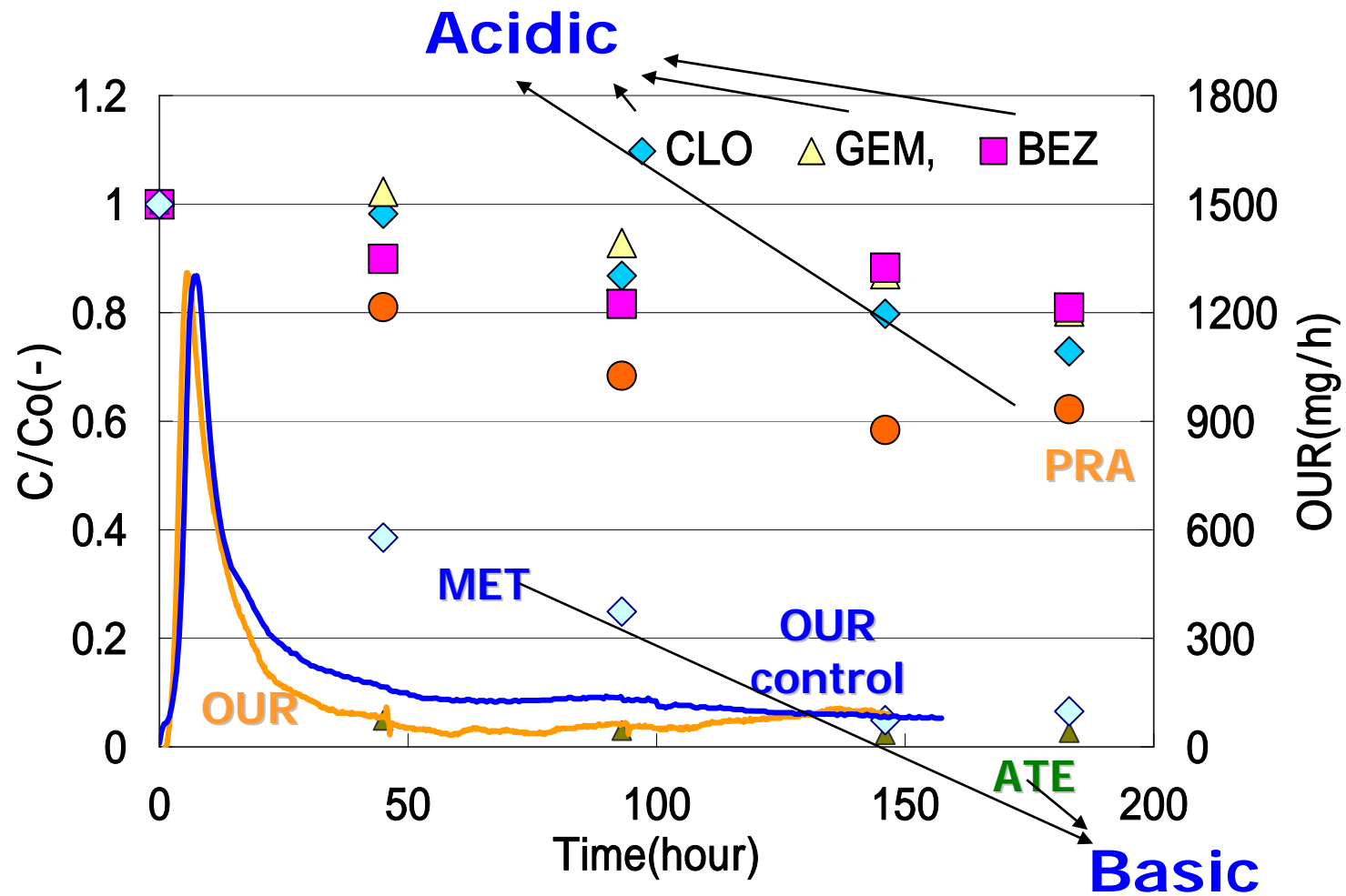
**Accumulation:
7.6 kg TS/6
months**

16

Health Risk : Mixing frequency · reaction time and infection risk



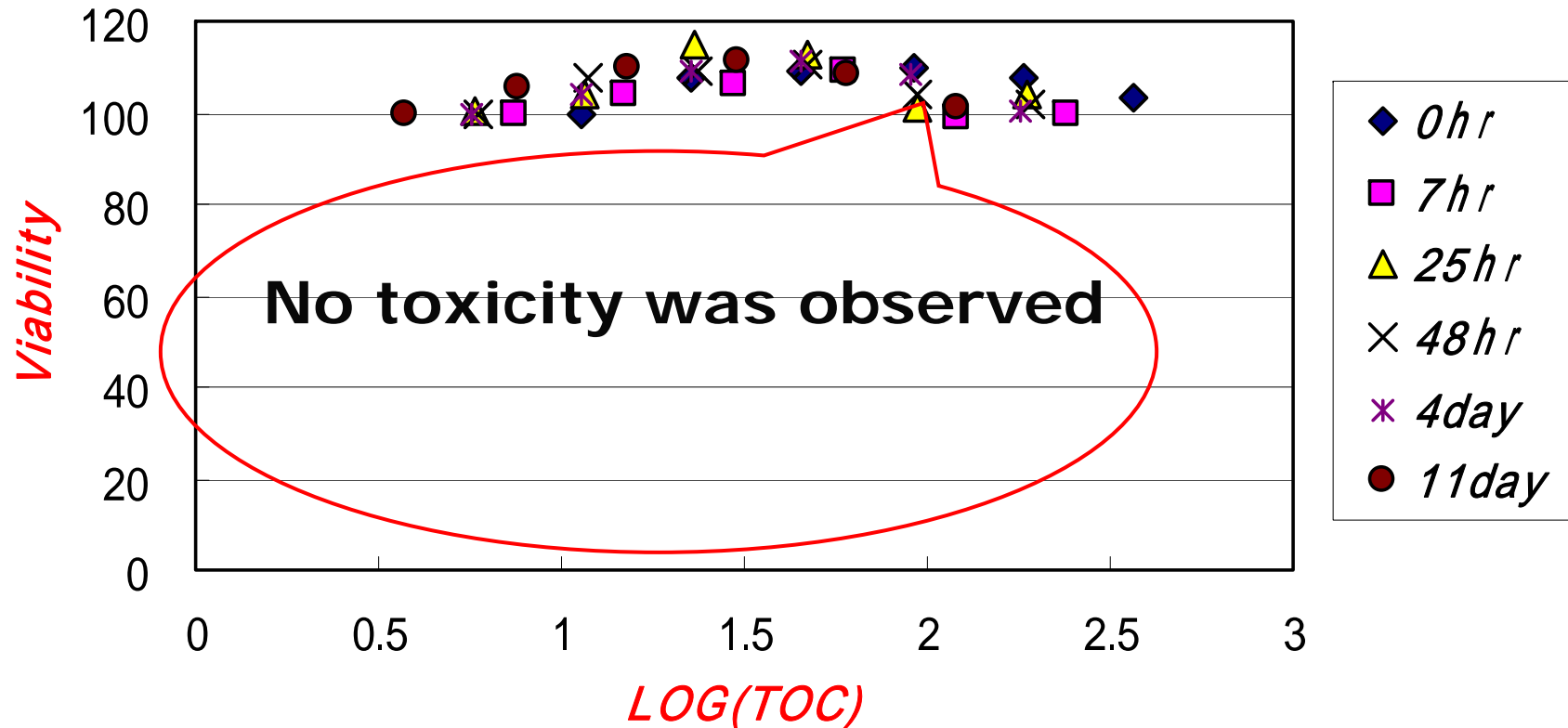
Compost is safe-1: Fate of pharmaceuticals (F/S=20%)





