Resource Recovery from Waste : Urine – Future Design

A South African Water Research Overview

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VUNA SYMPOSIUM

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What are the drivers in R&D investment?

Population Growth
- Coverage (water, energy, food)

Industrialization / Development
- Consumption of resources
- Improved wealth
- Deterioration of environment

Urbanization
- Densification
- To centralize or decentralize?
- New solutions
- Protection of environment

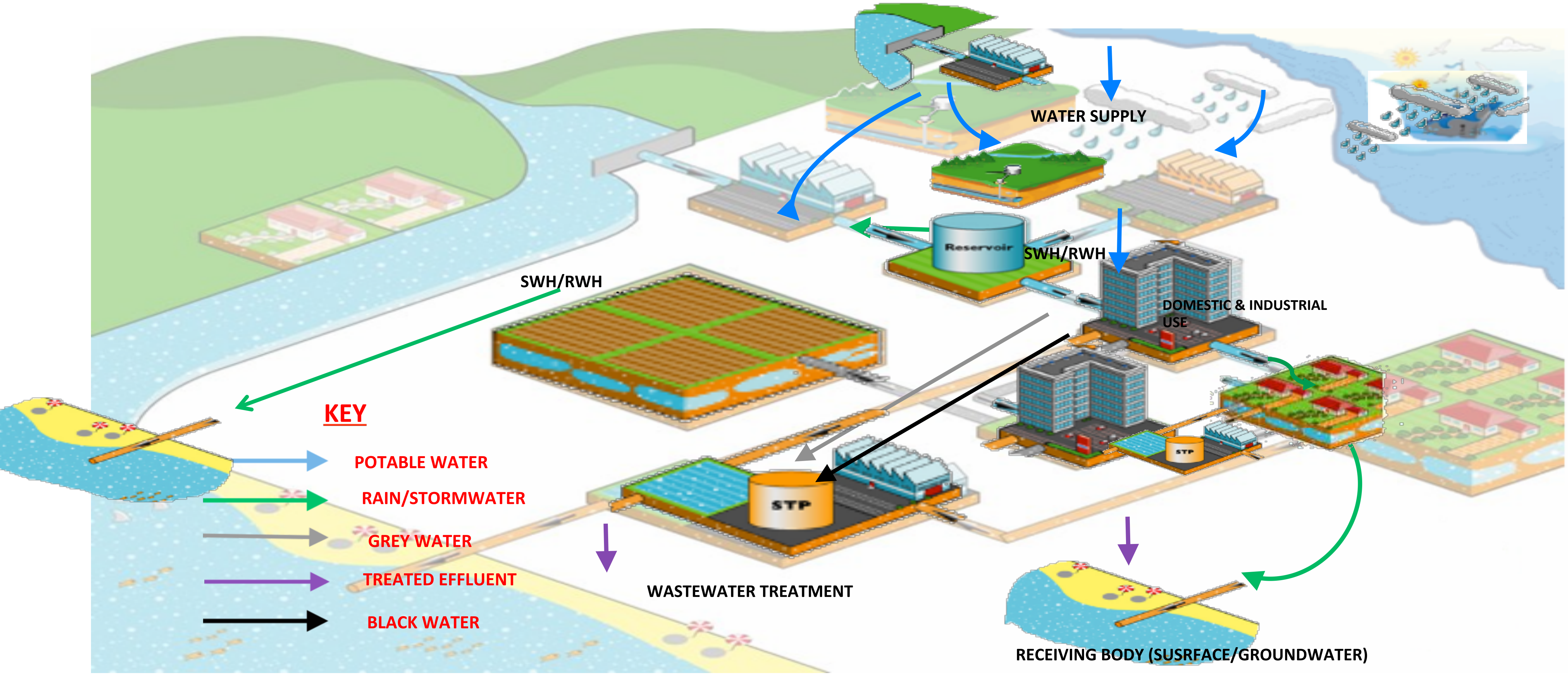
Limitation on Natural resources
- Water (quantity and quality)
- Food
- Energy

