Simulating Nutrient and Energy Fluxes in Non-networked Sanitation Systems

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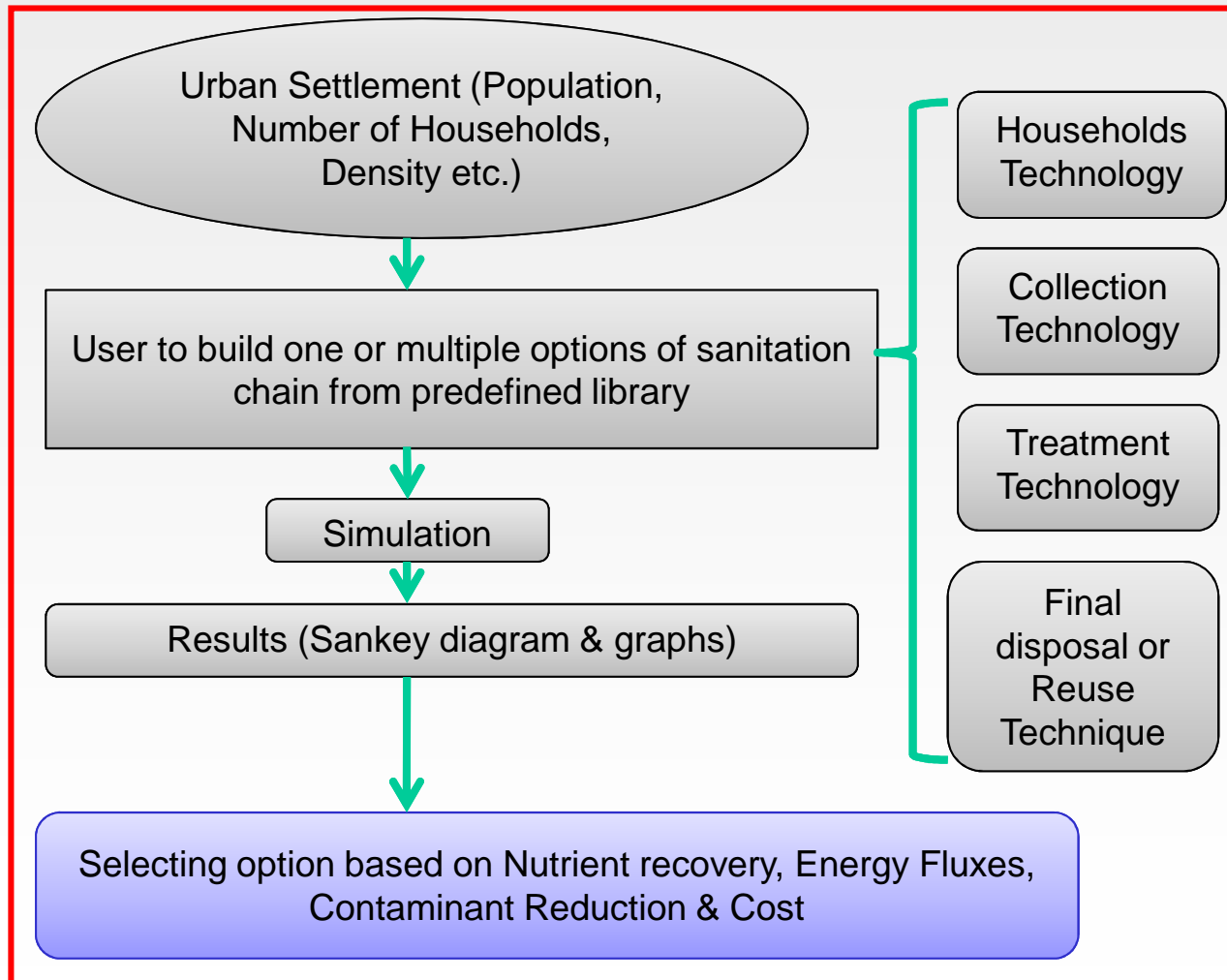# Simulating Nutrient and Energy Fluxes in Non-networked Sanitation Systems

