75<sup>th</sup> International Executive Council meeting & 9<sup>th</sup> Asian Regional Conference







# APPLYING MACHINE LEARNING AND WEF NEXUS TO ASSESS URBAN GROWTH IMPACTS ON WASTEWATER REUSE

Luxon Nhamo, WRC

Tinashe Dirwai, IWMI

Sylvester Mpandeli, WRC

Tafadzwanashe Mabhaudhi, LSHTM & UKZN

#### ICID Congress 2024, Sydney, Australia

The Water-Energy-Food-Nexus: Applications & Impact on Societies, Environment and Ecosystem

Working Group on Water Food Energy Nexus (WG-WFE\_N)

01-08 September 2024

Sydney ICC





# **Background: Rapid Urbanisation**

### Global Perspective





Today: More than 50% of the world's population lives in urban areas



- Witnessed an urban growth of more than 153% between 1986 and 2023
- Projected population density of 105 persons/ha by 2050
- 67% of the migration in the province is intra-regional
- Built-up area increased from 7.8% to 23% between 1986 and 2023



2050: More than 60% of the world's population will be living in urban areas





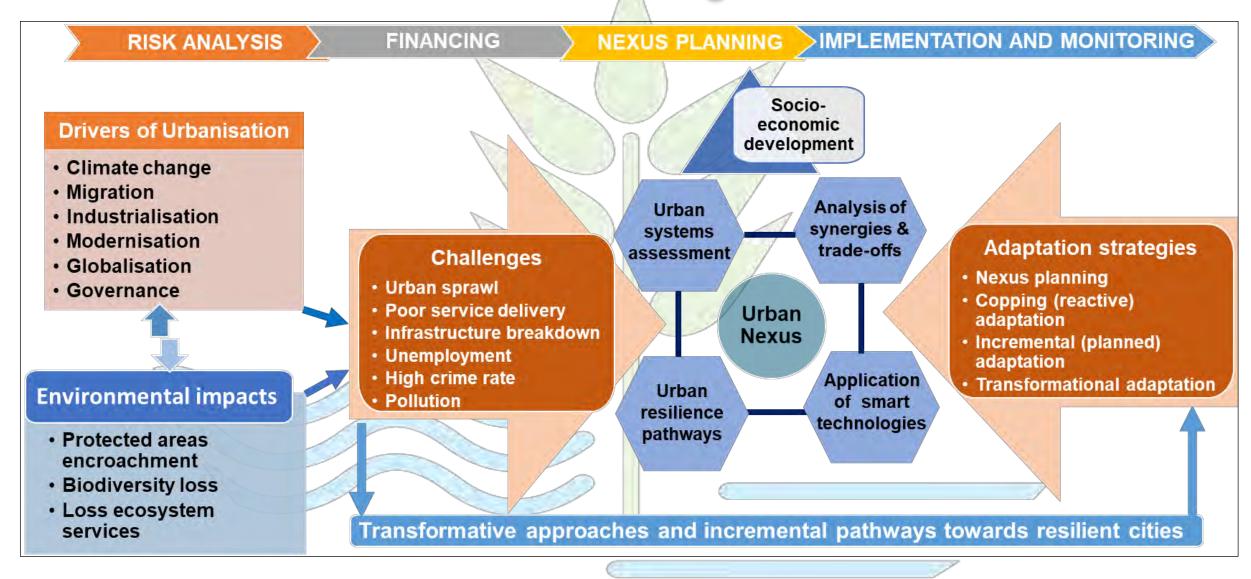


Rural to urban migration





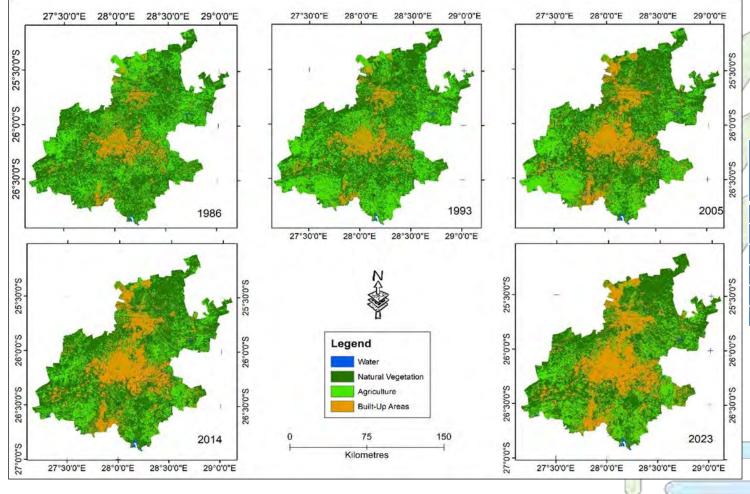
# An urban-wastewater nexus methodological framework







