Workshop on On-site Domestic Wastewater Treatment in Asia
Tokyo, November 2013

On-site Wastewater Treatment in Vietnam

Assoc. Prof. PhD. Viet-Anh Nguyen

•Vice Director, Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering.

•Head of Science and Technology Department, Vietnam Association of Water Supply and Sewerage (VWSA)

•Contact: vietanhctn@gmail.com; +84-913209689

Content

1. Urban and rural sanitation in Vietnam
2. Technical and Management aspects of On-site and Decentralized sanitation
   - On-site sanitation
   - Decentralized wastewater treatment
   - Sludge management
3. Discussions
4. Conclusions and Recommendations

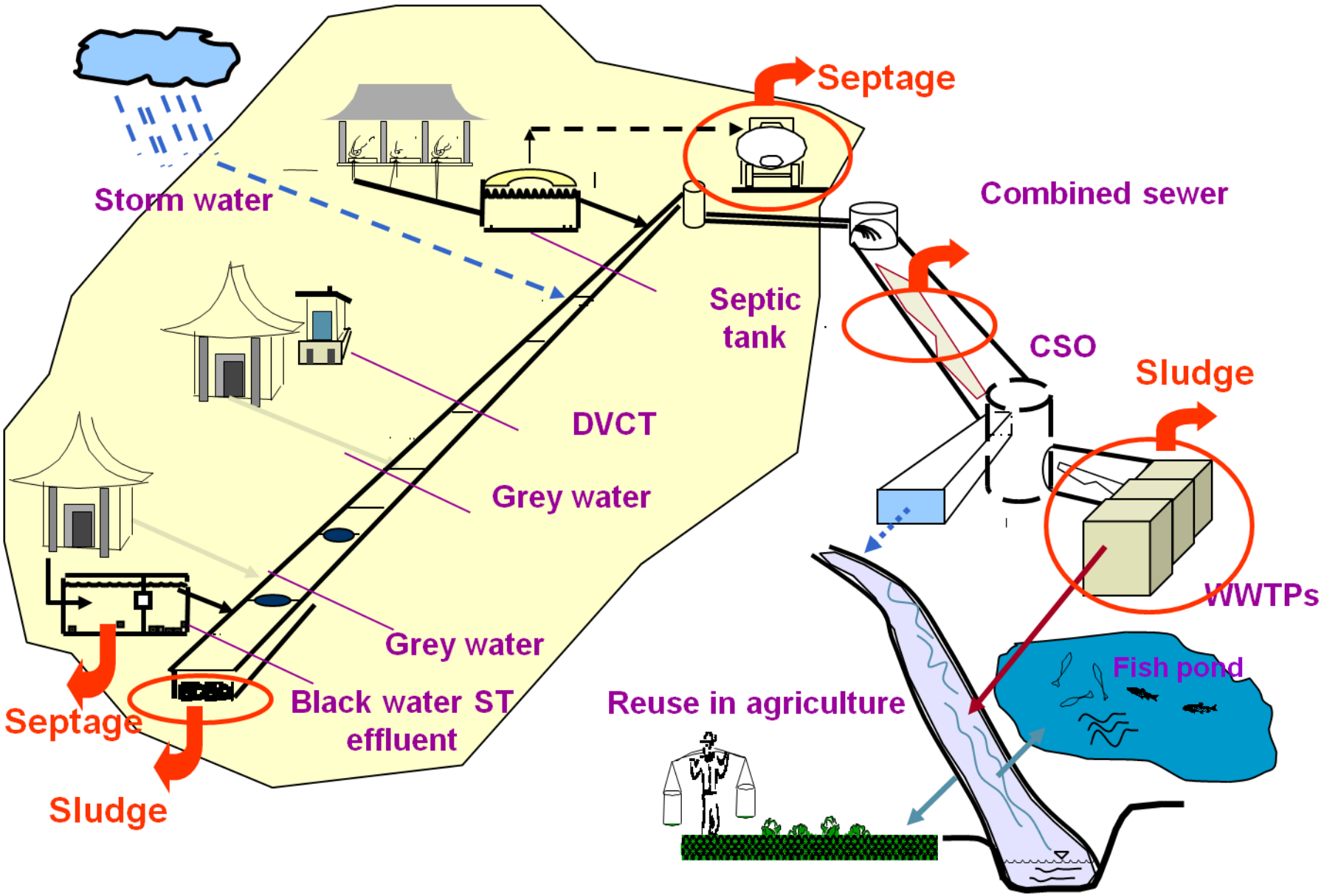
1. URBAN AND RURAL SANITATION

Urban water supply

- 9/2013: **765** cities and towns. 32% total population.
- Total design capacity of urban water supply systems: **6.5** million m^3/day.
- Actual operation capacity: **5.7** million m^3/day or **89%**) (from 48 to 137% design capacity)
- Urban population served with centralized water supply systems: **77% of 32.6 mio.** (from 57 to 80%) **through 4.7 mio. connections.**
- Non-revenue water: **27.8 %** (7.2 – 44.9%)
- Average water consumption rate: **101 l/cap/day** (from 33 to 213 l/cap/day)
- Main funding source: ODA.

Urban sanitation in Vietnam

- Combined sewerage system is a major type of wastewater collection
- 32 cities have executed sewerage and sanitation projects funded by ODA
- Access to toilets: > 90%
- 40 - 70% population have access to sanitation service (sewerage and drainage network)
- Majority of existing sanitation works in urban areas is septic tank: 80%
- Only > 10% of urban wastewater is treated
- 18 WWTPs only treat app. 345,000m3/d of total 3,080,000 m3/d domestic WW generated
- Diversified technologies
- Difficulties in operation and maintenance (cost recovery, skills, etc)



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Urban Wastewater Management

- **USD 250 MILLION INVESTED ANNUALLY OVER THE PAST 10 YEARS**
- **20 MUNICIPAL WWTPs CURRENTLY IN OPERATION**
- **30 MUNICIPAL WWTPs IN PLANNING/CONSTRUCTION**
- **94% OF URBAN POPULATION HAVE ACCESS TO HOUSEHOLD (HH) SANITATION**
- **90% OF HHs HAVE SEPTIC TANKS**
- **4% OF SEPTAGE DISPOSED SATISFACTORILY**
- **60% OF HHs HAVE ACCESS TO PIPED DRAINAGE/ SEWERAGE SYSTEMS**
- **10% OF COLLECTED DRAINAGE/ SEWERAGE TREATED BY CENTRALIZED WWTPS**

Urban Wastewater Management

- **92% OF WW CONVEYED BY USE OF COMBINED SEWERAGE SYSTEMS (CSS)**
- **8% OF WW CONVEYED BY USE OF SEPARATE SEWERAGE SYSTEMS (SSS)**

Urban Wastewater Management

- **13 WWTPs RECEIVE CSS-BASED FLOW**
- **67.5 mg/l – AVERAGE INFLUENT BOD AT WWTPs. (31 – 135 mg/l: Range of annual average flows)**
- **50 mg/l – NATIONAL CLASS "B" STANDARD FOR EFFLUENT BOD**
- **TREATMENT TECHNOLOGIES UTILIZED (among 13 surveyed)**

  ACTIVATED SLUDGE (8)

  ANAEROBIC PONDS (4)

  AEROBIC PONDS/STAB. PONDS (1)

Urban Wastewater Management

- **4 WWTPs RECEIVE SSS-BASED FLOW**
- **358 mg/l - AVERAGE INFLUENT BOD AT WWTPs (Dalat and Buon Ma Thuot WWTPs data; 336 – 380 mg/l: Range of annual average flows)**
- **TREATMENT TECHNOLOGIES UTILIZED:**

  ACTIVATED SLUDGE (2)

  TRICKLING FILTERS (1)

  STABILIZATION POND SYSTEM (1)

Urban Wastewater Management

- **98% OF FUTURE GENERATED WW FLOW WILL BE CSS-BASED (28 of 31 WASTEWATER SYSTEMS)**
- **TREATMENT TECHNOLOGIES SELECTED**
  - **ACTIVATED SLUDGE (26)**
  - **CEPT/TRICKLING FILTERS (1) – WB-FUNDED**
  - **STABILIZATION PONDS (1) – ADB-FUNDED**
  - **AERATED PONDS (1)**
  - **PRIMARY SEDIMENTATION (2) – KFW-FUNDED**

Rural water supply and Sanitation

- 2012 (NTP3):
  - 80% of HHS are with toilets, among them 60% are with hygienic toilets.
  - 85% schools, 85% clinics, 50% rural markets, 80% PC buildings are with WSS facilities.
  - 50% live-stock breeding are considered as hygienic including 1 mio. biogas digesters.
  - 35% communes are with solid waste collection and disposal.
  - Some trade villages have sanitation planning and waste management activities.