Compost is safe-2: Basal Cytotoxicity of compost from Bio-toilet Bio-assay by human

NB-1 basal cytotoxicity

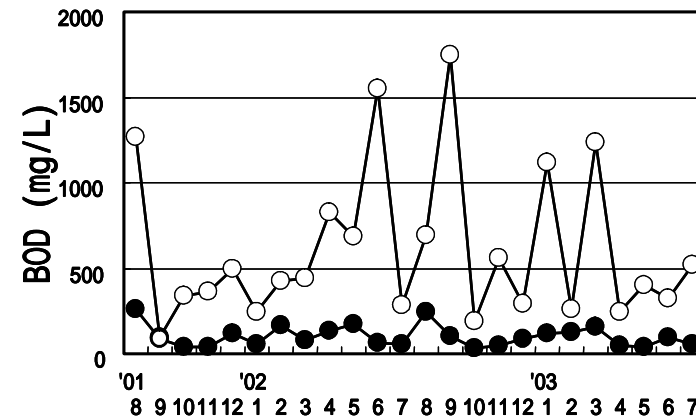
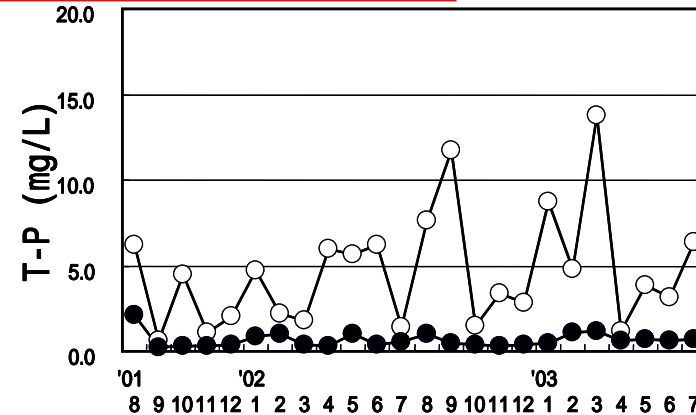
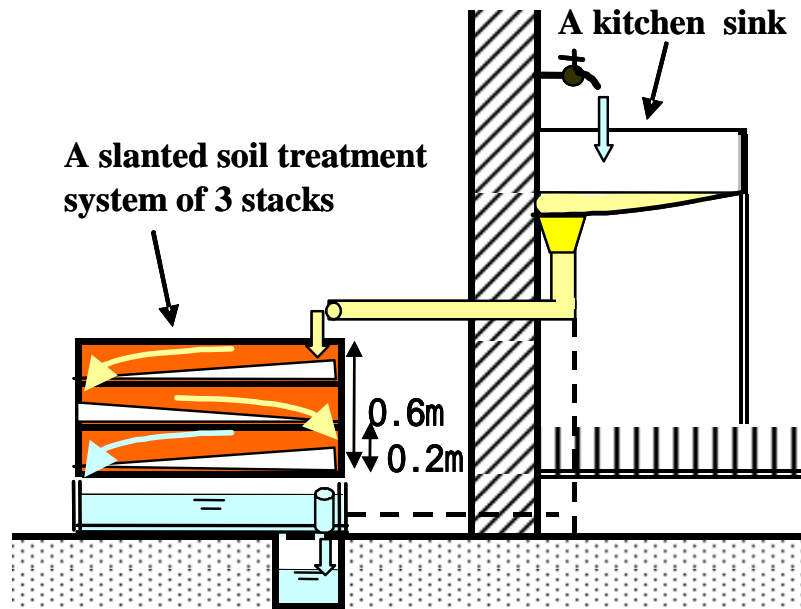