# Landuse/cover changes in Gauteng Province



Year	Water (Ha)	Vegetation (Ha)	Agriculture (Ha)	Built-up area (Ha)
1986	7 517.90	995 219.04	610 568.86	205 557.52
1993	7 736.49	932 842.88	667 753.32	210 532.28
2005	12 720.25	898 475.35	519 155.37	388 481.07
2013	9 295.32	955 230.26	420 264.91	434 236.72
2023	13 066.68	873 841.29	411 154.77	520 826.31
% change	73.81	-12.20	-32.66	153.37





# Implications of rapid urbanisation



Changing consumption patterns of the ever-growing middle class, leading to pressure on limited resources



Increased demand of already depleting water, energy and food (WEF) resources



Widening inequality that may cause conflicts

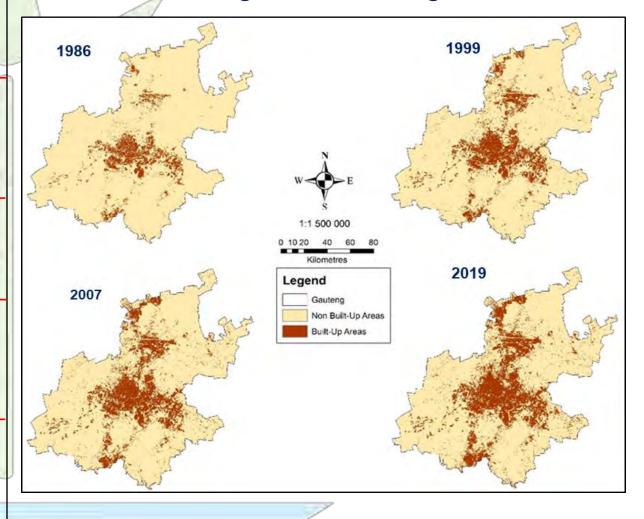


Increasing pollution



Increasing land surface temperatures (LST) (urban heat island)

#### Urban growth – Gauteng Province







# Implications of rapid urbanisation (cont.)



Increased incidences of flooding



Encroachment of built environment into ecological infrastructure



Increasing rate of unemployment, stands at 32% in Gauteng



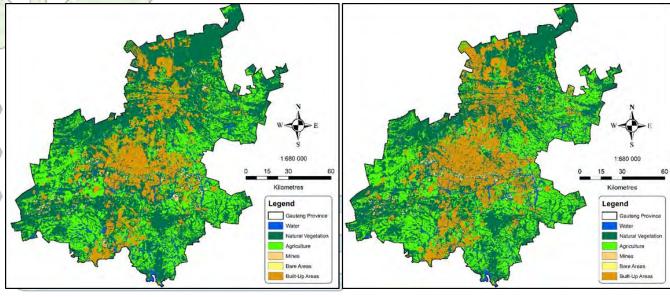
Increase in wastewater disposal



Increasing crime rate

Landuse	Area in 2010 (ha)	Area in 2019 (ha)	Percentage change
Water	73,107	62,967	-13,87
Natural Vegetation	943,999	845,695	-10,41
Agriculture	456,251	475,834	4,29
Mine	24,635	22,495	-8,69
Bare Areas	1,494	18,260	1,122,22
Built Up Areas	317,541	391,776	23,38