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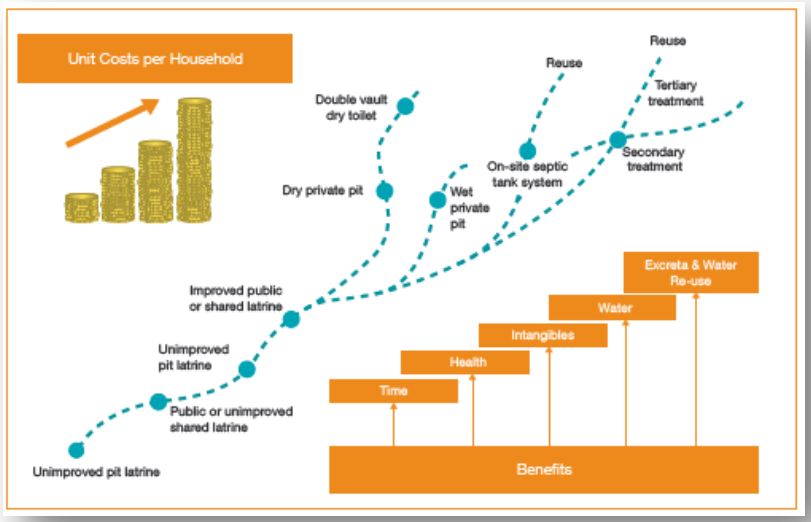
Major sector programs and plans

- Over last 20 years: ~ USD 2 bio have been ibvested for WS, including 80% from ODA.
- 1993 … 2011: 135 international projects on urban WSS based on loans, 67 TA projects and 98 grants have been, and are being implemented (ADB, 2012).
- In order to provide 100% urban population with clean WS up to 2020: USD 2 bio. is needed (2008).
- In order to provide 100% urban population with wastewater collection and treatment: USD 2 … 8 bio. (WB, 2008; NVA, 2011).

Government policies

- More and more stakeholders have started to recognize importance of DESA.
- This term is now mentioned more and more as a solution.
- Great efforts are to be acknowledged:
  - projects and activities of DESA group, IESE,
  - projects of GTZ and KfW, other donors,
  - BORDA
  - private investors and private DESA firms
  - etc.
- DESA concept and technologies have been brought into teaching curricula at some Universities.



Government policies (cont.)

- Effluent Standard for not connected to the sewers, and small flows: TCVN 6772:2000 has been developed, later replaced by the National Code QCVN 14:2008/BTNMT.
- Some technical guidelines are being compiled.
- Some thousands of DESA systems have been installed for office buildings, public toilets, hotels, factories, hospitals, new communities, trade villages, …

Vietnamese National Code for wastewater effluent quality QCVN 14:2008/BTNMT

No	Parameters	Column A[(a)]	Column B[(b)]
1	pH	5 - 9	5 – 9
2	BOD_5 (20^oC), mg/l	30	50
3	TSS, mg/l	50	100
4	NH_4-N, mg/l	5	10
5	NO_3^-, mg/l	30	50
6	PO_4^{3-}, mg/l	6	10
7	Total Coliforms, MPN/100 ml	3,000	5,000

(a) - Maximum allowable values for wastewater discharged to water bodies serving domestic water supply purpose.

(b) - Maximum allowable values for wastewater discharged to water bodies serving another purposes (irrigation, water transport, etc.).

2. Technical and Management Aspects of Decentralized Sanitation

On-site sanitation options

- **On-site dry sanitation**
  - UD eco-san toilet — Reuse of urine and compost
  - VIP
- **On-site wet sanitation**
  - PF toilet + infiltration pit/trench
  - PF toilet + Anaerobic treatment: Biogas digester/Septic tank/Improved septic tank
  - Anaerobic treatment + subsurface filtration (Infiltration trenches, sand filter, constructed wetlands)

Technological options (cont.)

- **Off-site (decentralized/centralized) sanitation**
  - (Anaerobic treatment) + natural wastewater treatment: WSP, CW
  - Conventional treatment processes
  - Combination: Conventional + natural processes
  - Package treatment systems: Anaerobic + Aerobic processes
- **Collection alternatives**
    - Conventional combined collection system with CSO
    - Conventional separate collection system
    - Septic tank + settled sewerage
    - Simplified sewerage
- **Reuse of wastewater and sludge** in irrigation, aquaculture