Changes to natural environment
- Droughts
- Floods
- Shortages
- Scarcity



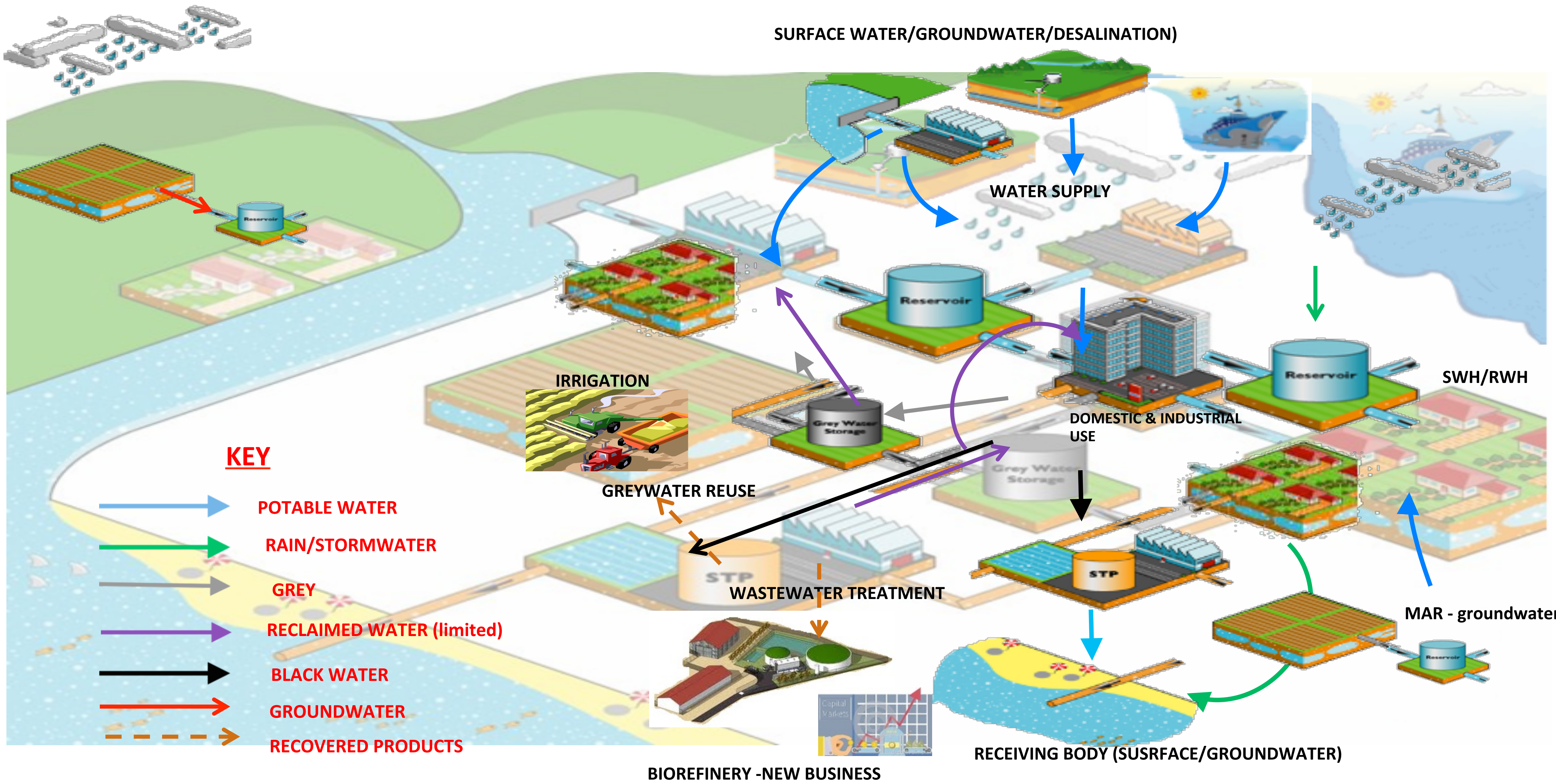


Current Practice - Linear



Adapted from Kalanithy Vairavamoorthy - GWP

WRC Long Term R&D Strategy : IUWM



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R&D Strategy

- **Improvements (current)**: Water reuse → Sludge beneficiation → Energy recovery → Efficiency → Technology shifts
- **Incremental innovation**: Embedding new concepts → Resource recovery → New infrastructure and design → New technology
- **Disruptive**: Paradigm shift → Off grid (next generation) → Biorefineries

