LIFE CYCLE MANAGEMENT:

Establishing an environmental profile of water supply in South Africa

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CSIR

our future through science

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Research problem

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- Insufficient LCIs for LCA practitioners and decision-makers
  - Water usage
- Total environmental burdens associated with potable water supply are ill understood in the South African context
  - Dissimilar infrastructure that are associated with the limited water supply
    - Environmental impacts directly related to infrastructure
      - Water losses
    - Auxiliary processes

Objectives of the research project

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- The existing LCI databases in South Africa could be developed and expanded, which address the needs of local LCA practitioners and researchers
- Environmental improvements of potable water supply systems could be identified
- The benefits of conducting LCAs as an environmental management tool could be demonstrated for the South African manufacturing industry

Objectives of this paper

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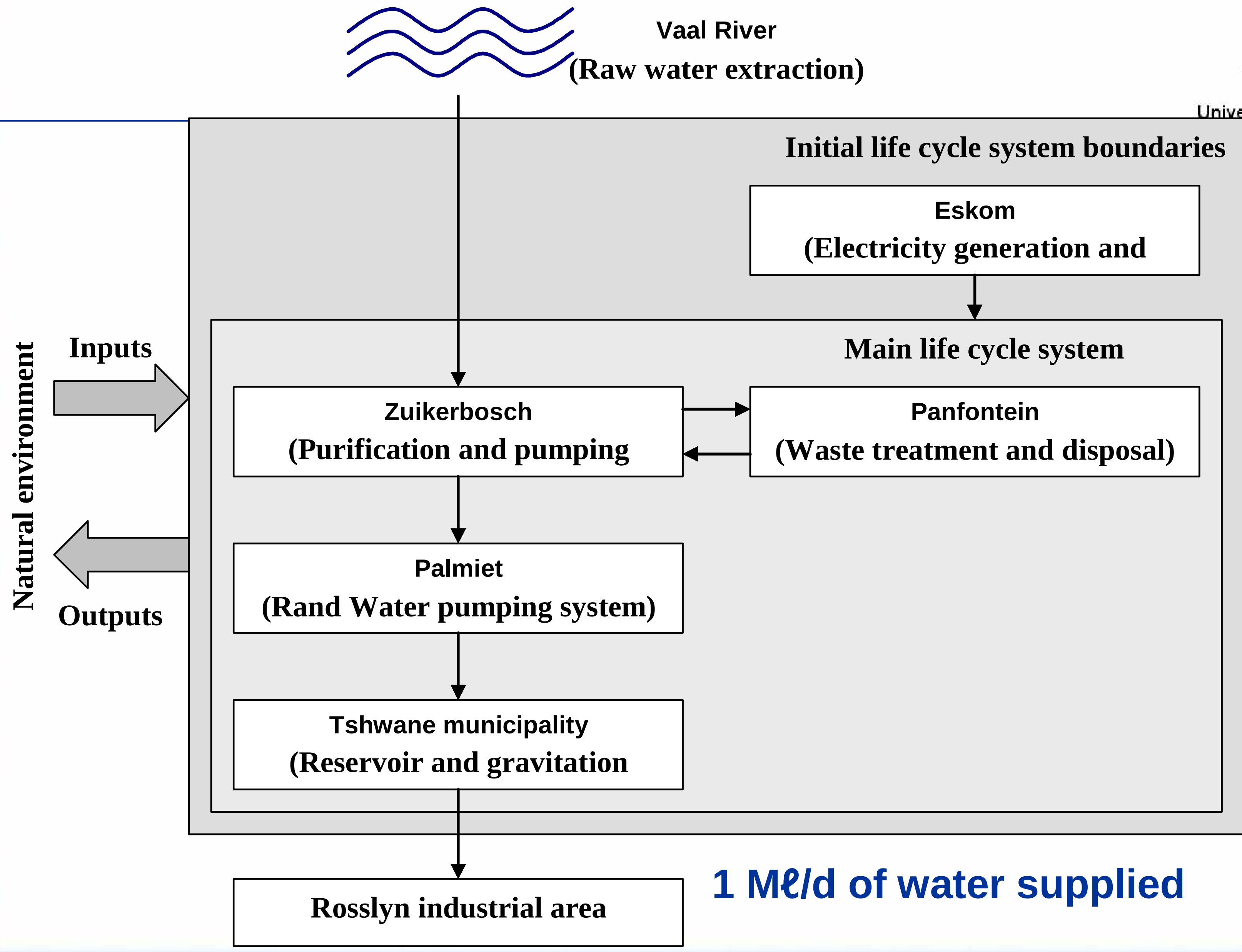
- Identify key environmental aspects that should be considered where water is used in the manufacturing sector of South Africa
- Identify possible shortcomings (for further research) in the LCA tool and associated methodologies when it is applied for decision-support in the South African manufacturing industry