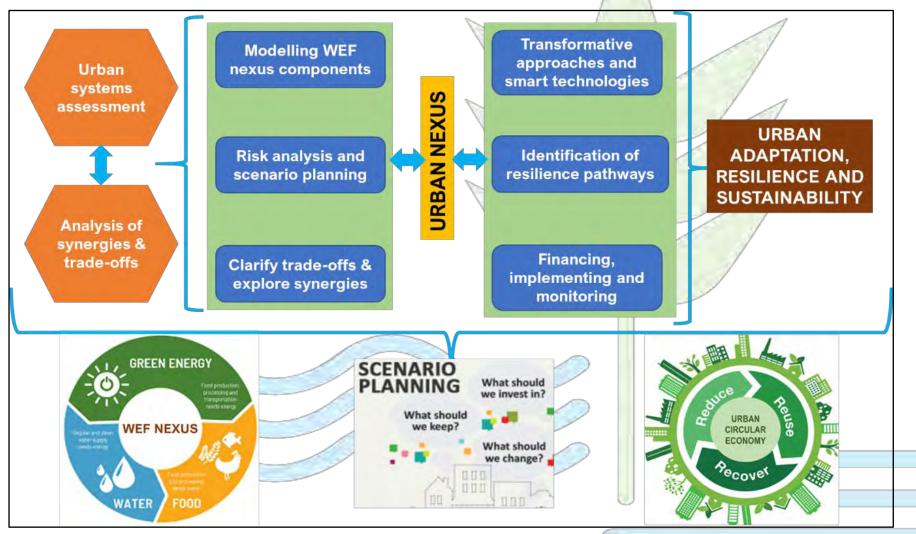
Encroachment into ecological infrastructure







# Urban nexus and systems provisioning

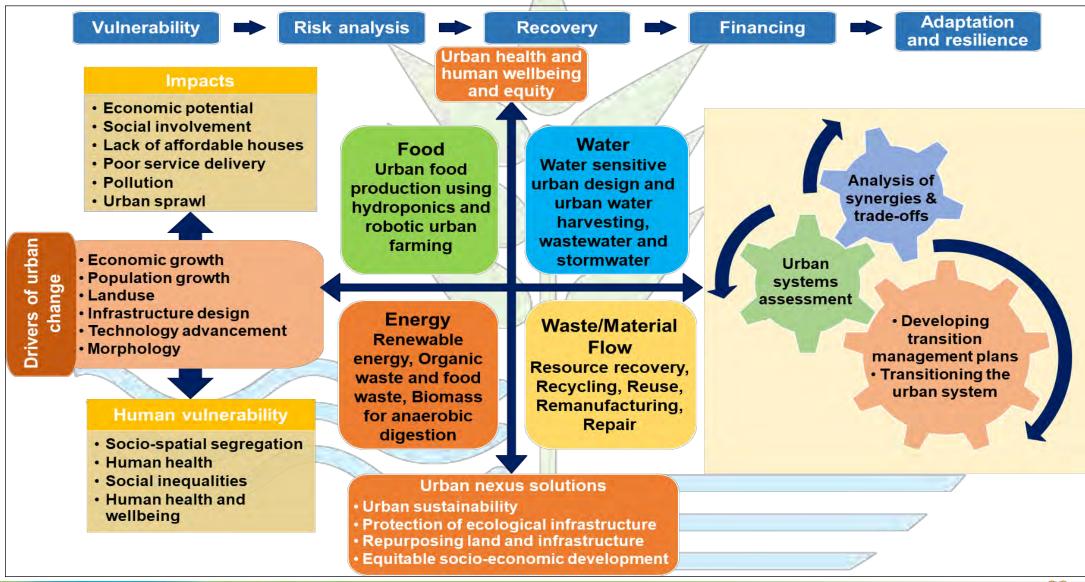








#### An urban nexus transformative framework for urban transition







# Sustainable urban agriculture and wastewater management pathways

#### Sustainable urban **Fransformative smart** Integrated governance and financial structures Transition to novel urban agricultural practices (hydroponics, vertical agriculture) Assess wastewater produced vs irrigable urban land Improved urban Assess urban population changes • Machine learning algorithms to map and assess change Challenges of rapid banisation on urban Improved public health and food Loss of agricultural land Adopt circular Increase in wastewater Promote Integrate urban Sustainable economy urbanisation hydroponics, planning with Risks human and urban practices for environmental health vertical transformative agriculture wastewater Job creation and farming, etc. approaches Exacerbates climate reuse change Risks of urban growth on agriculture Socio-ecological Increased food and water insecurity for the urban poor health benefits Increase in unused treated wastewater · Poor human and environmental health Urban rehabilitation and sustainable