Gray water Treatment-1

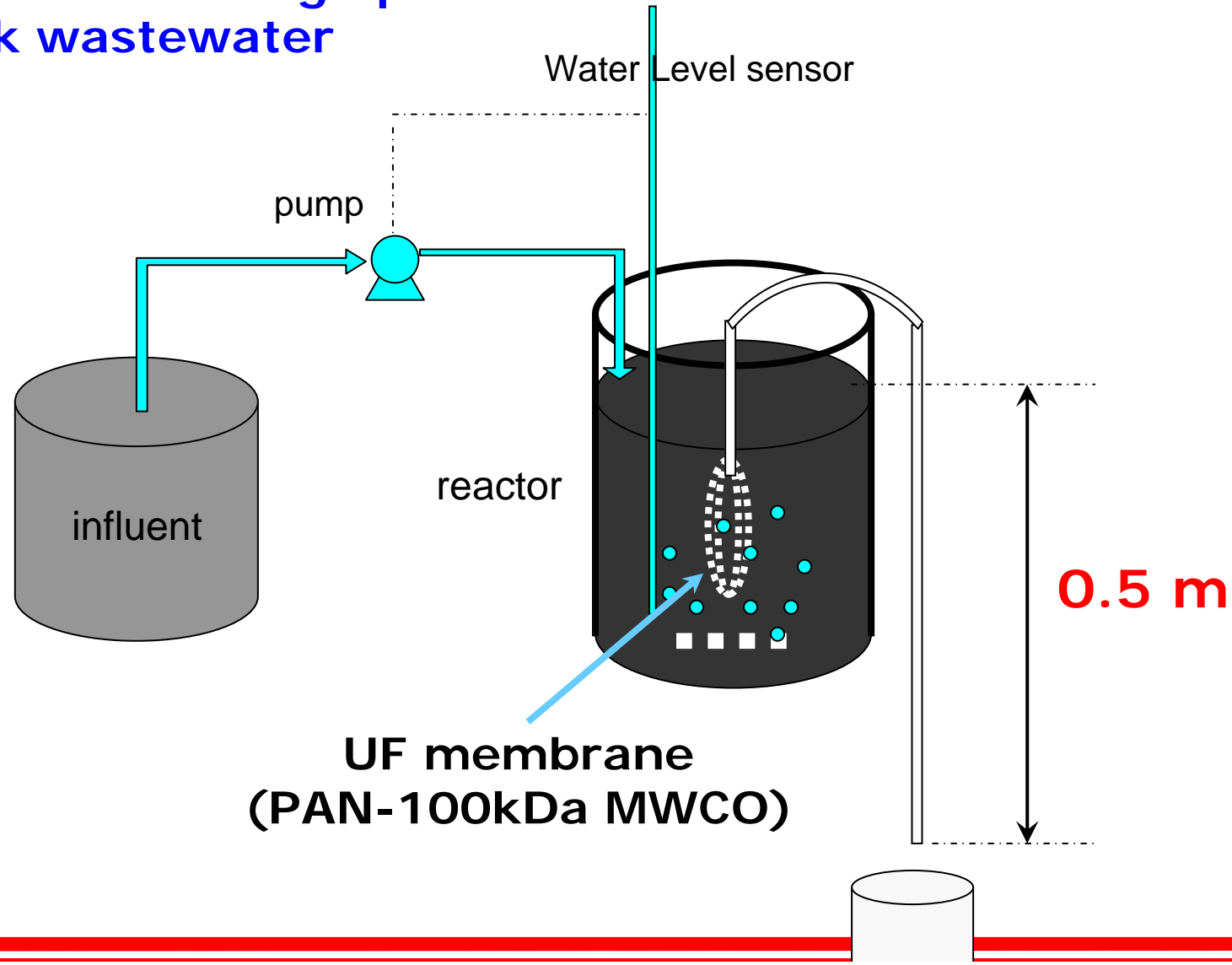
Slanted soil treatment system

by Dr. Itayama National Institute for Environmental Studies



Gray water Treatment-2