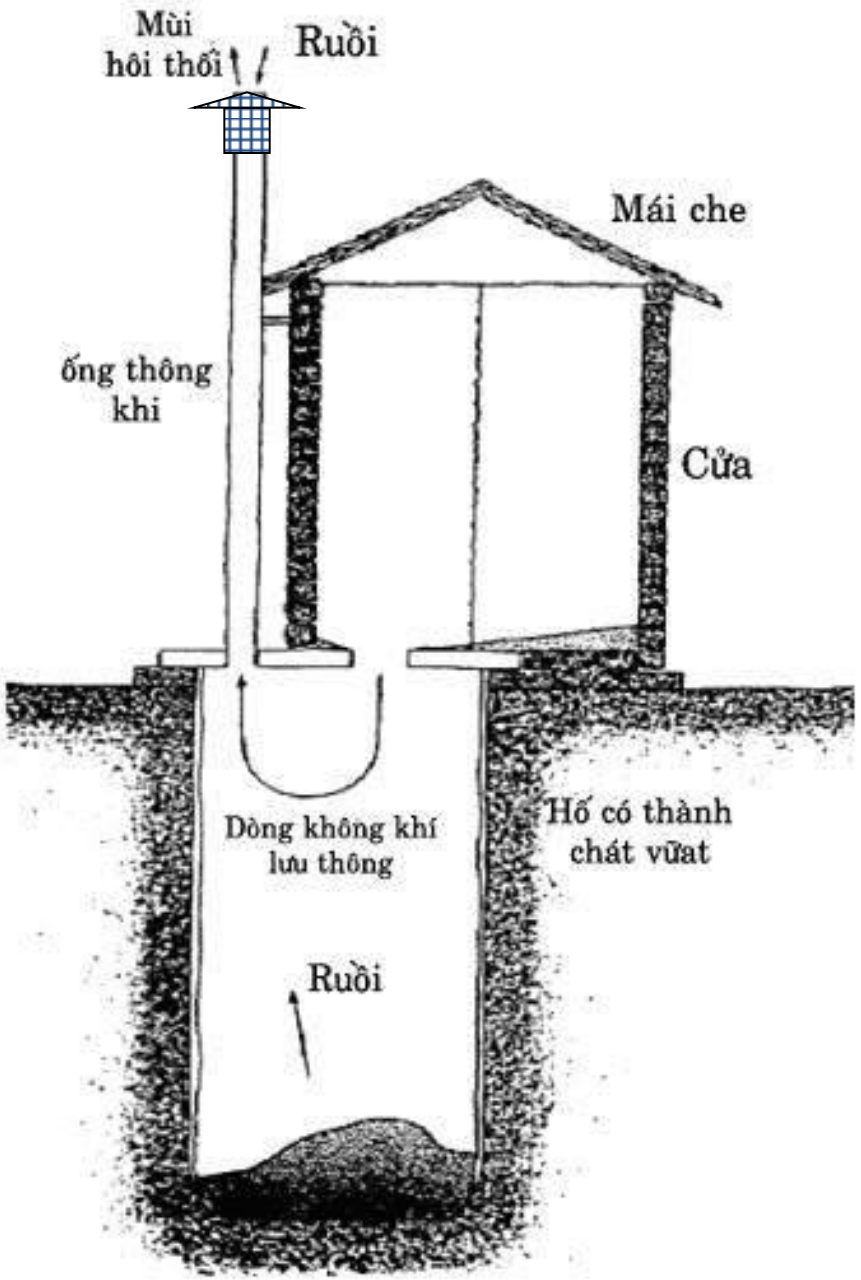
Hygienic latrine

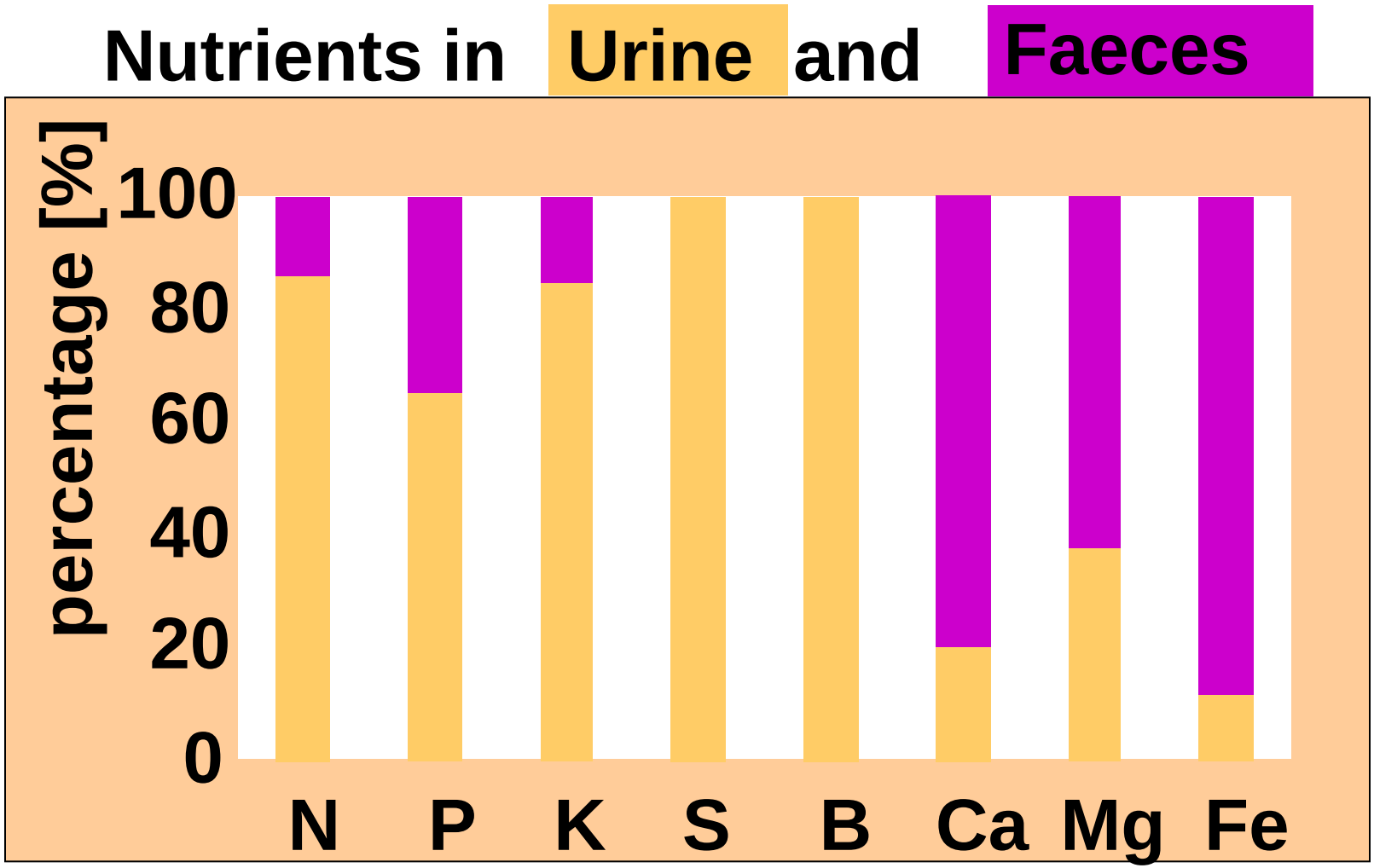
- Collecting and isolating of human and livestock waste from environment (soil, water, air, insects, …).
- Killing pathogens in the faeces.
- Clean, convenient for users including elder and children.

+ Enabling for reuse of nutrients from faeces and urine for plantation, soil conditioning

VIP latrines

- Not flush water
- Insects prevention
- Low-cost, easy to build
- When pit is full: close the pit for composting and move toilet to another site




Nutrients in Urine and Faeces
percentage [%]
100
80
60
40
20
0
N
P
K
S
B
Ca
Mg
Fe