1 Mℓ/d of water supplied

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Some of the auxiliary process included in the scope

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- Energy inputs, in the form of electricity and fuel, which must be generated or produced separately with associated environmental impacts, and raw energy materials, e.g. coal that are required for boilers, etc.
- The manufacturing of chemical materials that are required in the life cycle system, e.g. chlorine gas for the chlorination phase of the purification step
- Specific energy and material requirements during abnormal operations, e.g. when maintenance on any unit process is required.
- Construction material for the capital equipment in the life cycle system.
- Transportation within or between unit processes, e.g. rail or road transport of required materials, piping of the supplied water, etc.
    - RMEE method used for boundary cut-off

Limitations of the LCA case study

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- The study focused on the Rand Water network only
  - May therefore be problematic to relate the results to other water supply systems in South Africa or elsewhere
- Confidentiality issues
- Time-constraints reduced the completeness of the LCI data
  - Many other assumptions and data gaps identified

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9.041 Mℓ/d

Zuikerbosch and Panfontein sub-system

Total raw and recovered water = 2326 Mℓ/d
Total pumped water = 2310 Mℓ/d
Calculated losses = 0.7%

8.978 Mℓ/d

Pipe losses = ± 1.2% per 100 km
Assumed distance is 100 km

8.887 Mℓ/d

Palmiet booster station sub-system

0.2% losses [20]

8.856 Mℓ/d

Pipe losses = ± 1.2% per 100 km
Assumed distance is 50 km

8.750 Mℓ/d

Tshwane reservoir and gravitation sub-system

Total water bought from Rand Water = ± 420 Mℓ/d
Total supplied to Rosslyn = 1.667% or 7 Mℓ/d
Unaccounted for water (UAW) = 20%

7.000 Mℓ/d

Regional context of LCIA – using the RII method

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RII method for SA-specific LCIA profile