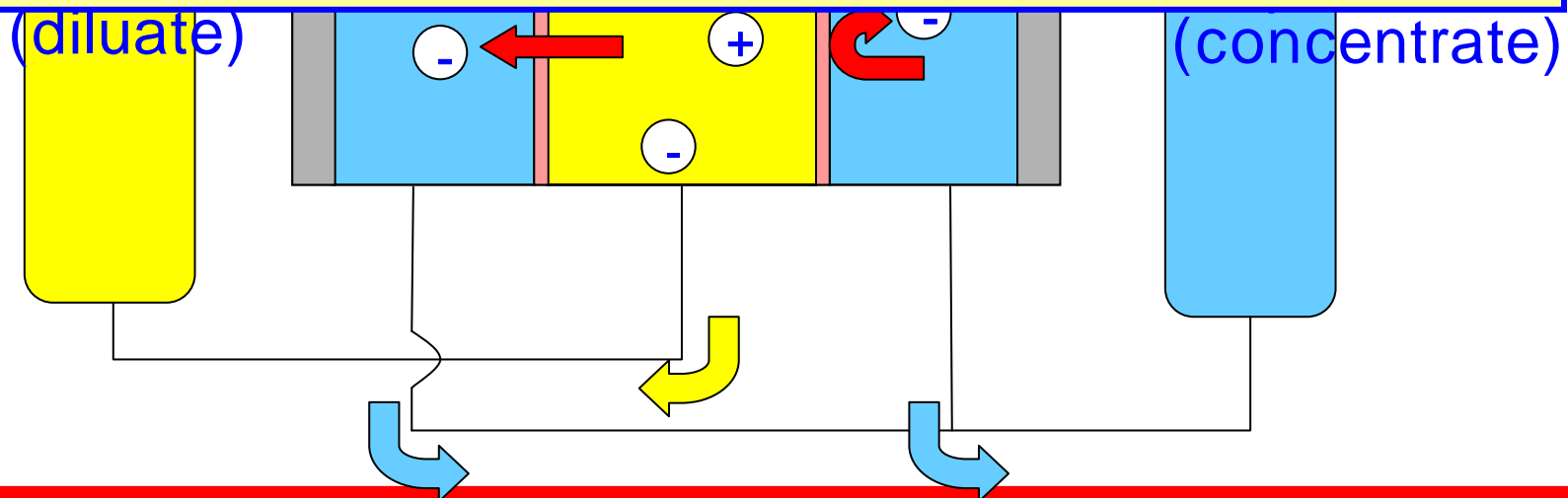
MBR without high pressure for kitchen Sink wastewater



Urine Treatment -1:

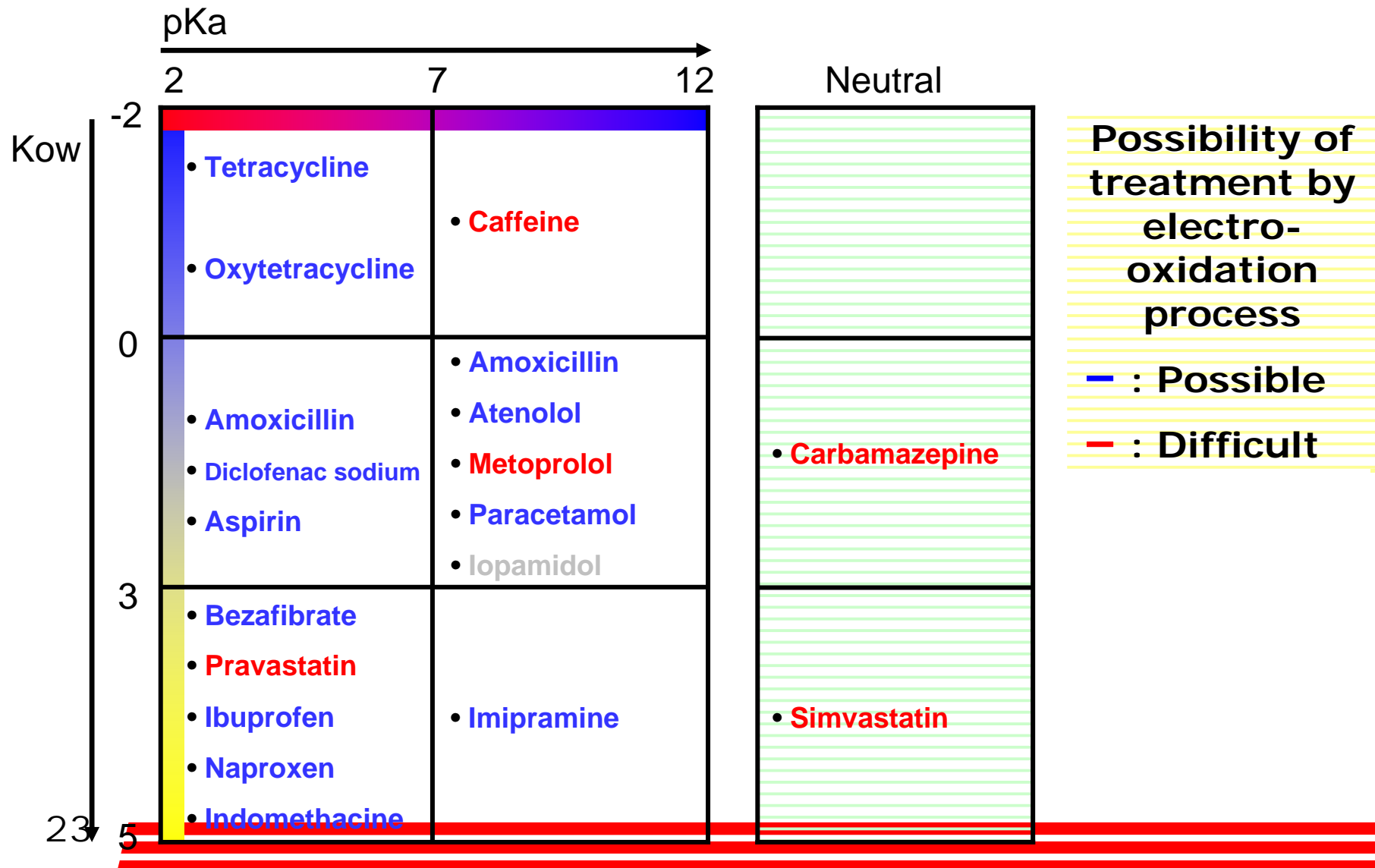
Concentration of Source-Separated Urine by Electrodialysis