- **Motivation**

  - Wide range of sanitation options available – **how to select?**

  - many **new sanitation technologies** are being developed

  - support on **policy development** and **strategic decisions**

  - Need for **simulation model** also for **non-networked systems**

- **Aim of this work**

  - to develop a simulator to model resource fluxes related to **human excreta** based on **material flow analysis**

  - from **household to final disposal/reuse**

  - to aid in determining sustainable sanitation **solutions for a site at scale**

Model Concept

NewSan Simulator

- *NewSan* simulates **water, nutrient and energy fluxes** of human excreta from household to final disposal/reuse;

- Blocks (modules) represent **various toilet and sanitation options**, including interfaces, storage/treatment, treatment and use/disposal options. Including future sanitation options and technologies

- *NewSan* allows technologies to be evaluated for **different urban situations and scenarios**;
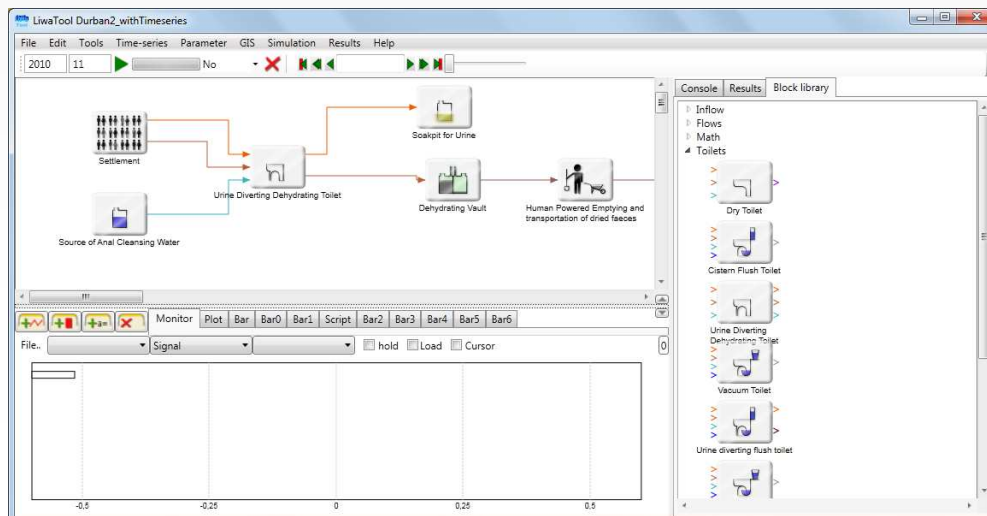
Main window of NewSan

NewSan Simulator

- Highly **flexible** in definition of processes, parameters and variables;