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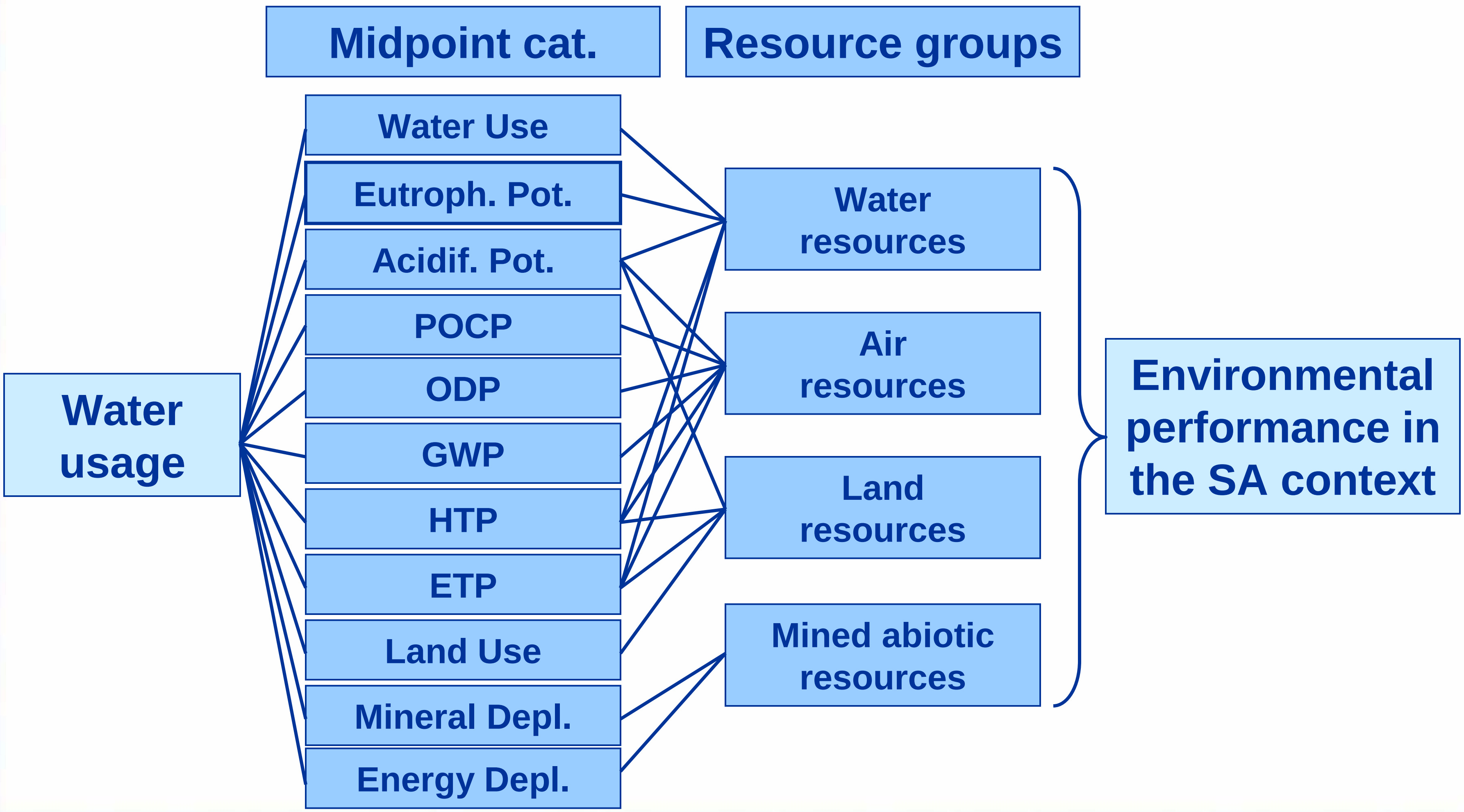

Calculation of Resource Impact Indicators (per unit of process parameters

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$$RII_G = \sum_C \sum_X Q_X \cdot C_C \cdot N_C \cdot S_C$$

- RII_G = Resource Impact Indicator calculated for a main resource group through the summation of all impact pathways of LCI constituents
- Q_X = Quantity release to or abstraction from a resource of life cycle constituent X of a LCI system in an impact category C
- C_C = Characterisation factor for an impact category (of constituent X) within the pathway
- N_C = Normalisation factor for the impact category based on the ambient environmental quantity and quality objectives, i.e. the inverse of the target state of the impact category
- S_C = Significance (or relative importance) of the impact category in a resource group based on the distance-to-target method, i.e. current ambient state divided by the target ambient state