Resource Recovery is the future! BUT

Regulatory

Policy

Risk Aversion

Lack of skills

Backlogs

Social protest

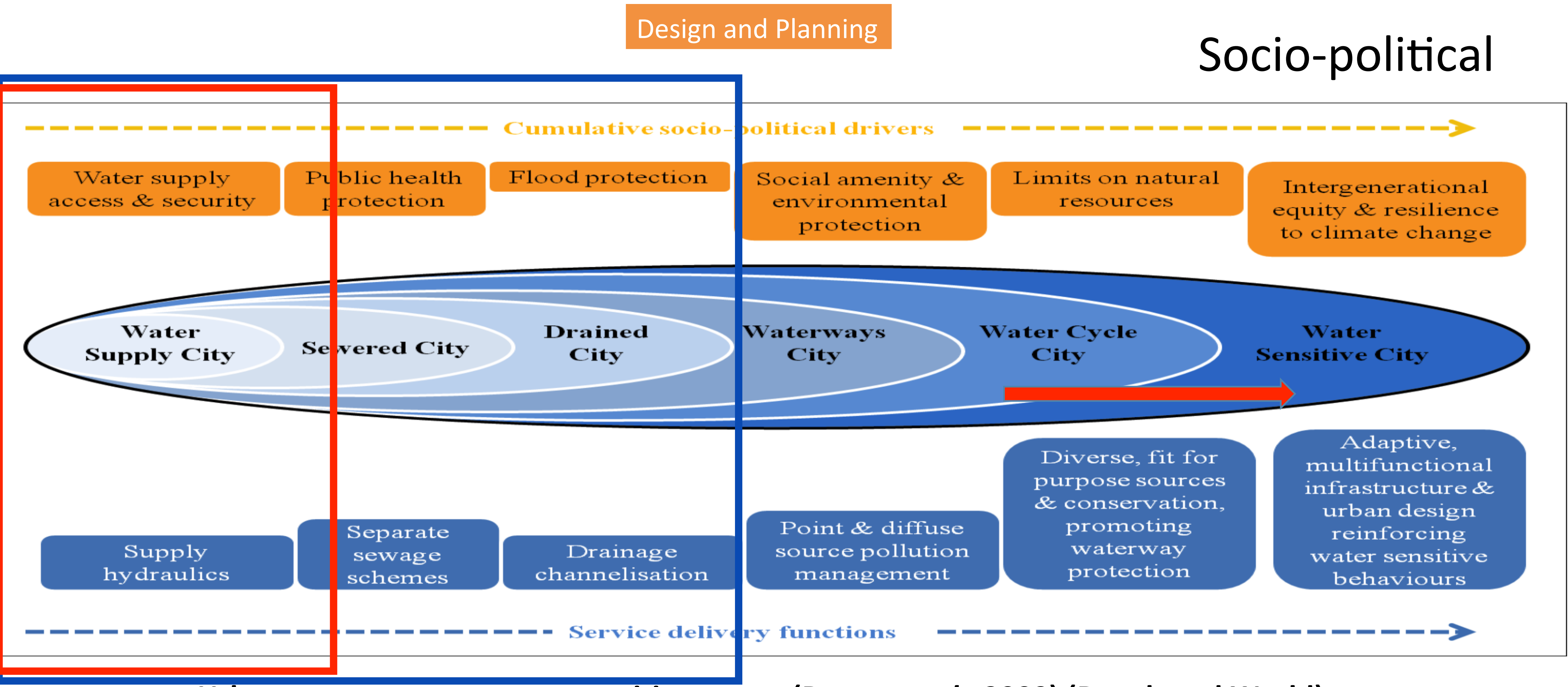
Lack of incentives

Lack of capacity

Leadership

Cost vs Opportunity Cost