- Max. consumption : 0.1W
- Voltage : 3.4V
- Required membrane area: 400cm² (for treating 4L of urine in 24 hours)



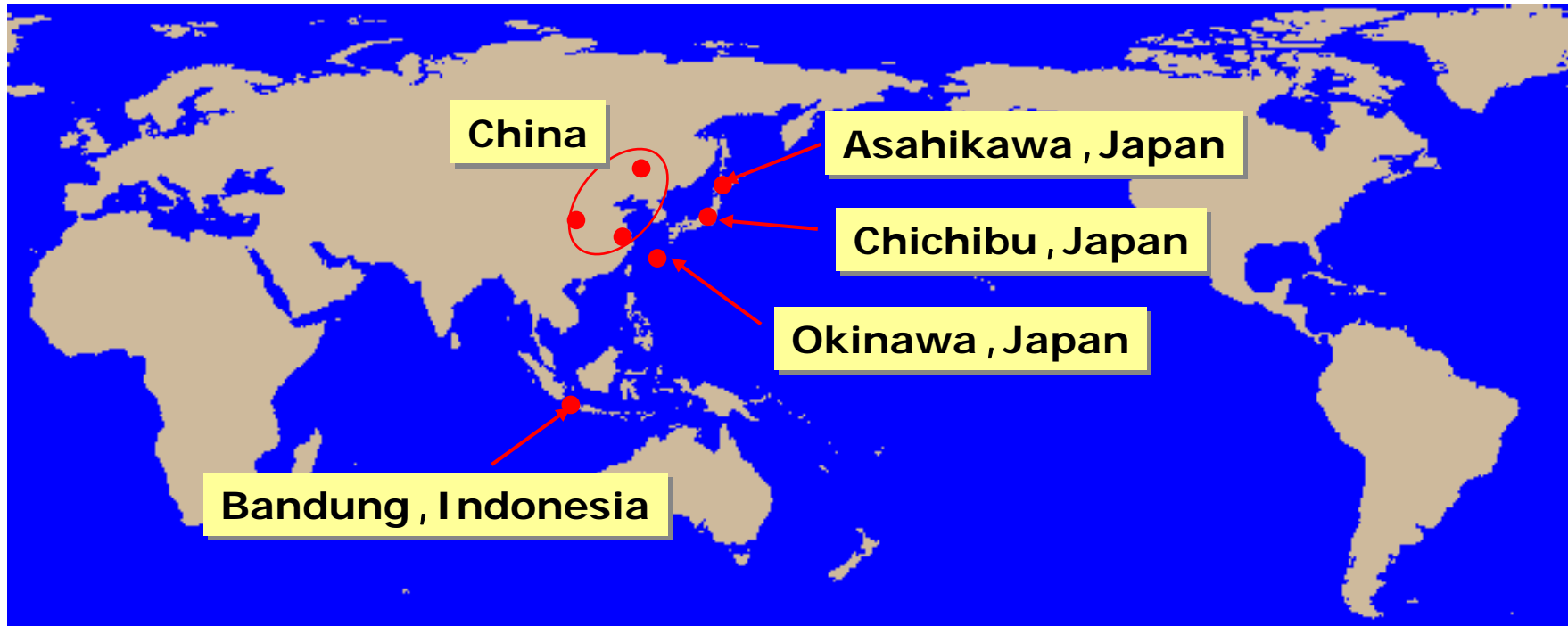


Electro-oxidation of pharmaceuticals in urine





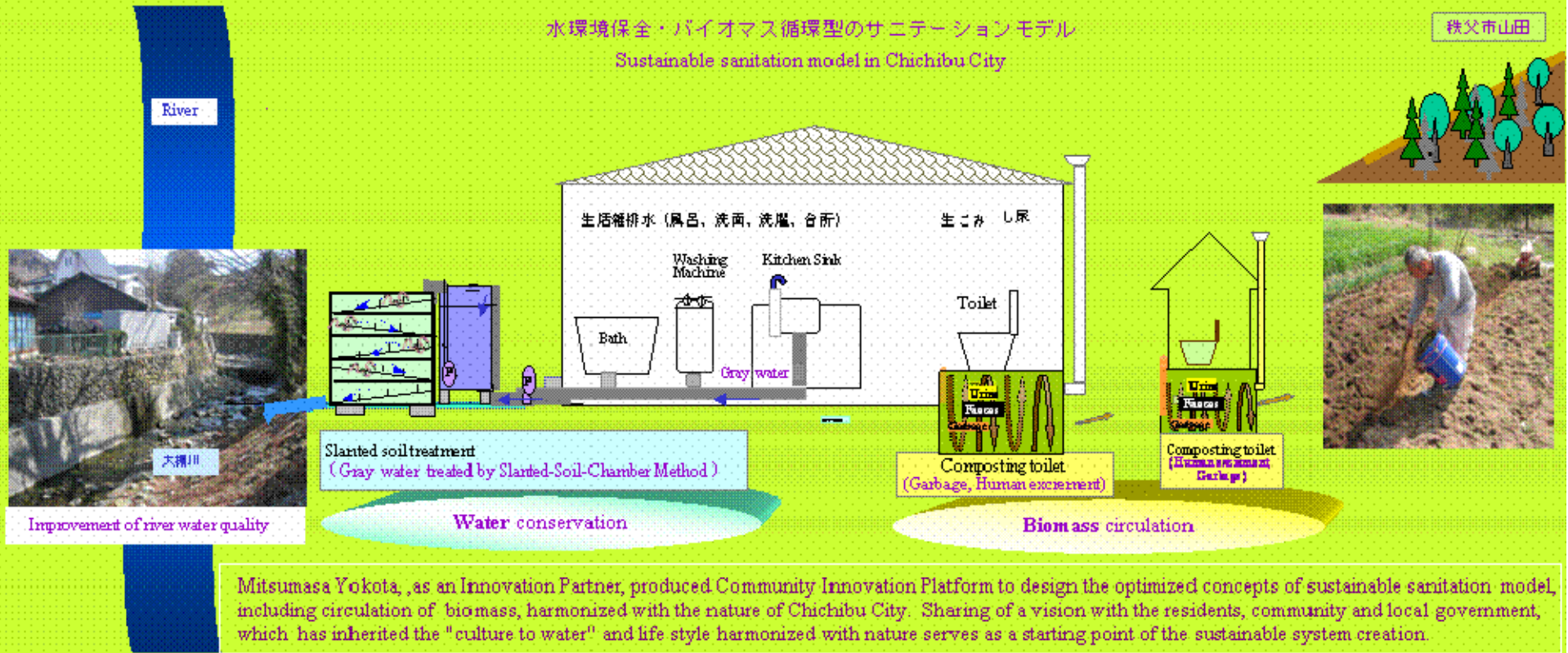
Pilot project



Chichibu: Japan Model

Sanitation model based on Community Innovation Platform (M. Yokota)

地域の自然・文化・伝統と調和し、「安全・安心・健康・癒し・感動」といった生活者・コミュニティにとっての価値向上に貢献する、「生命」や「感性」を豊かにするイノベーションのプラットフォームを創生致しました。
 秩父市においては、水・土壌・衛生・バイオマスの観点から、水環境を修復し、生物多様性を豊にする取組をスタートしております。 (Mitsumasa Yokota)



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Human friendly design

『水を中心として自然循環を重視するバイオニア・モデル』を生活者視点でプロデュース

秩父市山田

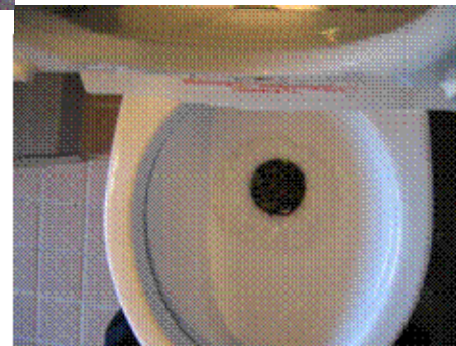
Quality : Functional, comfortable, safety and sustainable



山田地区2062屋外トイレ (洋式)

