A Systematic Review of Linkages and Trends in Water-Food-Energy/Urban Nexus Research

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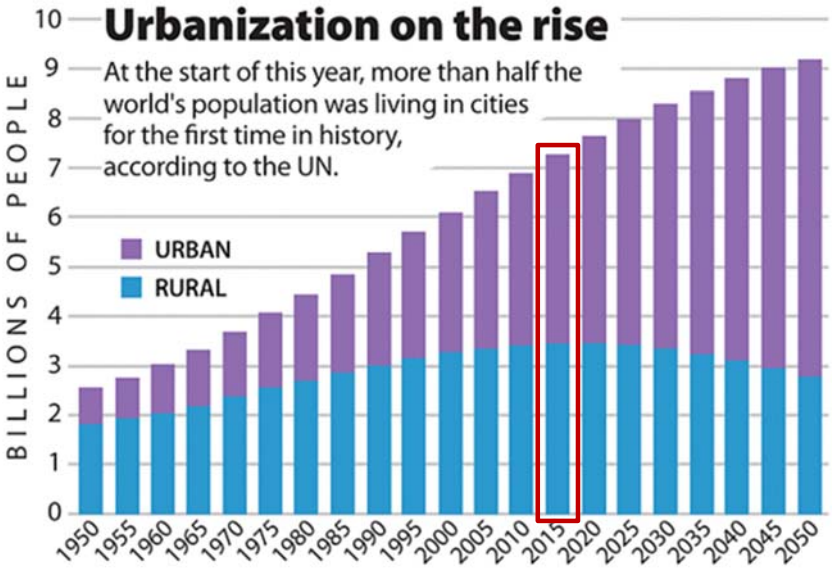
Water-Food-Energy/Urban Nexus

THE WATER, ENERGY & FOOD NEXUS

(IRENA.ORG 2015)



(UN 2015)

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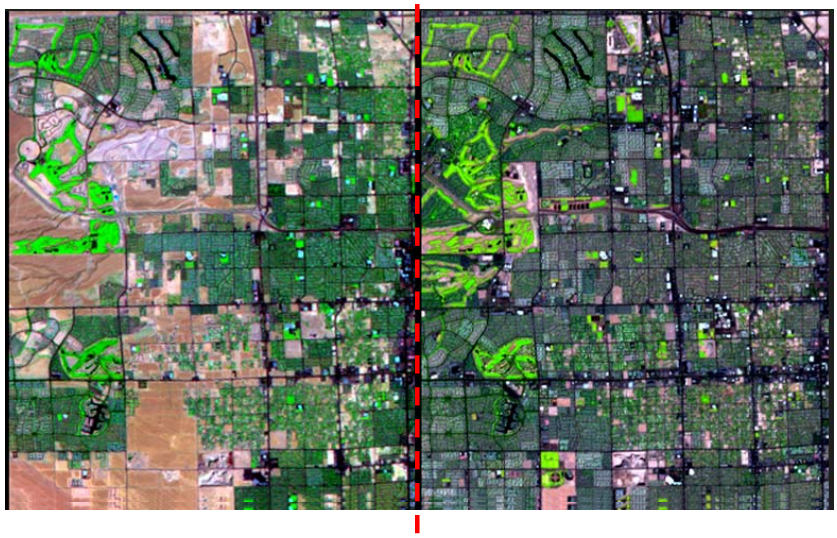
Water-Food-Energy/Urban Nexus

THE WATER, ENERGY & FOOD NEXUS

(IRENA.ORG 2015)

Landsat satellite images of rapid urban expansion in Las Vegas, Nevada. right: 1992, left: 2013 (USGS)



(USGS / GlobalChange.ORG 2015)