agriculture

outcomes

livelihoods

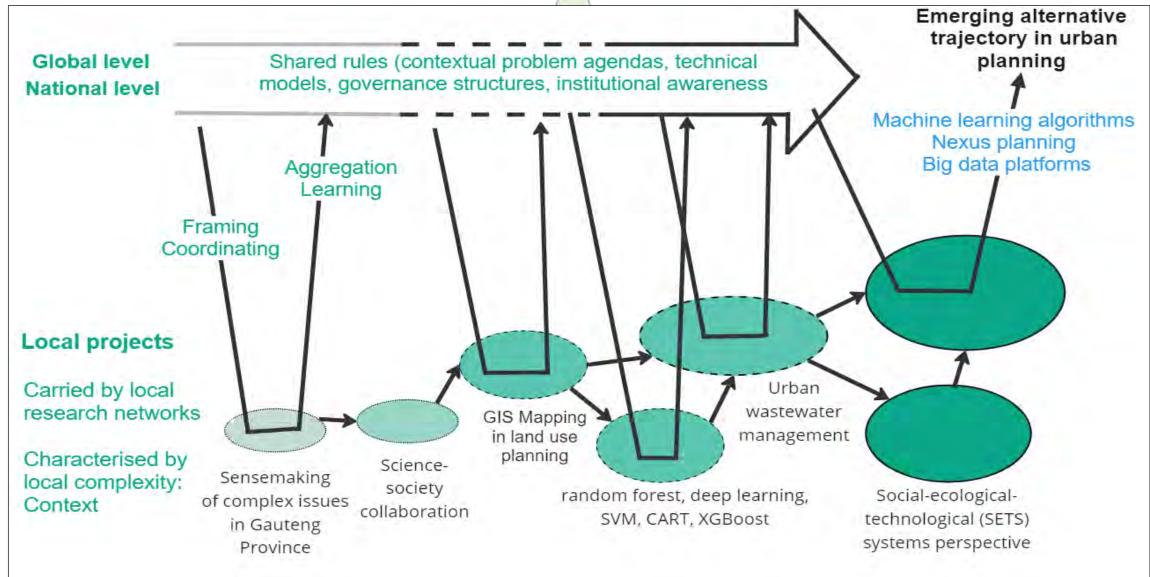
security

economic

development

development

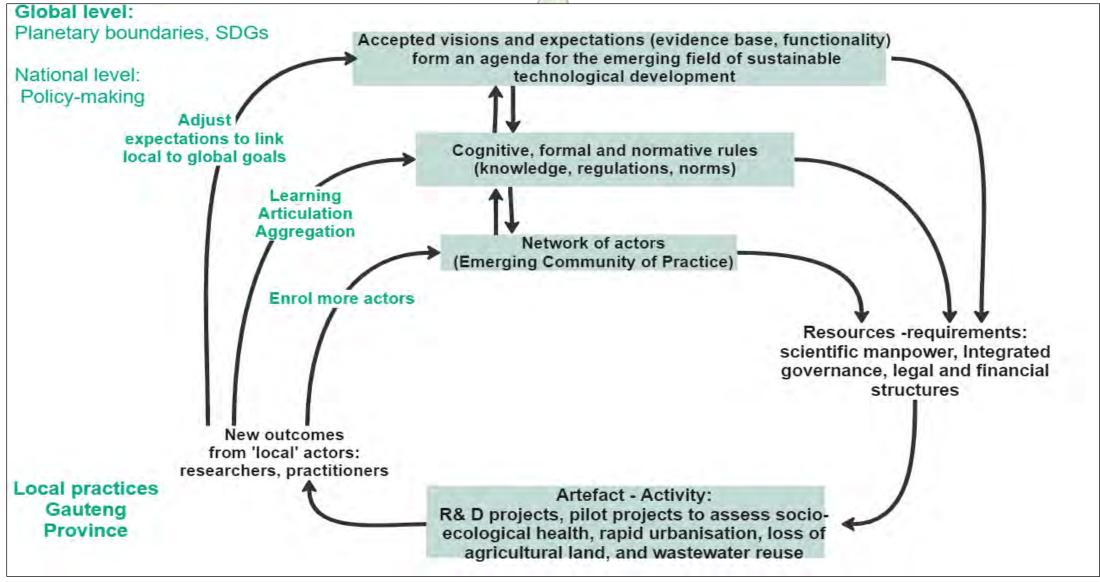
# Emerging alternative trajectories in urban planning







## Niche urban transformation actions and actors





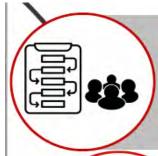


# Three key elements to achieve the urban nexus objectives



#### **SDG 11:**

Make cities and human settlements inclusive, safe, resilient and sustainable by 2030



#### Governance, Planning and enabling frameworks (soft ware)

Horizontal and vertical governance; stakeholder engagement; empowerment of cities; urban-rural linkages



#### Physical infrastructure (hard ware)

Innovative engineering technologies and standards, semidecentralized, cross sectoral infrastructure projects (grounded)



Circular economy approach