Dry ecosan toilet

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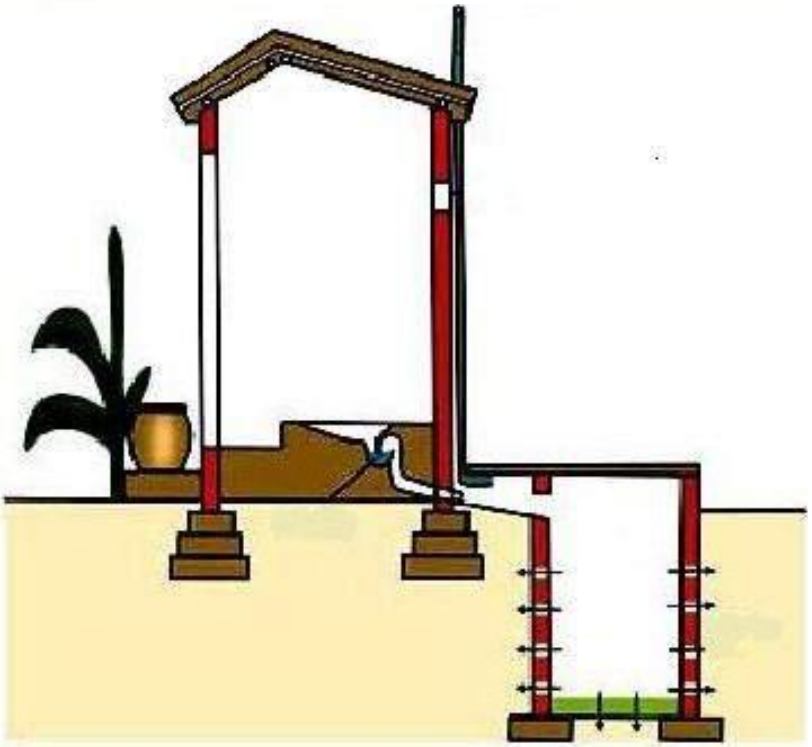
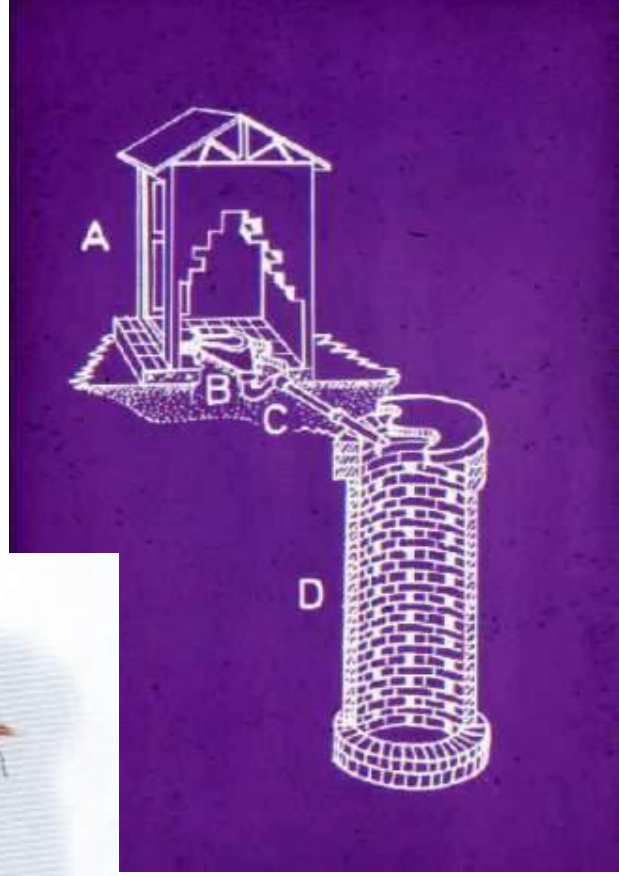
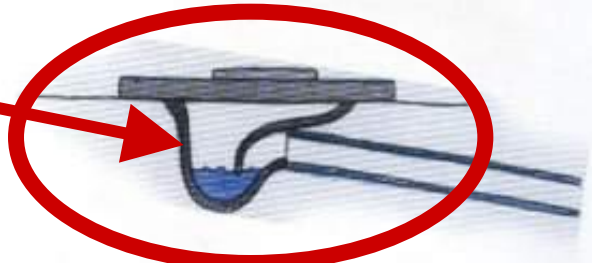
- No flushing water. Separating faece and urine
- To add lime or ash
- Diluting urine for irrigation
- 6 – 12 months compost for disinfection before fertilizer
- Low-cost