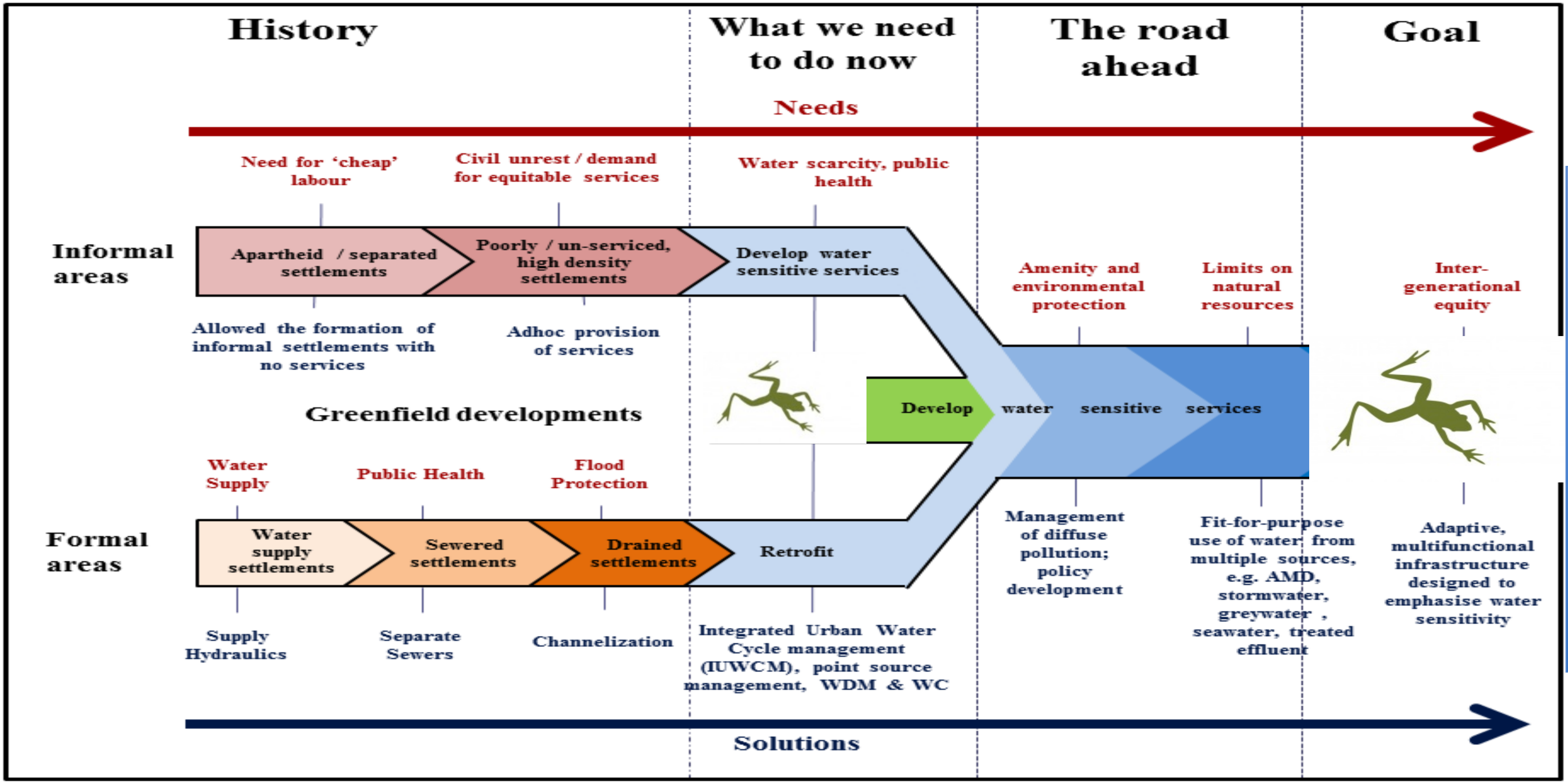
WRC Long Term R&D Strategy : Water Sensitive Design

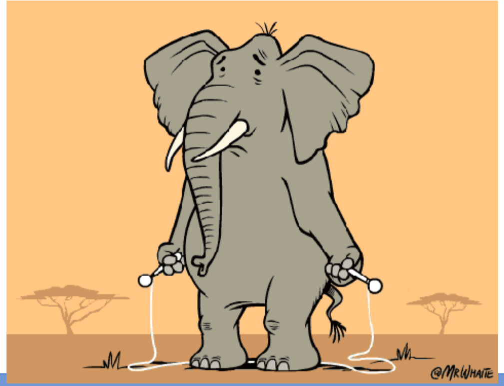


Urban water management transition states (Brown *et al*., 2009) (Developed World)