Designed by Mr. & Mrs. Hashimoto, Yokota & Imai 2004

多様で多様な地域の自然・文化・伝統を大切にし、人(生活者)に優しく、地域の特色を活かしたイノベーションモデル創出の舞台として、橋本様宅を選ばせて頂きました。
顧客ベネフィットを基点としたイノベーションを進めております。
写真のトイレの生活者の視点から見た品質・デザインのポイントは、
『①家族にとって安全で使いやすい仕組み、②人の目にふれる部分の清潔さ、③自然と調和した建屋』です。



「生活者・コミュニティにとっての新たな価値を創生する」スタンス、「生活者の立場で、人に優しい」仕組み・機能デザインの進化がなければ、Sustainable Sanitationは普及していかないと考えております。
「快適で安心して使える人とのインターフェース、生活者の視点で満足度の高い機能・デザイン、バリューチェーンのイノベーション」を、IIP Inc. 横田 & INAX今井は、重視しております。

Creation of Sustainable Sanitation model by emergent evolution which shall bring the best out of the wisdom harmonized with nature, culture and lifestyle of rural area.

2005年11月：地域の自然・文化・伝統と調和し、「生命」や「感性」を豊かにするイノベーションに関心のある皆様も加わり、橋本様と共に小麦の種を蒔きました。

In November 2005, Mr Hashimoto planted wheat with compost.



秩父市山田

We harvested wheat in June 2006.