- Categories of costs (**capex and opex expenditure** according to water operator's cost categories) **can be evaluated**;
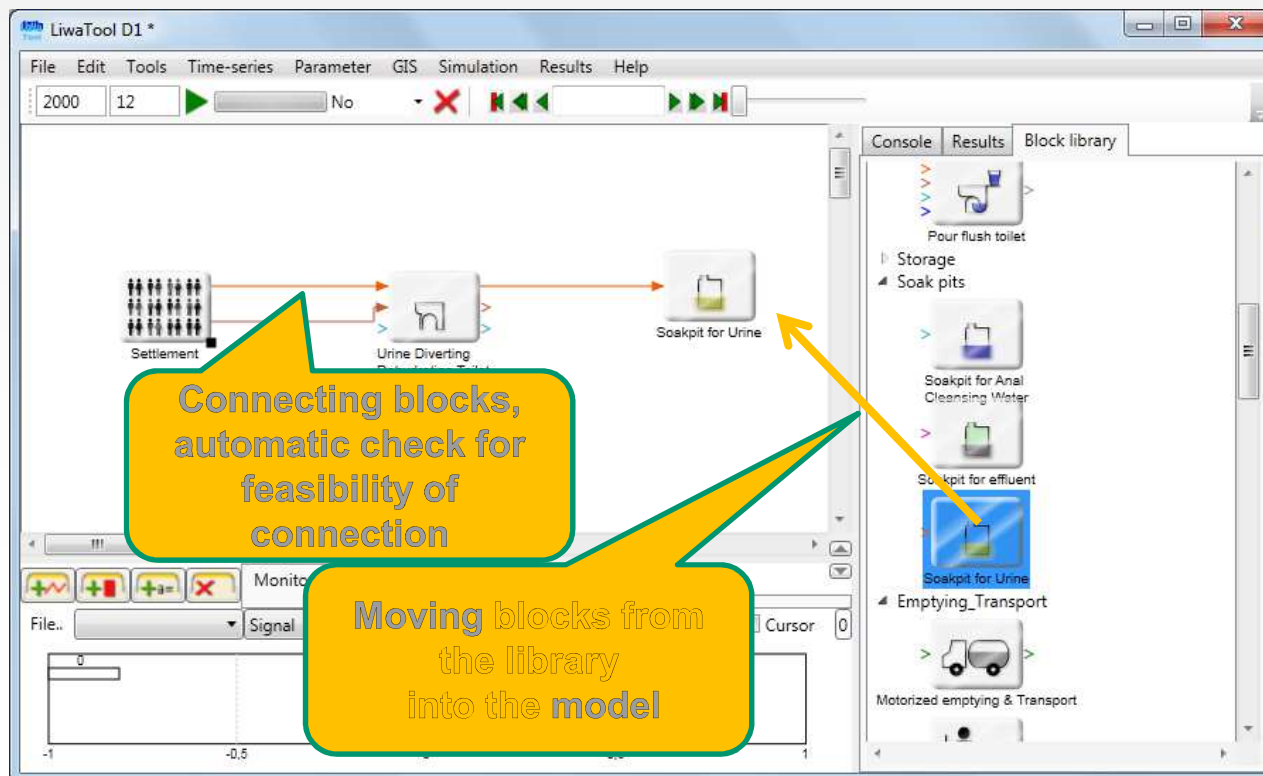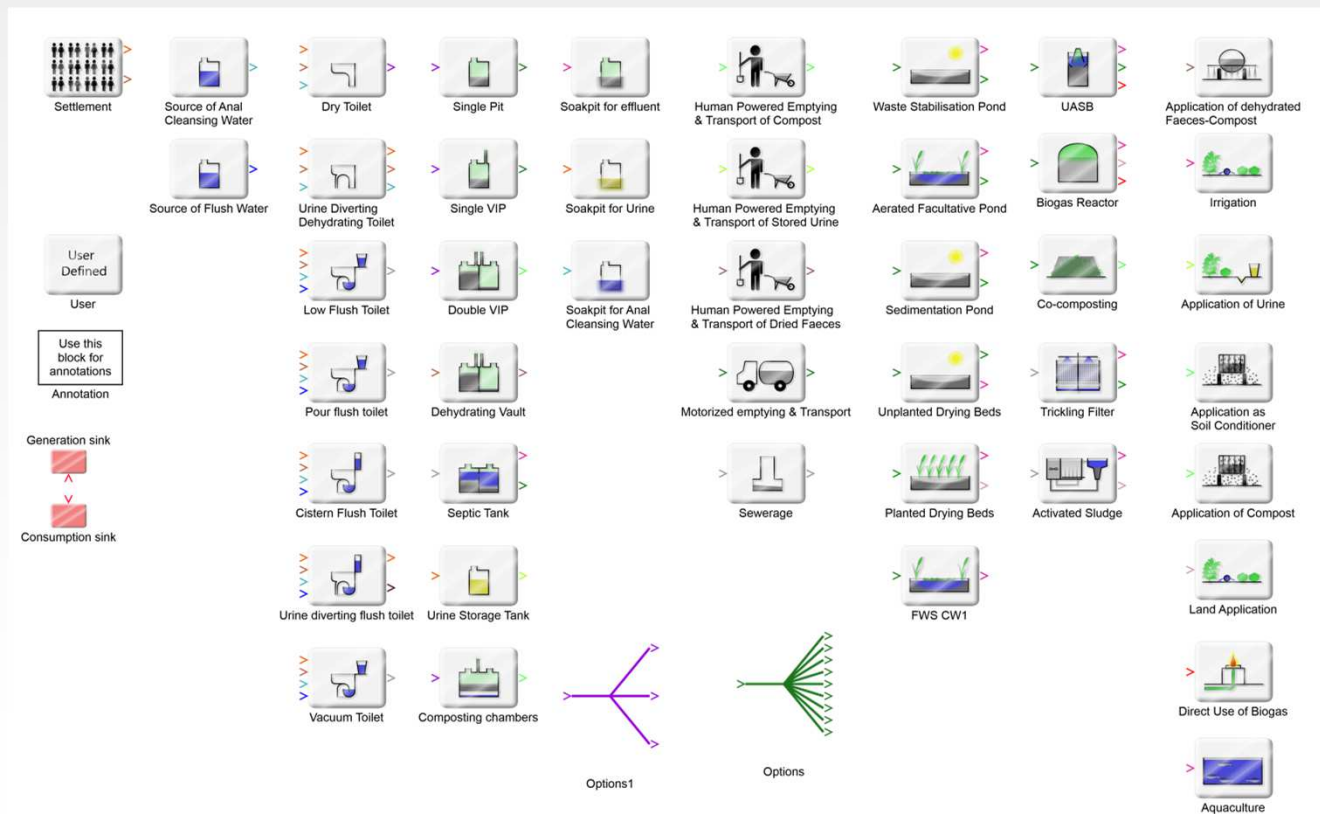
NewSan Simulator