Pour flush toilet

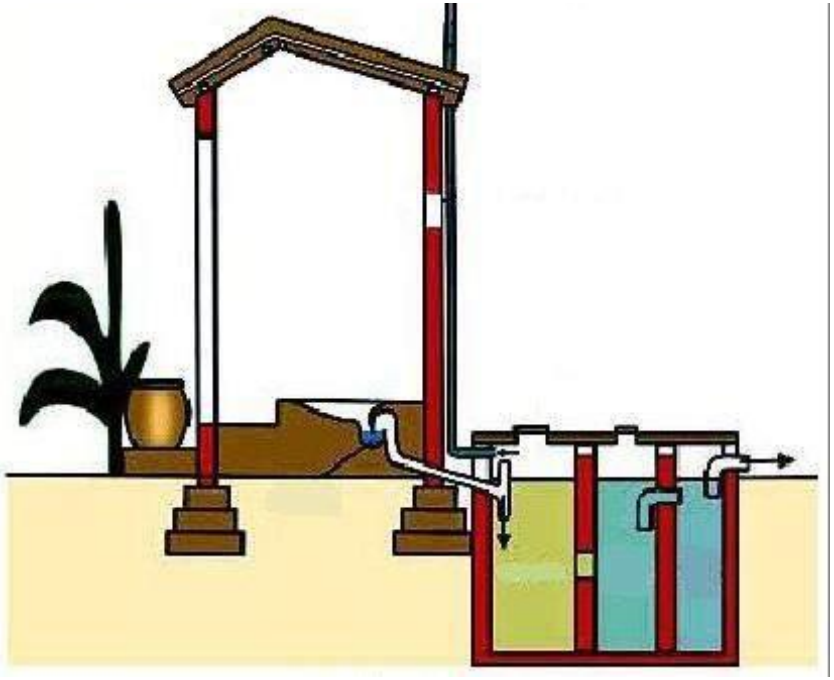




Siphon for odor control

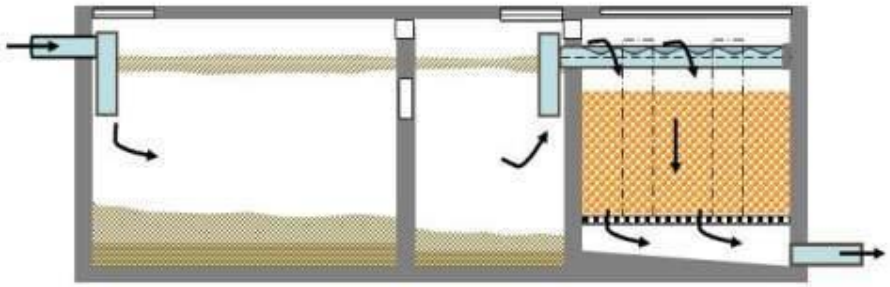


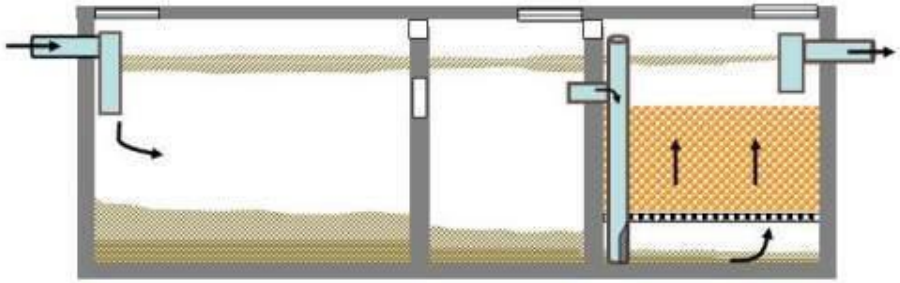
Pour flush toilet + septic tank

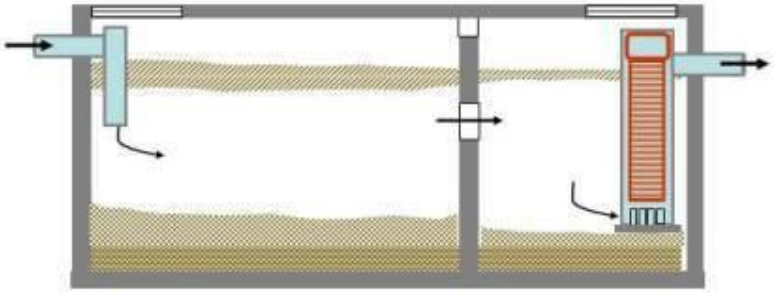


Cover
Effluent
Influent
Bồn cầu
Septic tank
Soak pit

ST treatment efficiency improvement



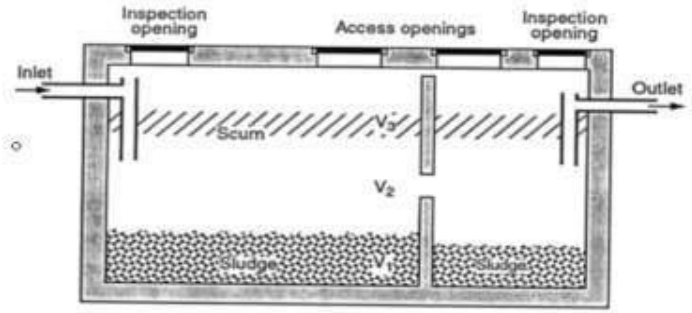


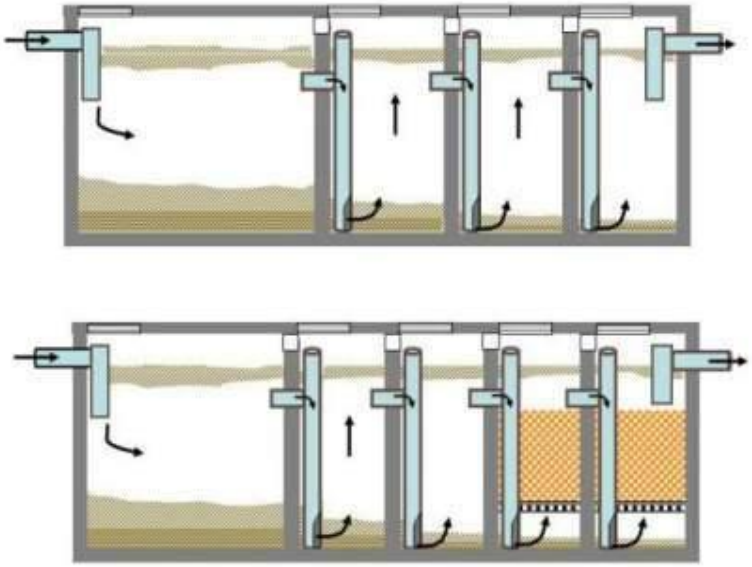


Baffled septic tank with anaerobic filter BASTAF (IESE – SANDEC, 1998 - 2007)

ST < BAST < STAF < BASTAF (HRT = 48 h)

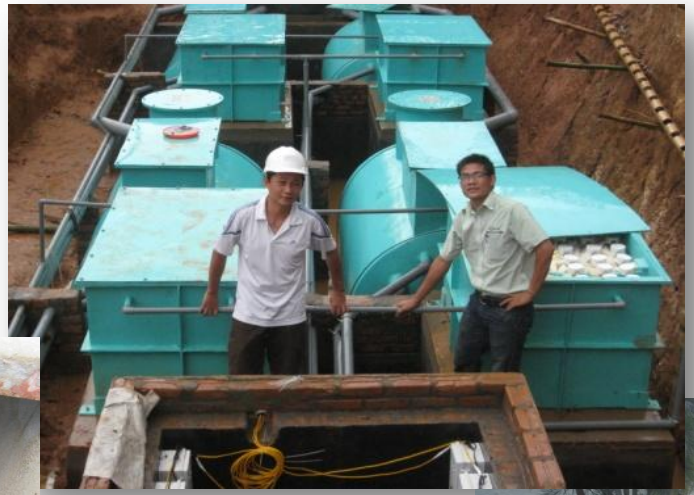
50 – 60% 70 – 80% 80 – 85% 80 – 90%





- ST – Septic tank
- BAST – baffled septic tank
- STAF-septic tank with anaerobic filter
- BASTAF – baffled septic tank with anaerobic filter.

PRE-FABRICATED WASTEWATER TREATMENT SYSTEMS
AFSB® and BASTAFAT®



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Decentralized w/w treatment technologies

Location	Technologies applied
Hospitals, hotels, apartments, office buildings in the urban centers(a)	Activated sludge process, MBR Tricking filter, RBC Submerged aerated filter A^2O Jokashou and other packaged pre-fabricated plants
Pig farms(a)	Biogas digester
Vietnam Friendship Village in Xuan Phuong commune, Tu Liem district, Hanoi (2008)(b)	Combined sewerage and drainage with CSOs, BASTAF + HF CW
Low-income residential area in Vinh Yen town, Vinh Phuc province (2007) (b)	Combined sewerage and drainage with CSOs, BASTAF

- A^2O – anaerobic – anoxic – oxic treatment process.
- ABR – anaerobic baffled reactor.
- BASTAF – baffled septic tank with anaerobic filter.
- CSO – combined sewerage with overflow chambers.
- HF CW – horizontal flow constructed wetland

(a) – implemented by different service providers.
(b) – by DESA team, IESE.
(c) – by BORDA Vietnam

Decentralized w/w treatment technologies

Location	Technologies applied
Xuan Mai concrete factory residential quarter, Chuong My district, Hanoi (2007) (b)	Combined sewerage and drainage with CSOs, BASTAF
Lai Xa village, Kim Chung commune, Hoai Duc district, Hanoi (2006 – 2007) (b)	Combined sewerage and drainage with CSOs, BASTAF + HF CW
Ta Thanh Oai and Huu Hoa communes, Thanh Tri district, Hanoi (2005) (b)	Combined sewerage and drainage with CSOs, BASTAF
Tam Da village, Tien Son district, Bac Ninh province (2002) (b)	Combined sewerage and drainage with CSOs, BASTAF

- A^2O – anaerobic – anoxic – oxic treatment process.
- ABR – anaerobic baffled reactor.
- BASTAF – baffled septic tank with anaerobic filter.
- CSO – combined sewerage with overflow chambers.
- HF CW – horizontal flow constructed wetland

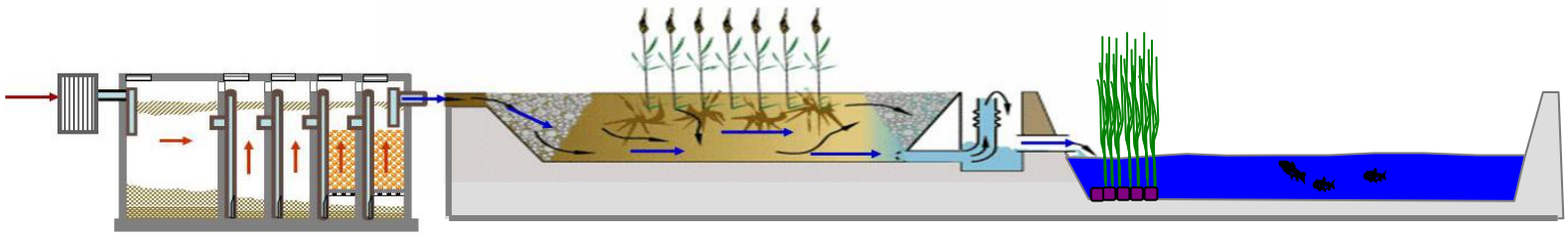
(a) – implemented by different service providers.
(b) – by DESA team, IESE.
(c) – by BORDA Vietnam

Decentralized w/w treatment technologies

Location	Technologies applied
Wastewater collection and treatment system for Cho Ra town, Bac Kan province[(b)]	Separate low-cost sewerage, BASTAF + HF CW
Wastewater collection and treatment system for Cho Moi town, Bac Kan province[(b)]	Separate low-cost sewerage, BASTAF + HF CW
Wastewater collection and treatment system for Nuoc Hai town, Cao Bang province[(b)]	Separate low-cost sewerage, BASTAF + HF CW
Kim Bang district hospital, Ha Nam province[(c)]	ABR + HF CW

Decentralized w/w treatment technologies

Location	Technologies applied
Thanh Hoa Children hospital, Thanh Hoa province[c]	ABR + HF CW
Bear care center in Tam Dao Natural park, Vinh Phuc province[c]	ABR + HF CW
Cluster in Kieu Ky Commune, Gia Lam district, Hanoi city[c]	Combined sewerage and drainage with CSOs, ABR + HF CW
Cluster in Lim town, Bac Ninh province[a]	Combined sewerage and drainage with CSOs, BASTAF + Facultative pond
Cluster in flood evacuation cluster, An Giang province[a]	Combined sewerage and drainage with CSOs, BASTAF + Facultative pond



BASTAF HF CW (Fish) Pond

- Type of sewerage and drainage system?
- Coverage? HH connection?
- Wastewater fee collection?