Overall RII profile

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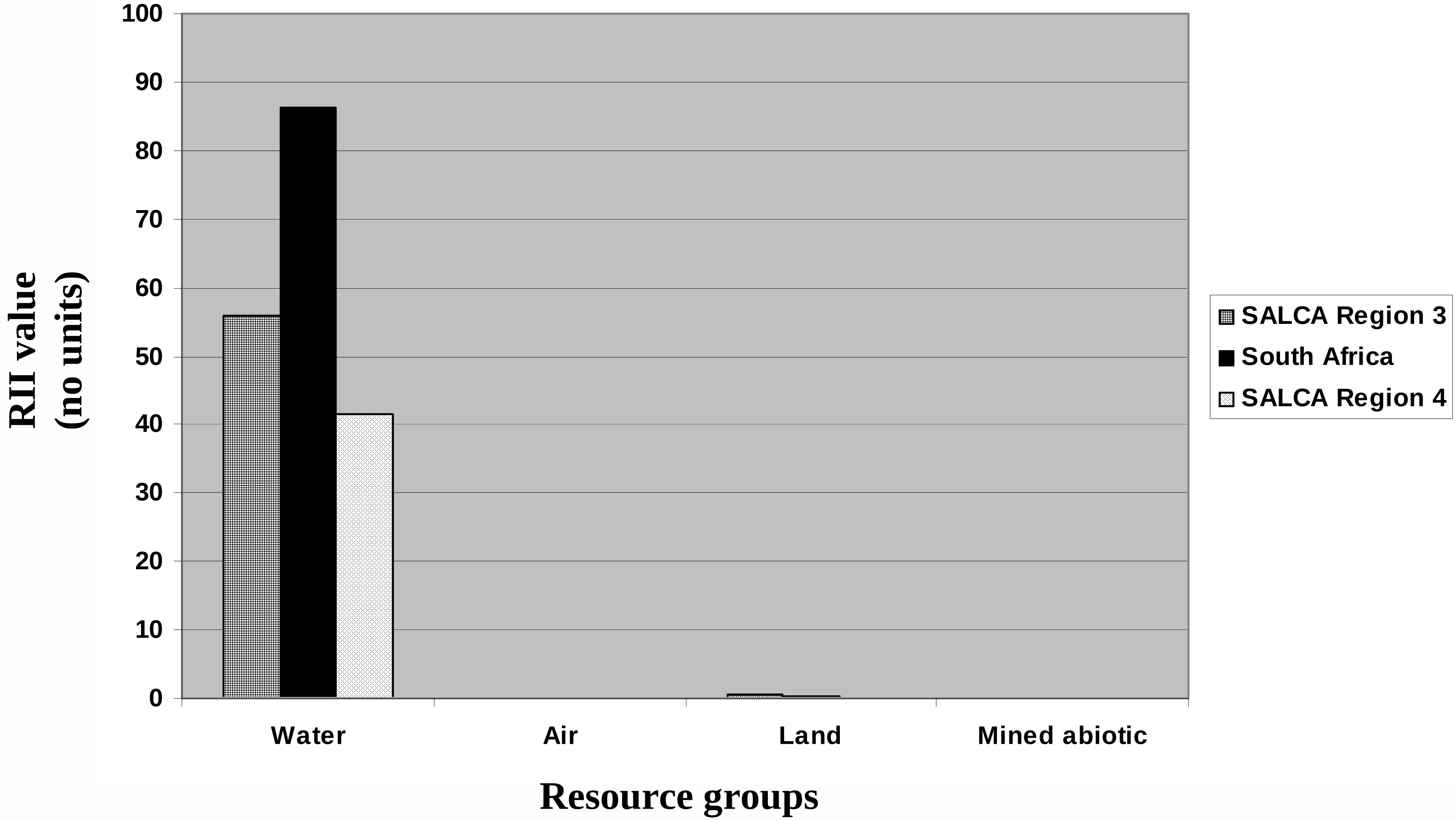