- *NewSan* results, feeding into multi-criteria decision analysis, **will assist informed stakeholder discussions and decisions**;

- It will support development of **city sanitation plans**

- Useful for **capacity building** measures

- *NewSan* **does not require costly third-party software**, thus is applicable in a developing country context.

- Simulator developed in C#, using Microsoft .NET Version 4

- Integrates numerical solvers and integrators

- Excel import/export features

- Based on **LiWatool simulator** (earlier development of ifak)

NewSan Simulator

- **Block** (module) **library** – would you like your technology to be included?

NewSan Simulator

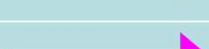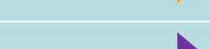- water and excreta fluxes implemented in NewSan

| Input/Output	Colour used	Input/Output	Colour used
Anal Cleansing water	→	Faeces	→
Black water	→	Flush water	→
Biogas	→	Faecal Sludge	→
Brown water	→	Organics	→
Compost/ Ecohumus	→	Stored Urine	→
Dried Faeces	→	Treated Sludge	→
Dry cleansing Materials	→	Urine	→
Effluent	→	Excreta	→

Adapted from: Tilley *et al.* (2008): Compendium of Sanitation systems and Technologies, EAWAG
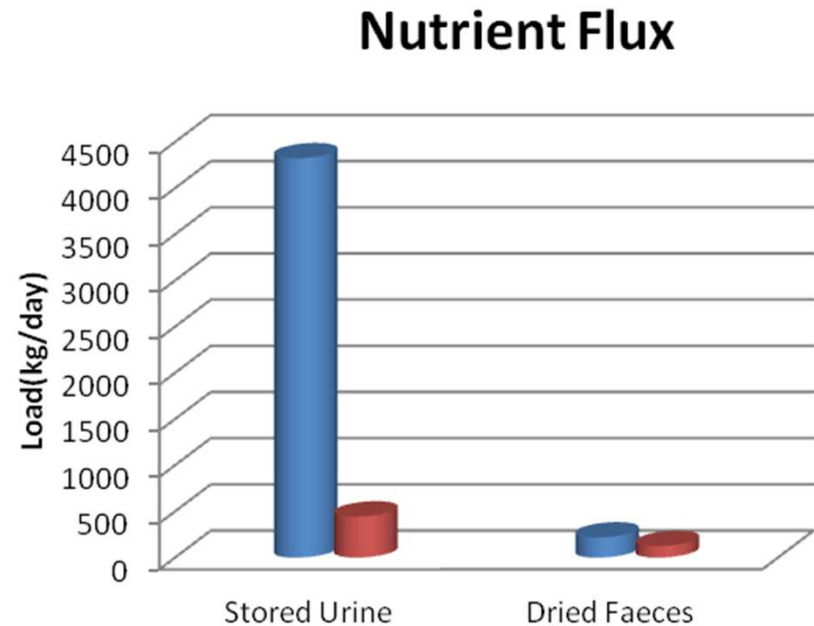
Simulating UDDT – eThekwini Case Study
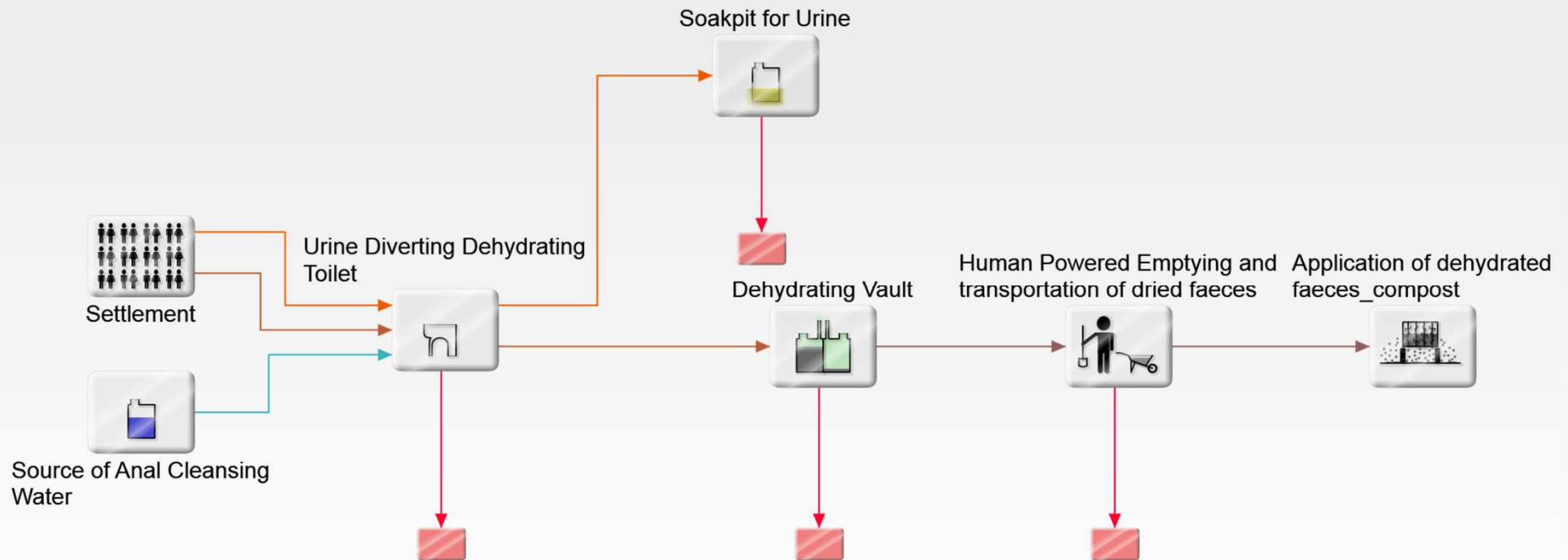
a) Scenario A: Current situation – UDDTs
b) Scenario B: UDDTs considering population growth
c) Scenario C: UDDTs compared with VIP toilets
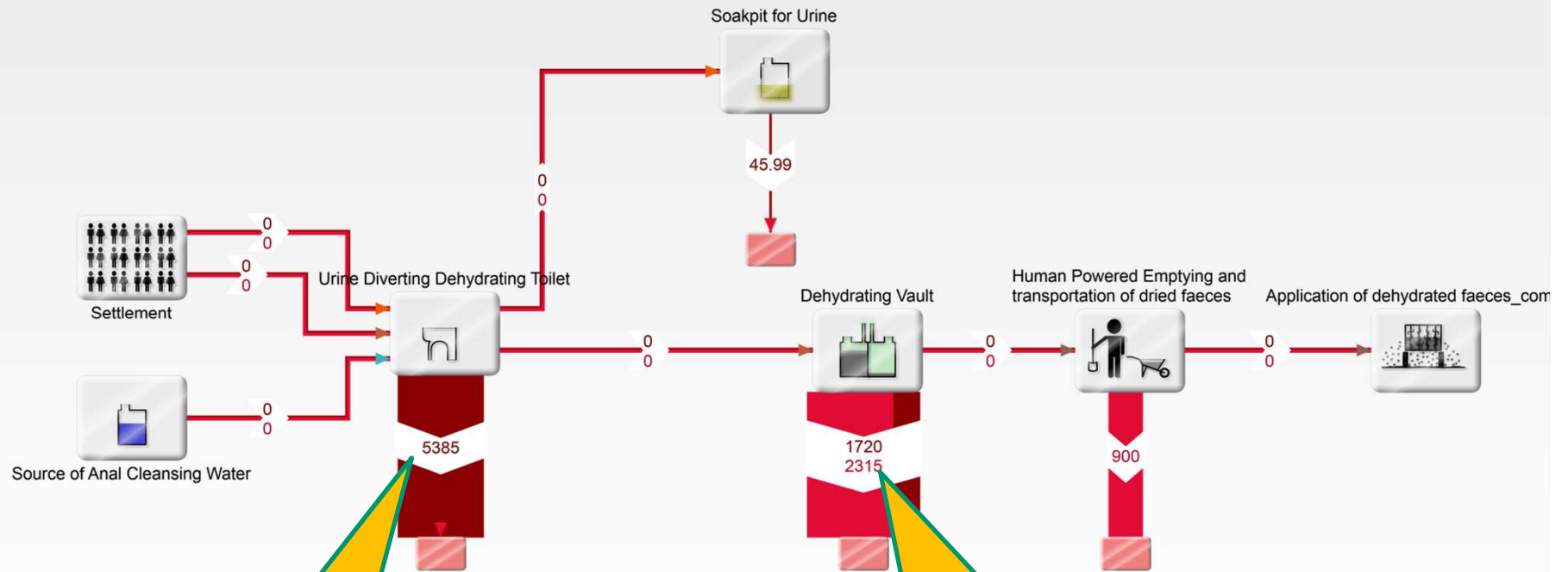
Scenario A - Current situation, eThekwini
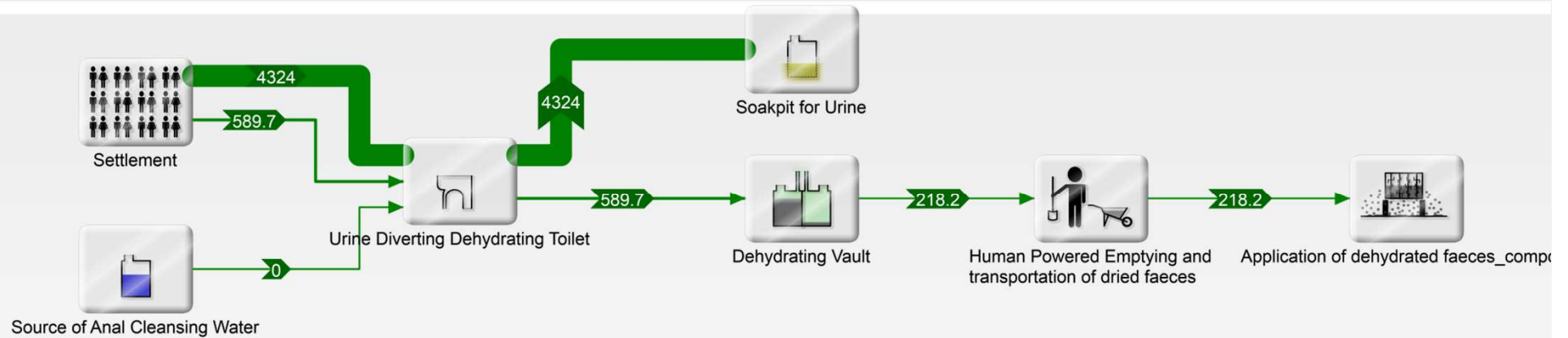
Simulation of N fluxes (kg/day)