Water Sensitive Design: VISION

Socio-political and economic reality





Strengthen :
- Planning
- Design
- Skills
- Alignment
- Co-operation
- Implementation
- Operating Models
- Business Case (opportunity cost)

Armitage et al, 2014 – adapted from Brown integration

Water Sensitive Settlements (WSS)

1. *'New taps'*
(New water resources)

- Water demand management and conservation
- Stormwater / rainwater harvesting
- Treated effluent
- Groundwater
- Desalinated water

2. *'Blue-green infrastructure'*
(Water sensitive management)

- Planning & design
- Economic value
- Health impacts
- Ecosystems services
- Social development
- Waterscapes
- Urban rivers
- Urban agriculture

3. *'Adapting to change'*
(Building resilience / Governance)

- Resilience
- Strengthening governance
- Learning alliances
- Policy and law
- Communication / Social acceptance
- Management

4. *'Maximising value'*
(Maximum value from minimum resource)

- Source separation
- Centralised *vs* decentralised
- Towards zero emissions
- Water treatment for purpose
- AMD treatment *vs* prevention / value recovery
- Integrated treatment
- Resource recovery
- Wastewater biorefineries

Civil Engineering - Environmental Science - Planning – (Construction) Economics - Biological / Molecular Science - Chemistry
Political Science - Geohydrology - Health Science - Sociology - Chemical Engineering - Public Administration - Anthropology

(from WRC Project ; TT 588/14

A closer look at urine diversion R&D in SA

Alternative technology

WRC Reports
K5/1439 (1 to 4)
K5/1745

Peri-urban /
rural/urban
On-site
Dry

Toilet Design and efficacy
Operation
Handling
Risk
Use & Social Acceptance
Nutrient Value

- **Community participation was key**
- **Accept of toilet but not broader principles of use of products**
- **Awareness continuous**
- **Risk**

- **Agriculture – urine – salinity was a problem**
- **Agriculture – dry faeces – soil amendment – increased yields compared to manure but poorer than inorganic fertiliser – Class B sludge – helminth ova a problem**

No-Mix – Impact and Scenarios

“Its like peeing in a test tube”

Urban
Centralised
waterborne

Perception
Initial fearful and nervous
Awareness that it will improve wastewater treatment
But unwilling to pay a higher cost
Majority happy with no mix – females toilets experienced problems - blockage
Concerns over the use as fertiliser – salts ; EDC’s , pharmaceuticals

WRC Reports
K5/1824

No-Mix – Impact and Scenarios

K5/1824

Technical

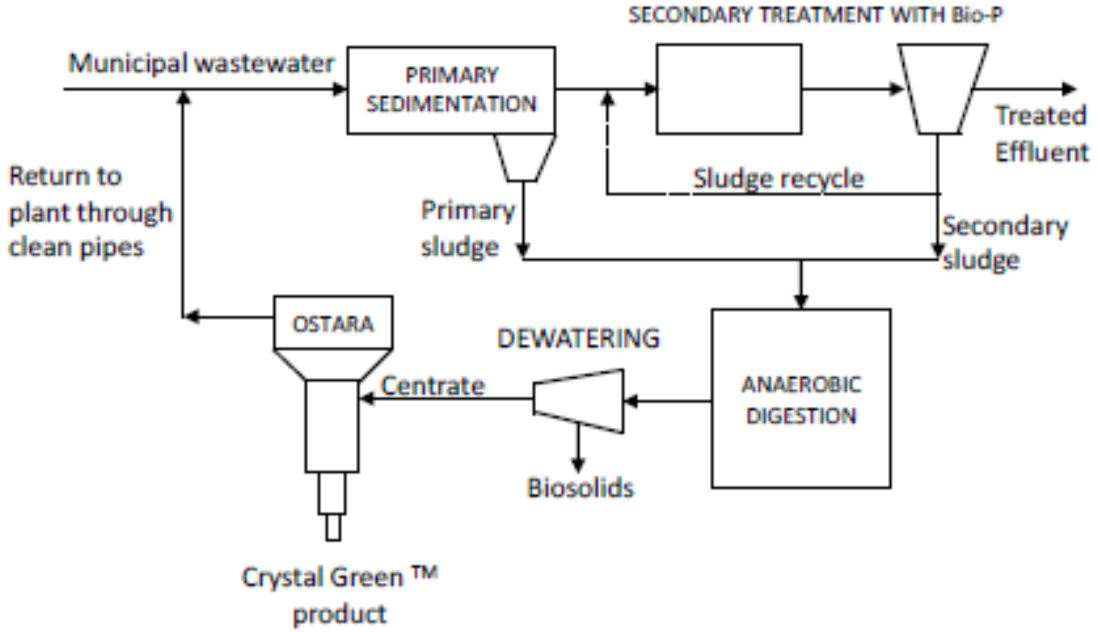
Urine
Infrastructure
Treatment – SBR (concentrated) / AAD (diluted)