2006年 6月26日 小麦収穫



小麦収穫調査

Expermen	穂長 cm	稈長 cm	穂数 本/m ²	全重 kg/a	わら重 kg/a	子実重 kg/a
試験区	8.5	82.9	380	88.1	40.2	33.4
対照区	8.5	79.3	293	60.6	28.6	21.8

Slum in Bandung

Bandung City

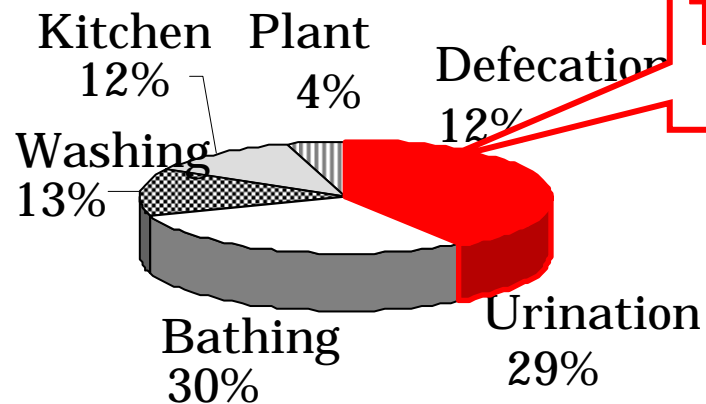
Kiaracondong

Interview Survey

- Water flush toilet (87%)
- Septic tank
- No treatment



Result of interview (62 households)



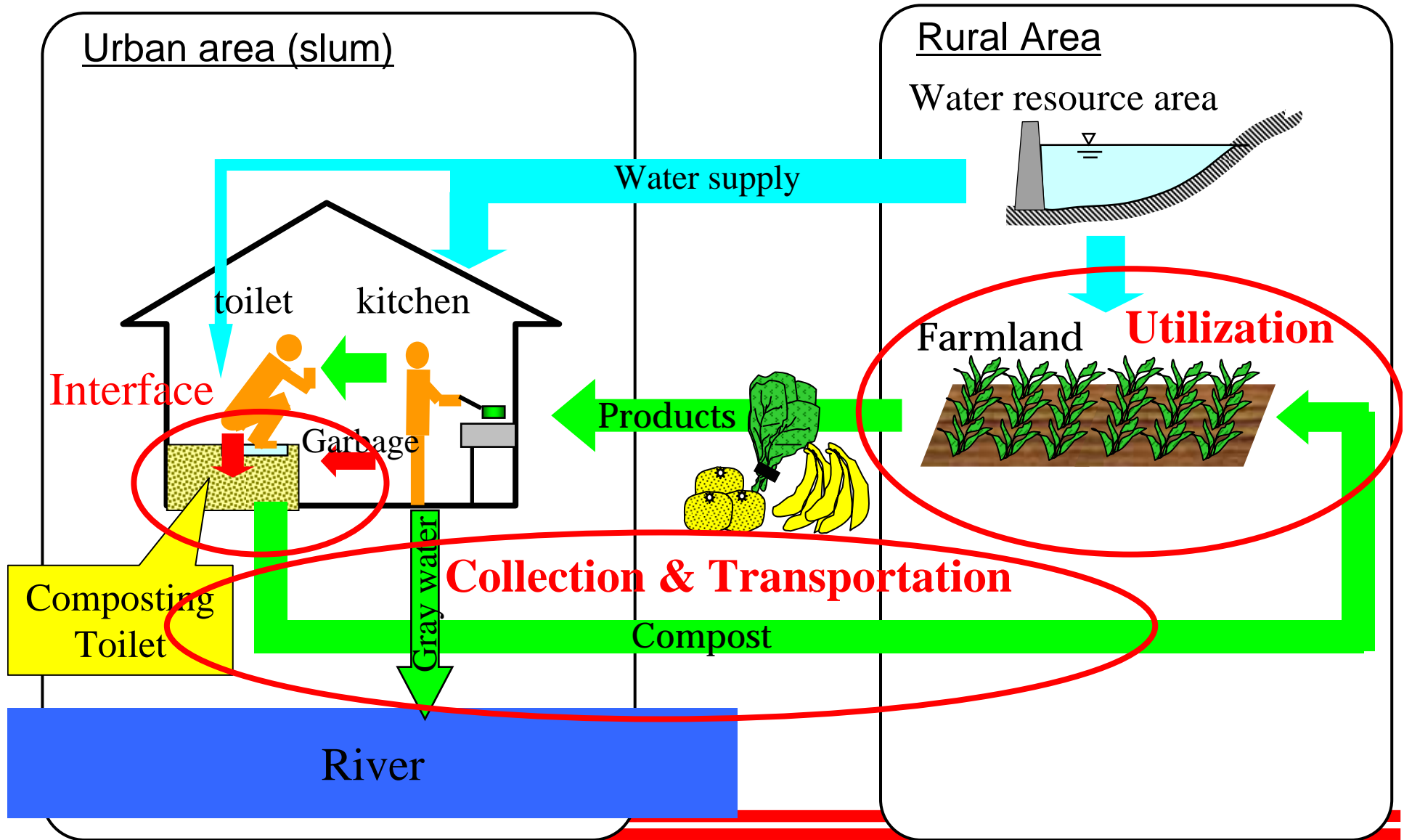
Ave. 89 liter/day/capita

rement



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RW02, SU
Kiaracor
Population
Househol
Area : (