Daily load (kg/day) for Scenario "A" (Blue cone = Nitrogen; Red cone = Phosphorus)
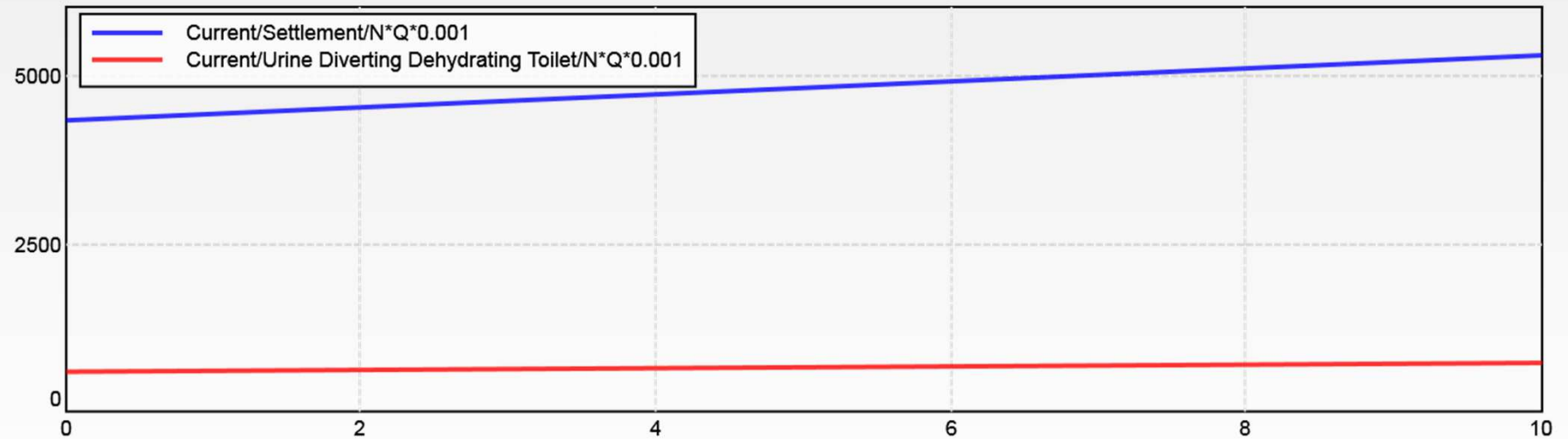
Scenario A – Visualisation of costs