No-mix (blackwater – no urine)
Increased plant capacity
Improved effluent quality
Reduction in energy consumption - Nitrification/DN
Sludge age (5d)

More pilots on the scenarios proposed

Nutrient and Energy Technology Review

- Technologies for phosphate recovery have reached early full-scale use
- Crystallization based technologies to produce struvite – promising
- Cost comparison – within cost of standard



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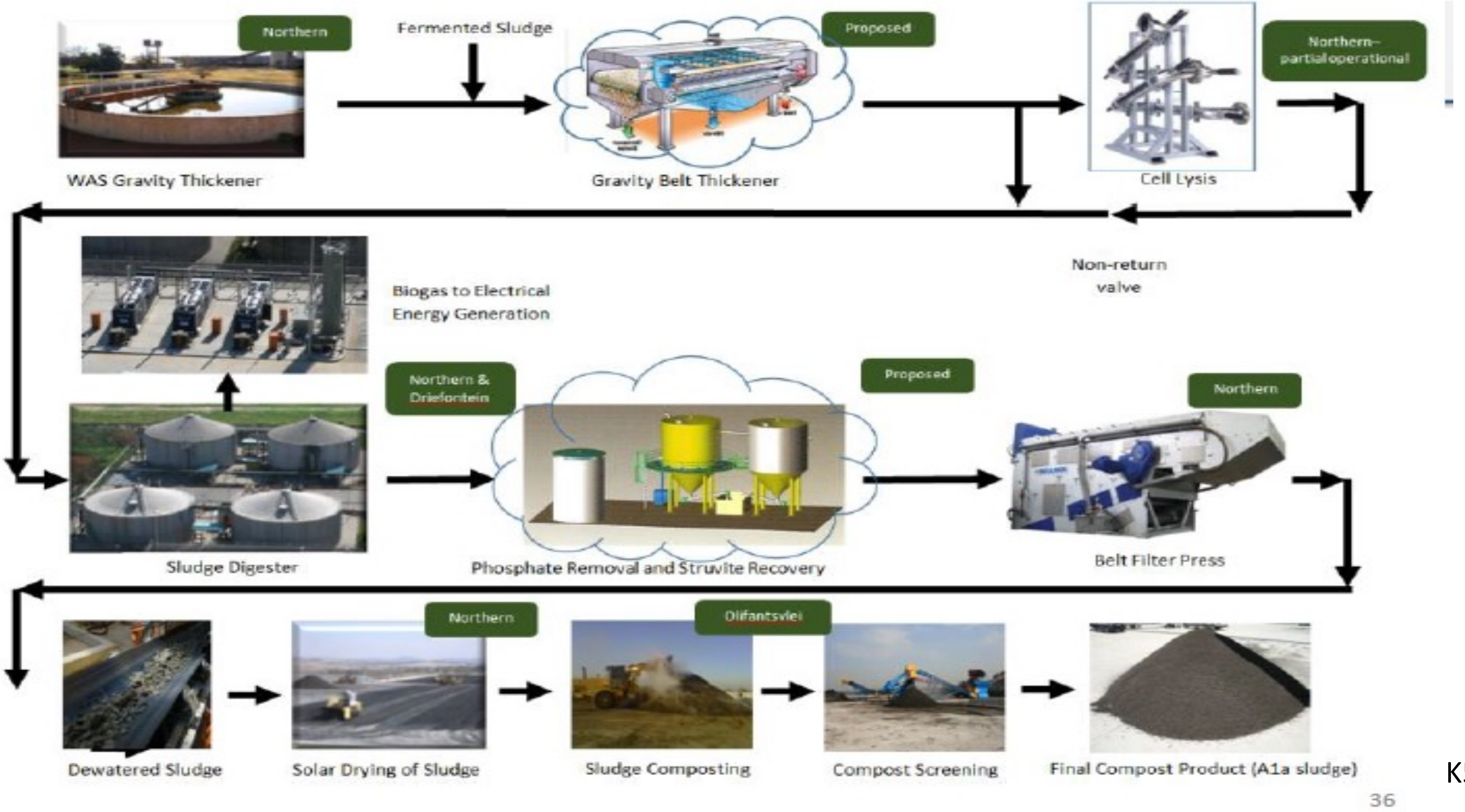
CHP & Struvite : Northerns Works