DWWM in peri-urban areas

Lai Xa village, Hoai Duc, Hanoi

Kieu Ky, Hanoi, Gia Lam

VFV, Xuan Phuong, Hanoi

- Type of sewerage and drainage system?
- Coverage? HH connection?
- Investment?
- Wastewater fee collection?

Features of built systems (BASTAF + CW)

Parameters	Baffled septic tank	Constructed wetland
Treatment performance	Removal efficiency: COD = 72–90%; BOD = 72–83%; SS = 78–94%; TP = 33%; TKN= 47%	Removal efficiency: COD = 80 – 90%; BOD = 75 – 85%; SS = 80 – 95%; TN = 40 – 60% Effluent quality: BOD < 30 mg/L
Unit configurations	1 sedimentation chamber (50% of total volume) and 2–3 up-flow chambers; HRT= 48 hours (0.2 – 0.3 m^3 per person) Critical up-flow velocity = 0.5–0.7 m/h	Series of vertical-flow units, horizontal-flow units, free-water surface units ; 2 vertical-flow units Sizing: 14.5 m^2/m^3/day or 0.35 PE/m^2 HRT = 4 days Pre-treatment is required
Construction costs	150–200 USD/m^3 of wastewater	(land price not included)
Operation and maintenance	Desludging frequency: 2–3 years Reactor start-up period: 90 days Critical hydraulic peak-flow factor = 4	Regular harvesting of wetland plants Removal of oil and grease on the CW surface Cleansing of CW unit surface

(Morel et al, 2007)

Sludge management

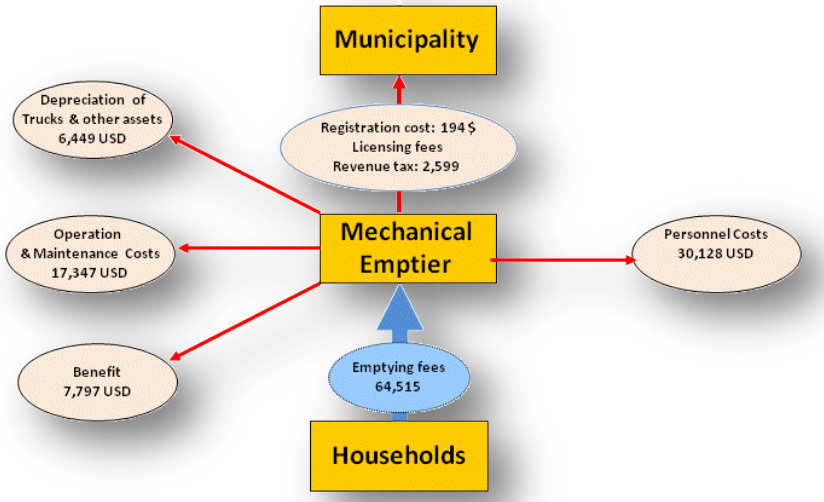
- There is no effective fecal sludge management in place in Vietnam.
- Previous efforts have been short-lived or only seen as demonstration efforts.

  –A suitable management scheme should be instigated.
  –Again, the planning with adequate resources allocation is required

Find more information in:

BILL & MELINDA GATES foundation

Business Model Assessment of Fecal Sludge Management in selected Vietnamese cities



Assoc. Prof. Dr. Nguyen Viet Anh
Institute of Environmental Science and Engineering (IESE),
Hanoi University of Civil Engineering

3. Discussions

Financing mechanisms for sanitation projects

- Work order for O&M: paid by city's budget. Part of it: collected w/w fees
- Urban w/w fee: 10% surcharge to water bill. Hai Phong city: 15%. Other cities are preparing to increase.
- For not connected households: environmental fee (10%). (Decree No. 67/2003 to be revised)
- Industrial w/w charges: Decree No. 67/2003, followed by Decree No. 04/2007 (kg of COD, BOD, SS, heavy metals discharged)

Major challenges in sanitation projects

- Lack of knowledge of decentralised options
- Quality of design and construction, associated with
  - consultants' competency,
  - administrative appraisal procedures,
- Low rate of household connection,
- Capacity building component during project implementation is poor,
- Financial sustainability,
- Problems in O&M, M&E
- Shortage of qualified work force and skills for O&M.
- Out-sourcing services are often not available or not affordable in the area.
- Others.

- **Technical aspects**
  - There are still very **few decentralized technical options** developed and applied.
  - **Systematic review** has not been conducted:
    - DEWATS system performance, public acceptance, etc.
    - Balancing of investment, and O&M costs, including required space, manpower, energy and chemicals.
  - After AD (mostly under-ground), polishing step (**large space**) is required.
    - Alternative options: Packaged system BASTAFAT, Jokashou, etc.

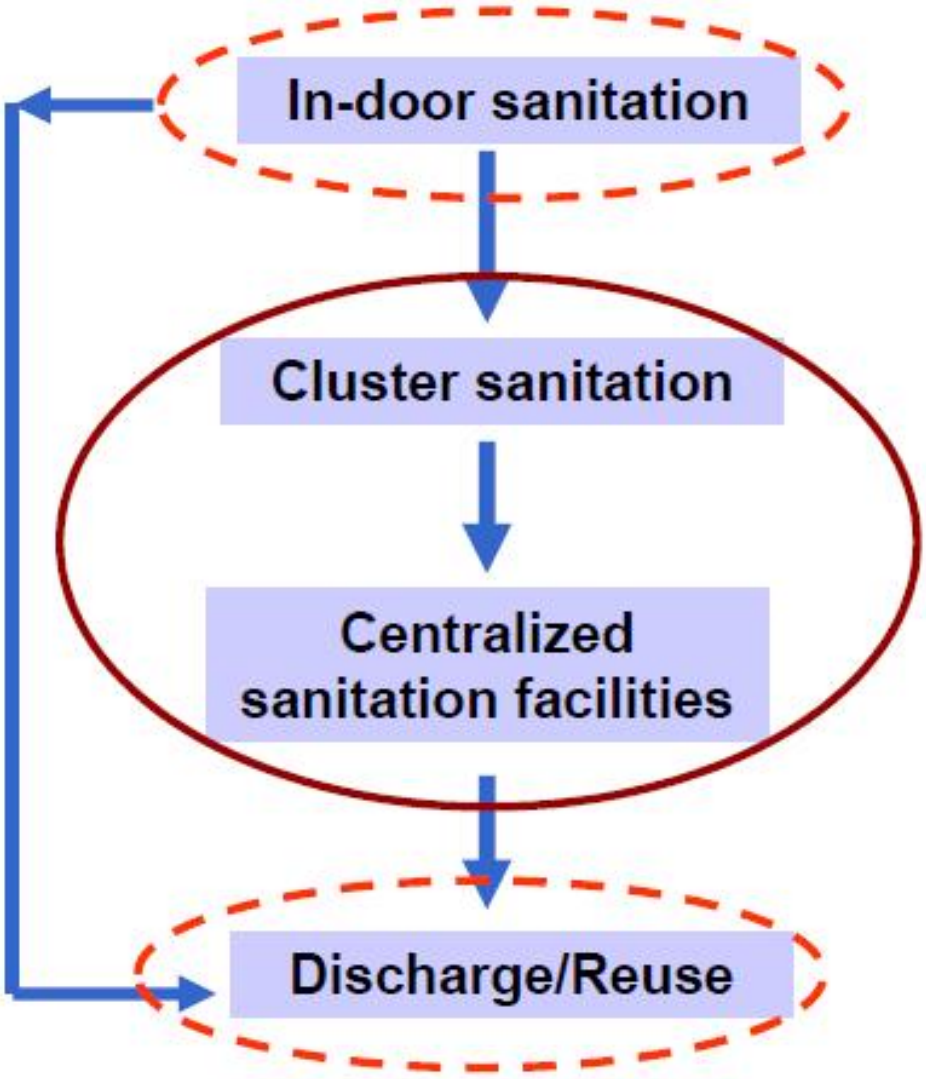
- **Technical aspects** (cont.)
  - Collection of wastewater: little national and international experience in combined drains + septic tanks.
  - Design guidelines are still lacking.
  - Most of urban sanitation projects: neglect tertiary network.
  - Most of rural sanitation projects: focus on on-site sanitation facilities.
  - Environmental sanitation and infrastructure planning of the community is lacking.
  - Environmental industry is still very weak. Lack of firms' capacity for R&D, marketing strategy, etc.
  - Import of hi-tech products with ''heavy armed'' marketing campaigns are contributing to weaken this young industry.