- *Representation of CAPEX and OPEX in one Sankey diagram*

Capital costs p.a.
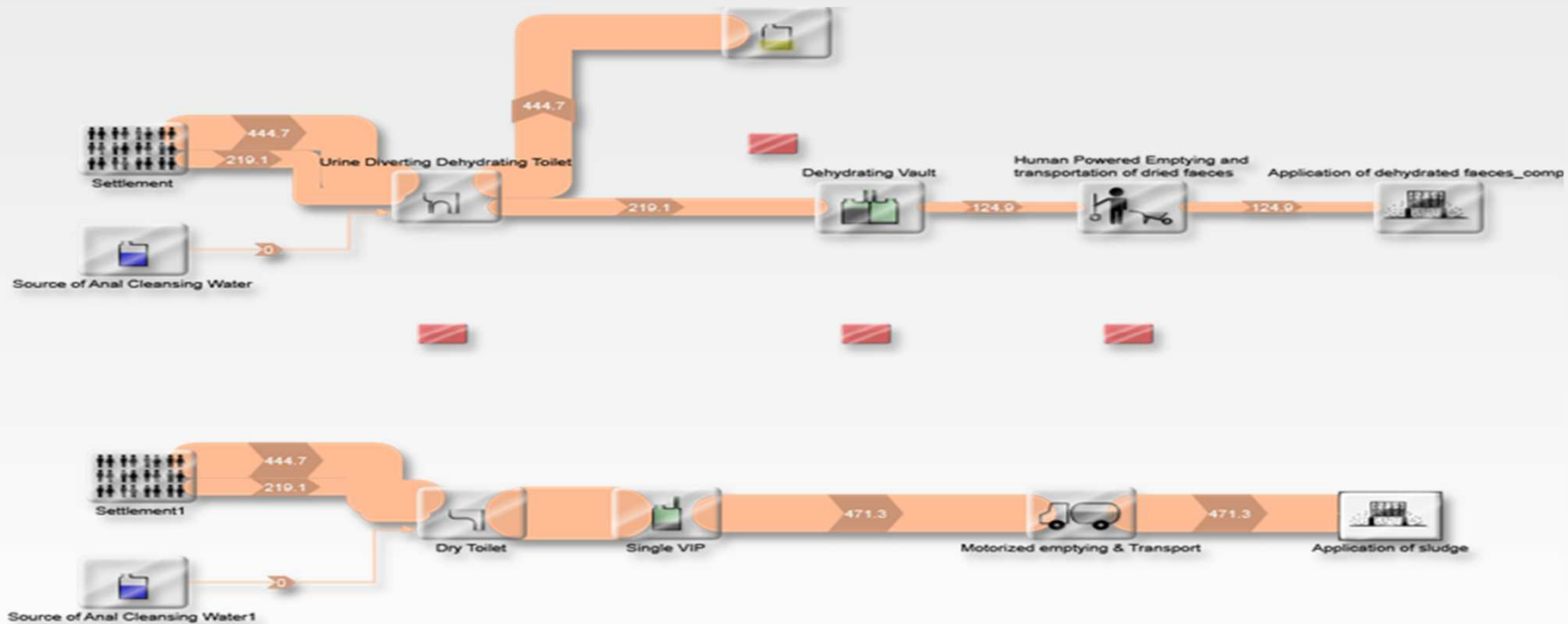(capital costs divided by lifetime)

(light red:) Operational costs

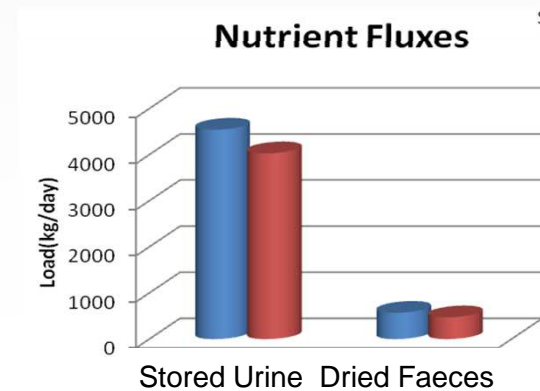# Scenario B - UDDTs assuming population growth

Nitrogen Flux of Scenario B

Scenario C - UDDTs compared with VIP toilets

Simulation of P fluxes (kg/day)

Nutrients daily load (kg/day) for Scenario "C"

Conclusions and further steps

- *NewSan* allows to represent fluxes (and related costs) in the sanitation system

- Sanitation options can be compared on a case-study base

- Input of your technology welcome!

- NewSan: flexible, ressource-flux based simulator

- Energy aspects

- Georeferenced representation of information (e.g. GoogleEarth)

- Non-quantitative information

- More detailed description of biochemial conversions

- Further case study applications

Thanks for listening!

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