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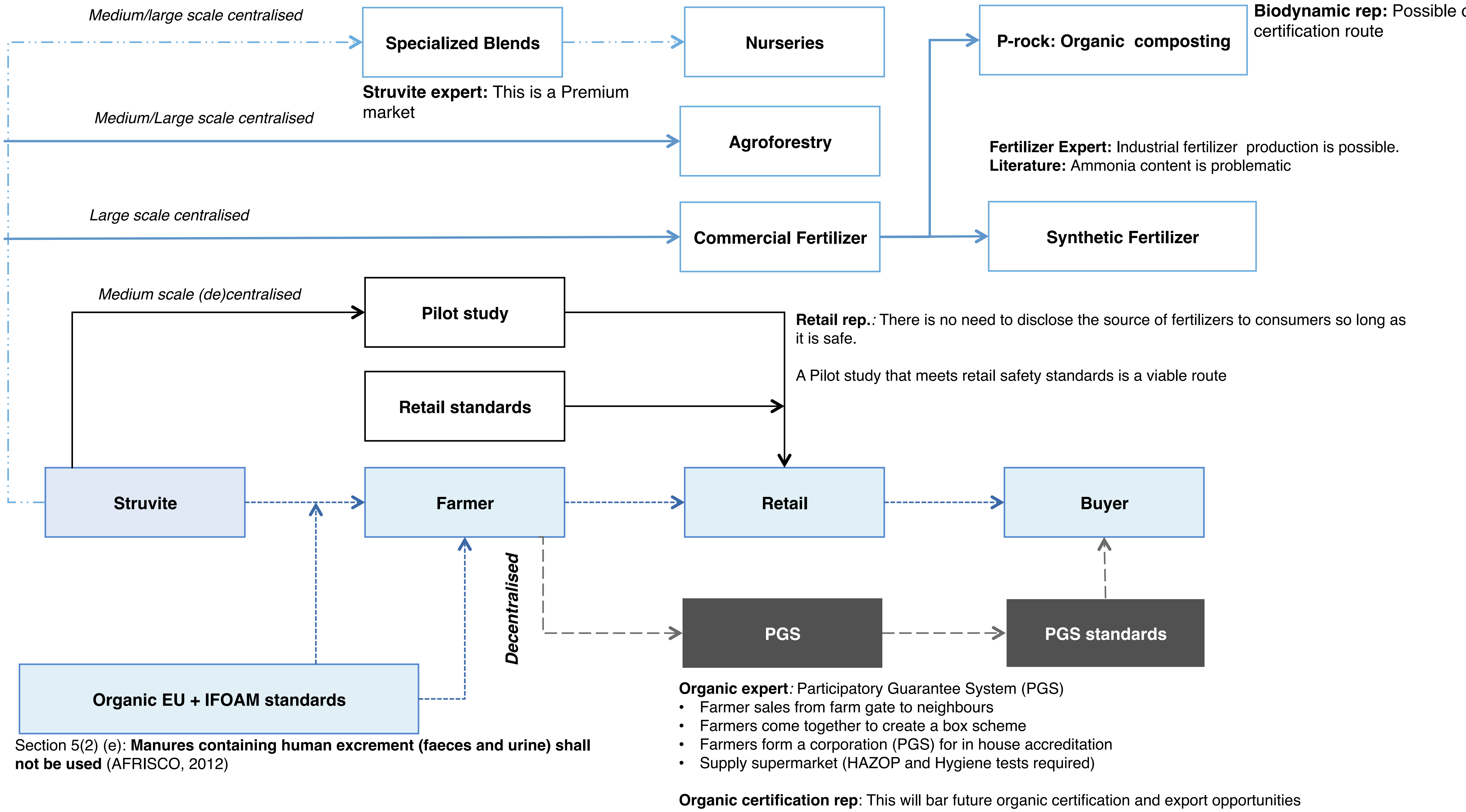
Products & Markets