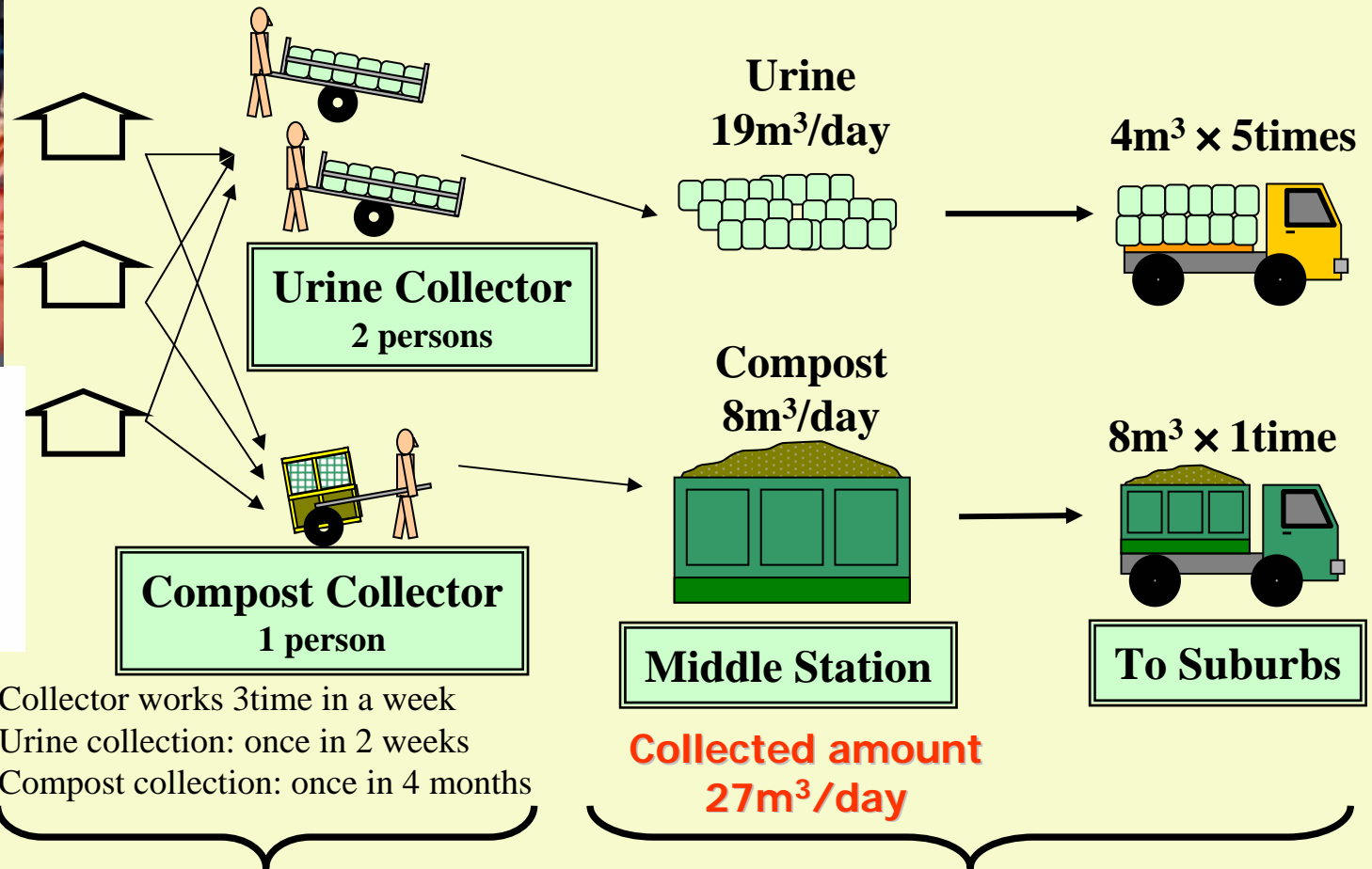
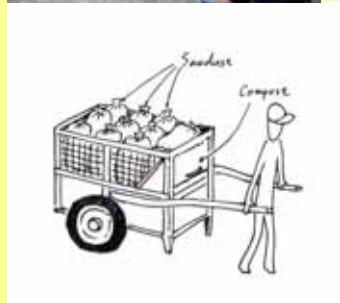
Shift the social system



Low cost composting toilet



Compost Collection System



Collector works 3time in a week
Urine collection: once in 2 weeks
Compost collection: once in 4 months

Managed by local community

(Each residents pay the cost)

Managed by Bandung City

(Each residents pay the cost)

Summary

- **Sustainable sanitation system**
 - **“Don’t mix ! ”, “Don’t collect”**
 - **Onsite Wastewater Differentiable Treatment System**
 - We have developed and analyzed several technologies for on-site differentiable wastewater treatment system
 - The new system for rural area in Japan: Pilot plant in Chichibu, Japan
 - The system for developing countries: Pilot project in Indonesia



CREST team

- Hokkaido University, Graduate School of Engineering:
Prof. Funamizu, Prof. Takahashi
- Hokkaido University, Graduate School of Agriculture:
Prof. Terasawa
- Tokyo Institute of Technology: Prof. Ishikawa
- Industrial Innovation Partners Inc. Ex-Prsident,
Advisor of Chichibu City: Mr. Yokota
- University of Tokyo: Prof. Aramaki
- Ochanomizu University: Prof. Ohtaki
- Tsukuba University: Prof. Isoda
- Nagasaki University: Prof. Tanabe
- Waseda University: Prof. Sakakibara





CREST team

- Indonesian Institute of Science: Dr.Neni
- Xi'an University of Architecture & Technology: Prof.Wang
- Nanjing University: Prof. Xin Qian
- Tsinghua University: Prof.Guangheng Ni
- Northeast Normal University: Prof. Linaxi Sheng
- Water Resources Environment Technology Center:
Mr.Kumagai
- IDEA Consultants, Inc.: Mr.Itoh
- Okinawa National College of Technology: Dr.Tada
- National Institute for Environmental Studies: Dr.Jo
- NPO Kokaigawa Project: Mr.Kitamura