LCIA profile for the water resources group

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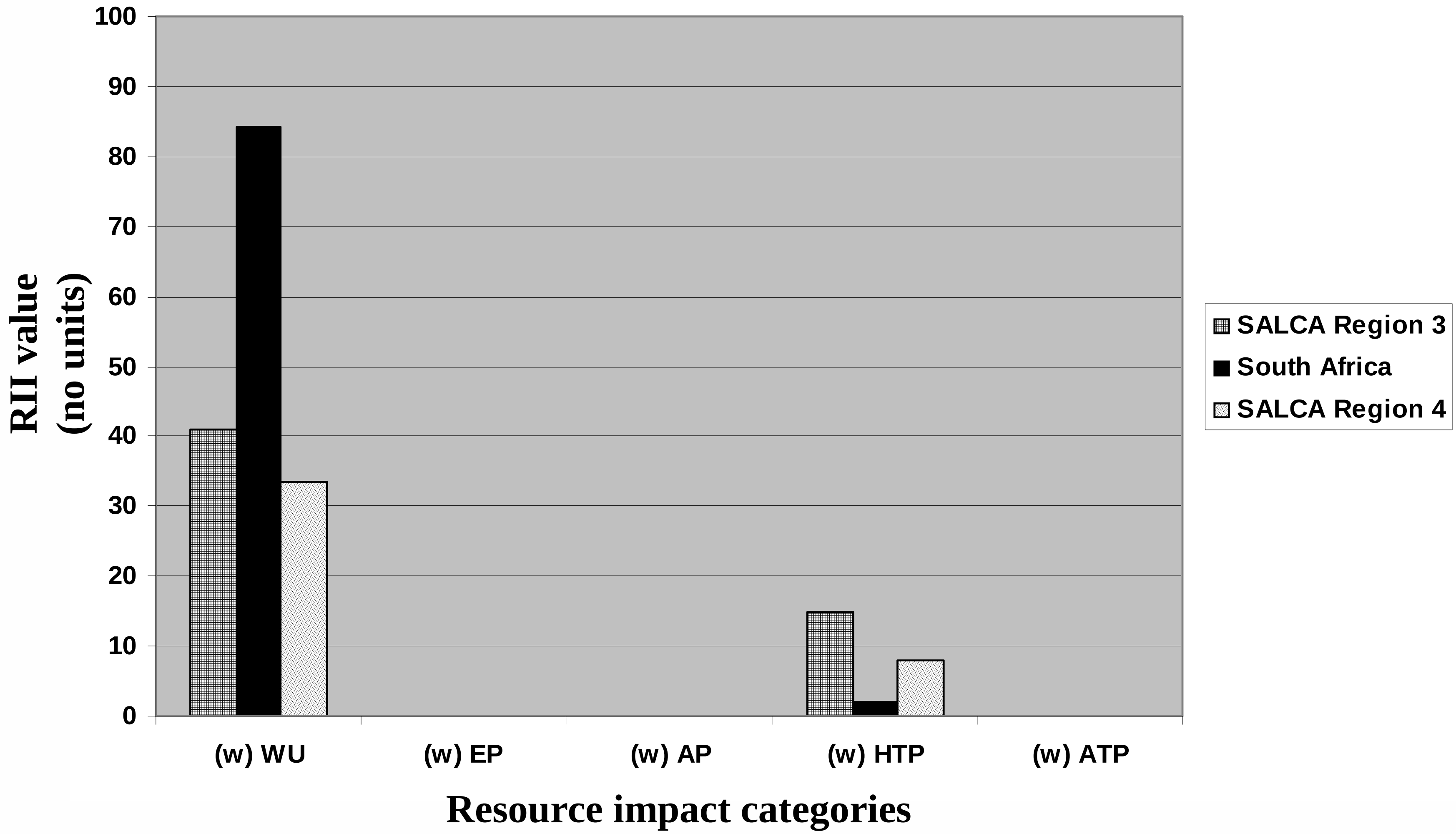

Conclusions

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- Actual extraction of the water from the ambient environment is in fact the most important consideration
  - The toxicity potential impacts on water resources, mainly due to the required electricity for the water supply system, are of secondary importance
- However, the extent of the impact due to water extraction is not accurately reported in the water use category of the LCIA profile
  - Lack of appropriate categorisation factors
    - For example, ambient water quality may be influenced by the reduction of water quantities
    - Similarly, the uncertainty of the applied LCIA method and the resultant indicator profile was not included in the interpretation of the LCA study

Recommendations – on the LCI side

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- In order to improve the environmental performance of the water supply system, water-losses must be addressed foremost
- Especially within the management domain of the municipality, data are not monitored and recorded to identify the current large problematic areas

Recommendations – on the LCIA side

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- **Characterisation factors should be developed and/or adapted for South Africa**
  - **For Water Usage, Acidification Potential, Toxicity Potential and Salinisation Potential categories**
- **Normalisation factors for these categories must be established by a larger South African focus group, which represent the different environmental sciences' disciplines, and with international participation**

Closure and questions