Cost competitive
Meet Market Demand (safety)
Product Quality
Brand

K5/2218



Medium/large scale centralised
Specialized Blends
Nurseries
P-rock: Organic composting
Biodynamic rep: Possible c
certification route
Struvite expert: This is a Premium market
Medium/Large scale centralised
Agroforestry
Fertilizer Expert: Industrial fertilizer production is possible.
Literature: Ammonia content is problematic
Large scale centralised
Commercial Fertilizer
Synthetic Fertilizer
Medium scale (de)centralised
Pilot study
Retail rep.: There is no need to disclose the source of fertilizers to consumers so long as it is safe.
A Pilot study that meets retail safety standards is a viable route
Retail standards
Struvite
Farmer
Retail
Buyer
Decentralised
PGS
PGS standards
Organic EU + IFOAM standards
Section 5(2) (e): Manures containing human excrement (faeces and urine) shall not be used (AFRISCO, 2012)
Organic expert: Participatory Guarantee System (PGS)
• Farmer sales from farm gate to neighbours
• Farmers come together to create a box scheme
• Farmers form a corporation (PGS) for in house accreditation
• Supply supermarket (HAZOP and Hygiene tests required)
Organic certification rep: This will bar future organic certification and export opportunities

Land Application for Agriculture : Matching Supply And Demand

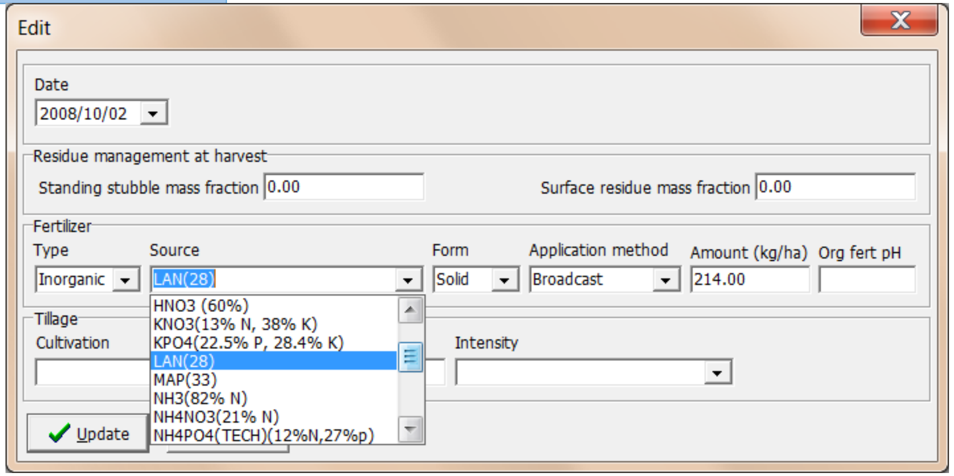
Concrete drying beds at Vlakplaas from which sludge was taken for this study

Panoramic view of the study site during the summer season with dryland and irrigated maize, dryland pasture, and lawn for sod production

Panoramic view of the study site during a winter season with irrigated oats and lawn for sod production

Turf grass growth with sludge

All hypotheses were accepted for application rates not exceeding 33 t ha-1, on the proviso that some soil loss was acceptable and that the leaching fraction was carefully managed during the first two months after sludge application.



Locally developed SWB-Sci Model for N and P modelling

Conclusions

- Set a vision
- Get the design of the toilet right (social acceptance)
- Develop Learning culture from pilots - adapt
- Develop safe quality based products
- Markets for products
  - Organic Fertilizer and food security
  - Health and safety
  - Social acceptance
  - Alternative market routes

Growing List of University Partners

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UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

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science & technology
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SALGA
South African Local Government Association

Thank You