- **Financial aspects**
  - Wastewater fees is still very low in urban areas, and zero in rural areas (Decree 88…)
  - Private sector is till not interested in this business.
    - No recovery for O&M and system upgrading
    - Lack of financial sustainability after construction works.
- **Social aspects**
  - Traditional acceptance of untreated wastewater disposal by most of people.
  - Wastewater reuse attitudes of the public and policy makers hinder the adoption of wastewater treatment and safe reuse systems.
  - The main challenge is to create informed demand for improved sanitation.

4. Conclusions and Recommendations

- Sanitation improvement should start from household
- Ecosan concept
- Technical aspects
- Wastewater management regulations
- Sustainable sanitation model

Sanitation has to be started from the household !



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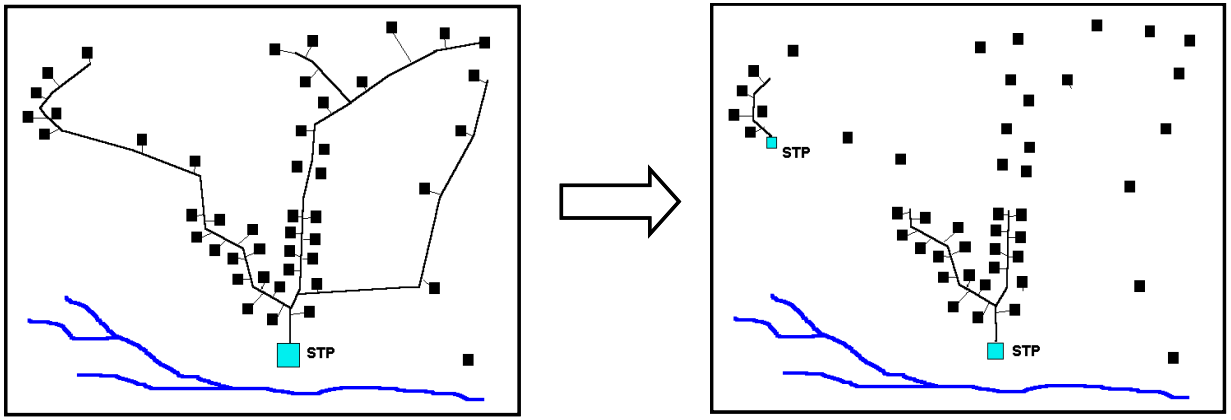
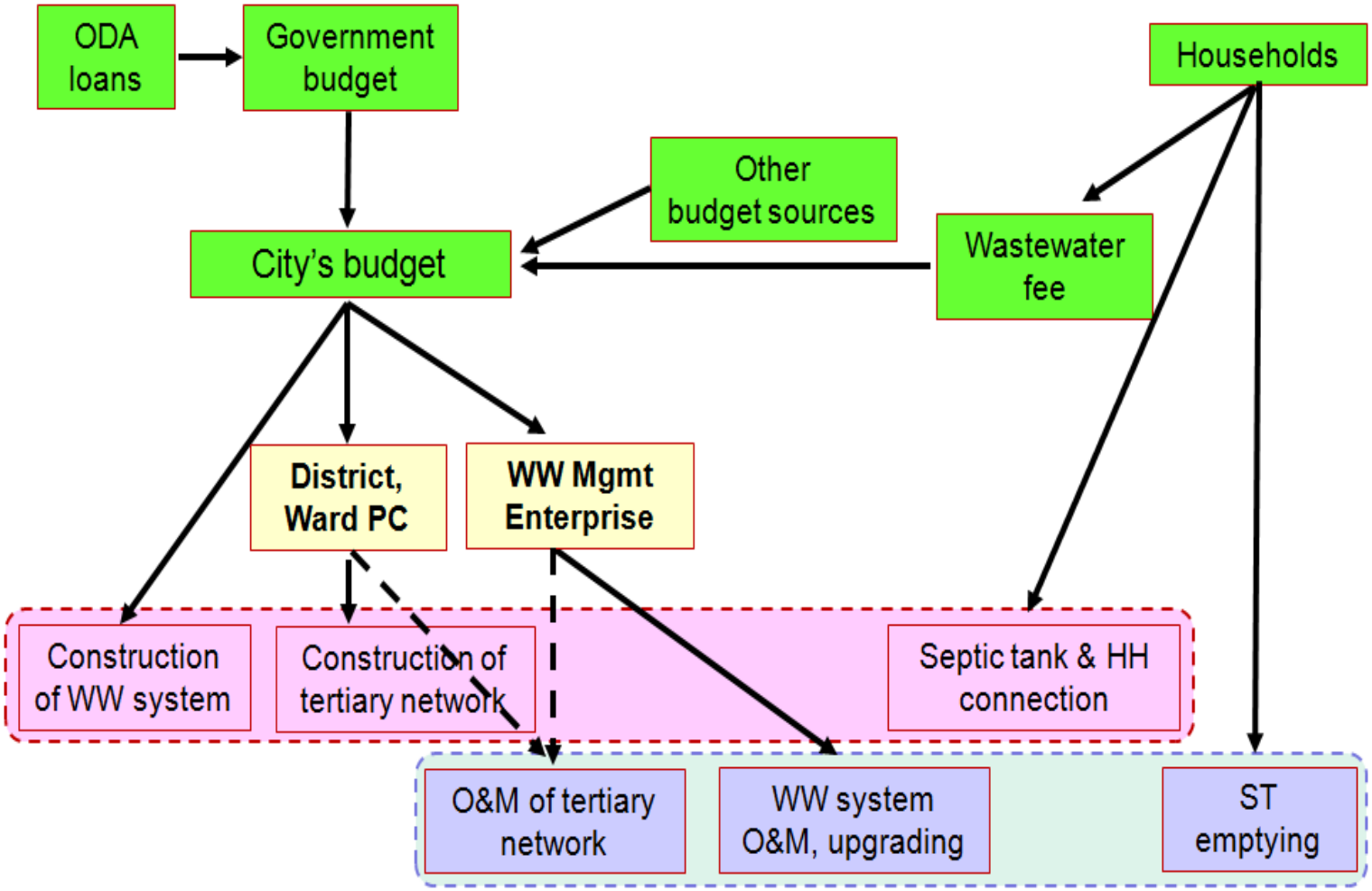
- **Technical aspects**
  - Combination of different options
  - Cost-benefit analysis of different sanitation options should be developed.
  - We need information of unit costs of different sanitation options, in different local contexts



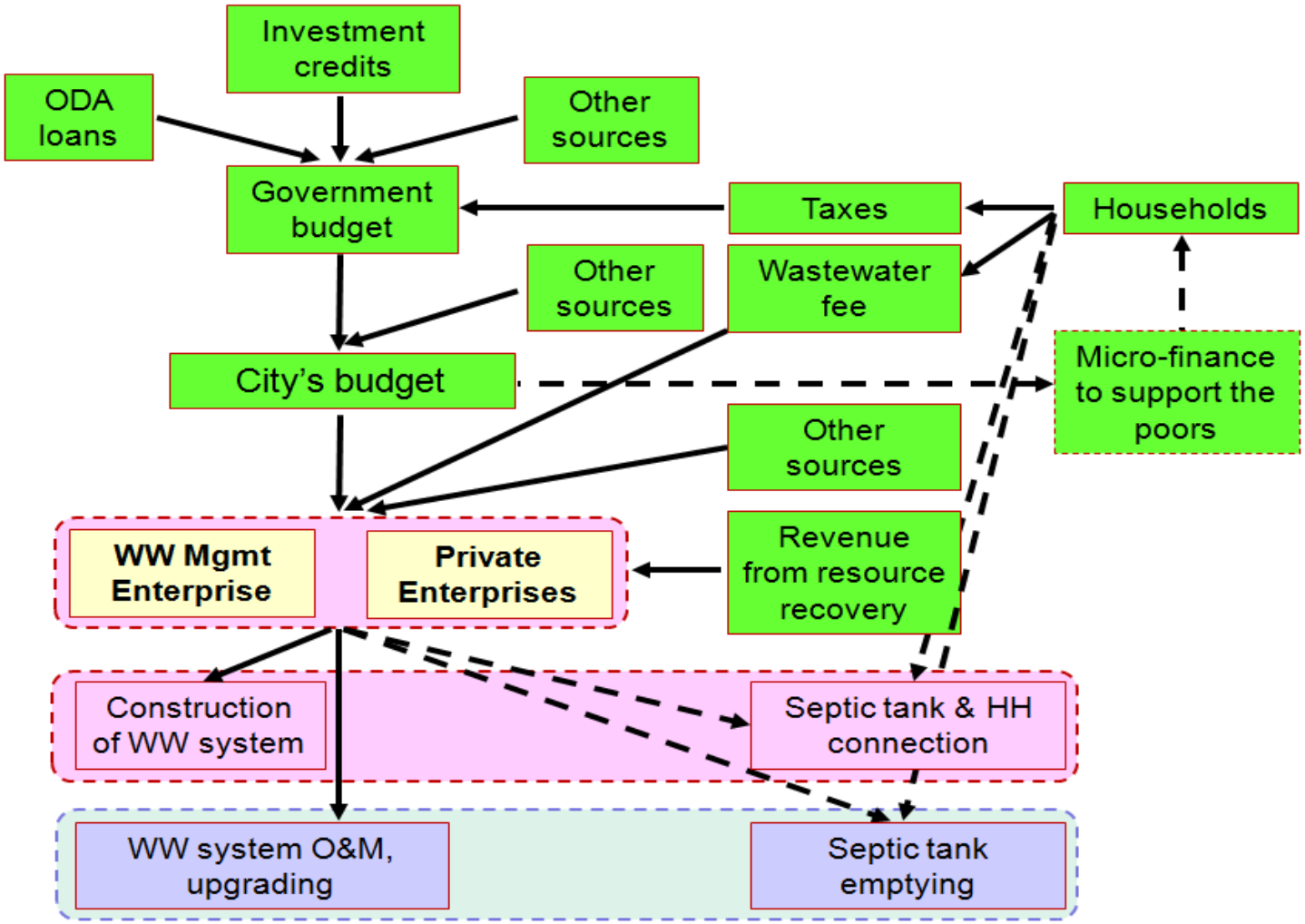
Other issues to be considered

- Sludge management (centralized or decentralized. Resource recovery options).
- A special National policy on DWWM is needed in order to fill the gap of sanitation coverage besides Centralized WWM.
- Together with: Codes, Standards, Technical Guidelines, local w/w management regulations. Enabling Environmental Industry's development.
- For sustainability:
  - Household connection regulation.
  - O&M activities
  - Organization structure, management and financial models.
- DWWM in special environments: flooding, rocky soil, low density, etc.

Source of funding for urban wastewater mgmt in Vietnam



Recommended financing mechanisms for wastewater investment and O&M



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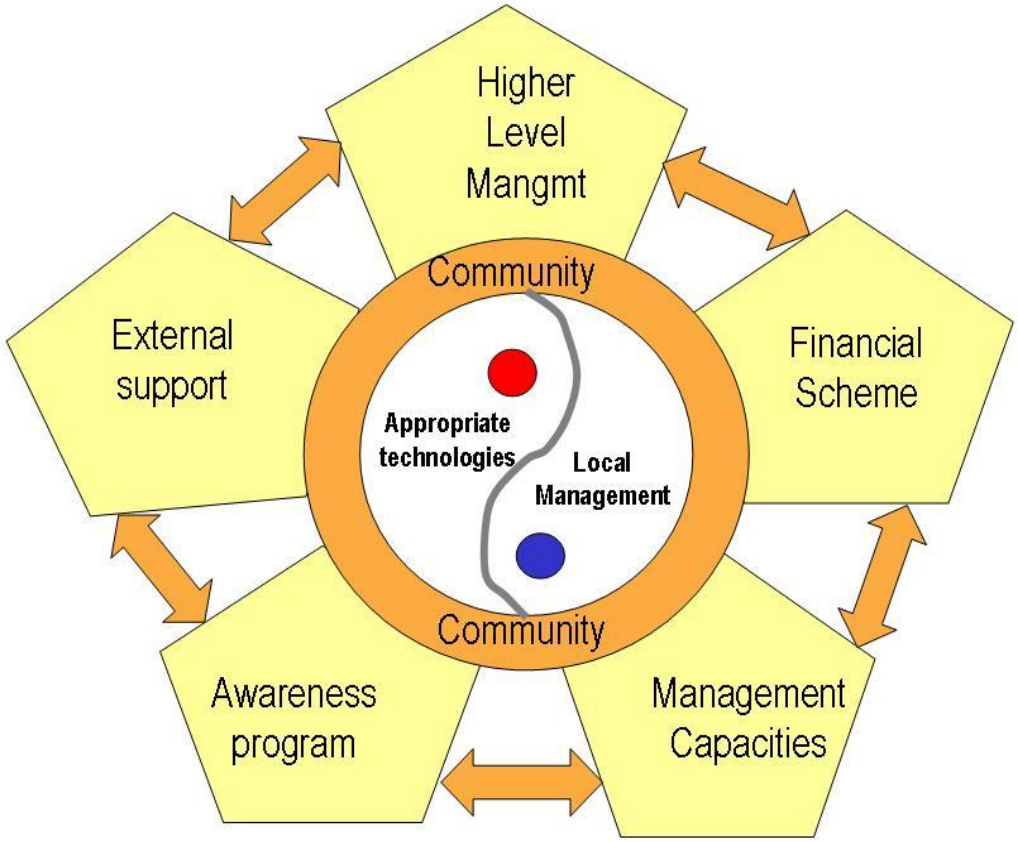
CONCLUSIONS & RECOMMENDATIONS (Cont.)

- **Sustainable Sanitation Model**



Xin trân trọng cảm ơn

Thank you

Assoc. Prof. Dr. Nguyen Viet Anh
Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering.
Add. 55 Giai Phong Rd. Hanoi, Vietnam. Tel. 04-3628 45 09, Fax 04-3869 3714, MP. 091320.9689,
Email. vietanhctn@gmail.com; www.epe.edu.vn