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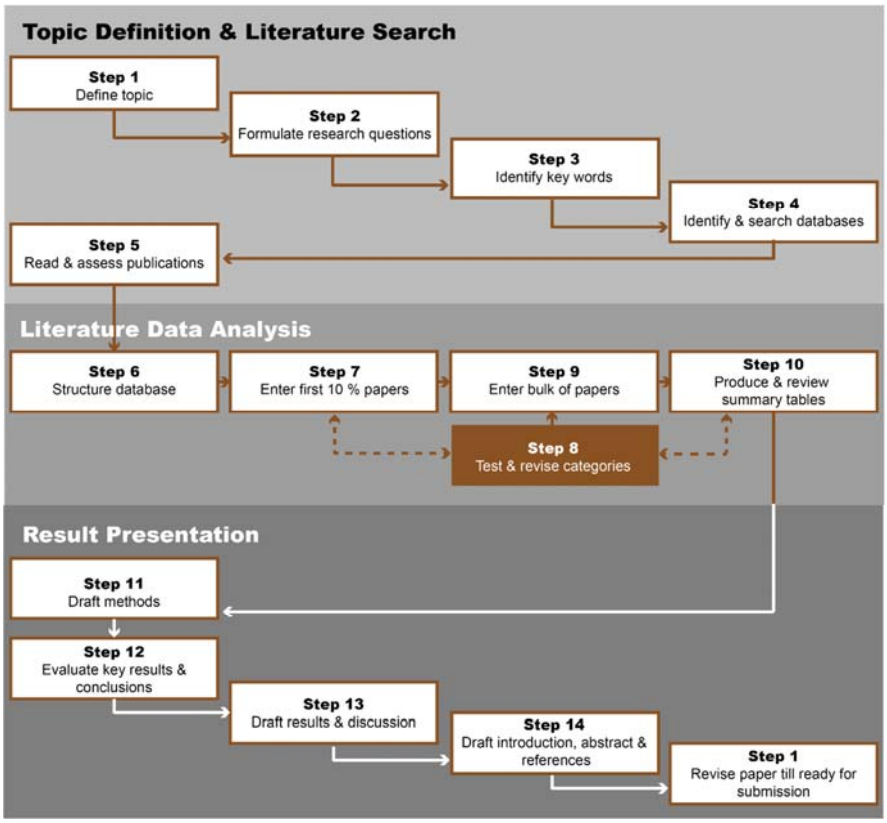
Literature Review Methods Comparison

	Narrative Review	Systemic Review	Bibliometric Review
Objectives	Objectives may or may not be identified	**Clear objectives are identified**	Objectives may or may not be identified
Background	All provide summaries of the available literature on a topic		
Search Strategy	Strategy not explicitly stated (by experience)	**Comprehensive search in a systemic way**	Systemic mining from literature databases
Literature Covered	Limited (a few to dozens)	Large (dozens to hundreds)	Large
Process of Selecting Articles	Evaluation of study quality may or may not be included	Comprehensive evaluation of study quality	Comprehensive
Depth of Review	May be influenced by the reviewer's experience, theories, needs and beliefs	Reliable, quantitative, and reproducible with standardized methods	Overview analysis & breakdown analysis
Results and Data Synthesis	Summary based on studies where the quality of articles may not be specified.	Clear summaries based on high quality evidence	**Big data analysis approach**
Judgement Basis	Subjective	Systematic Process	**Data-driven**
Discussion	Written by an expert or group of experts with a detailed and well-grounded knowledge of the issue		

Systemic Literature Review

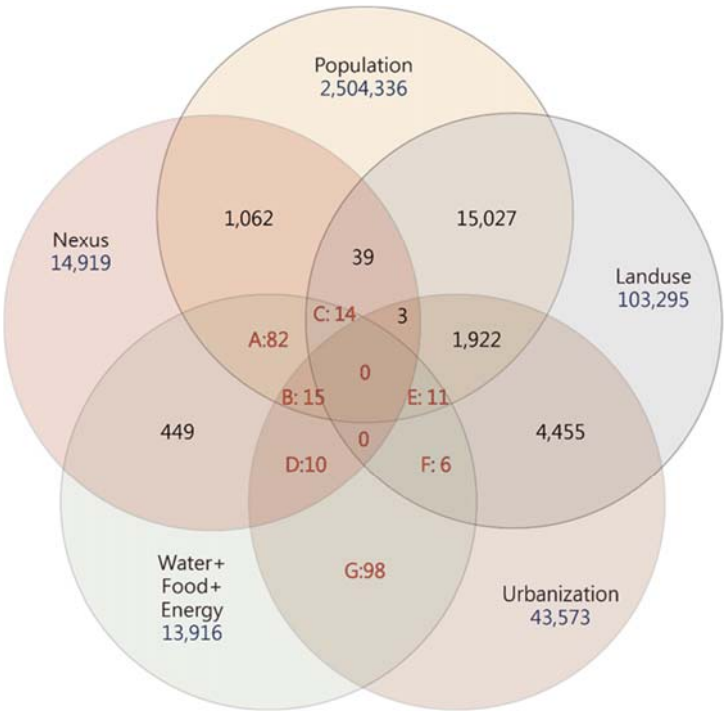


(2013) Pickering, C. , Byrne, J.

Search Set & Word Cloud Analysis

Text cloud analysis

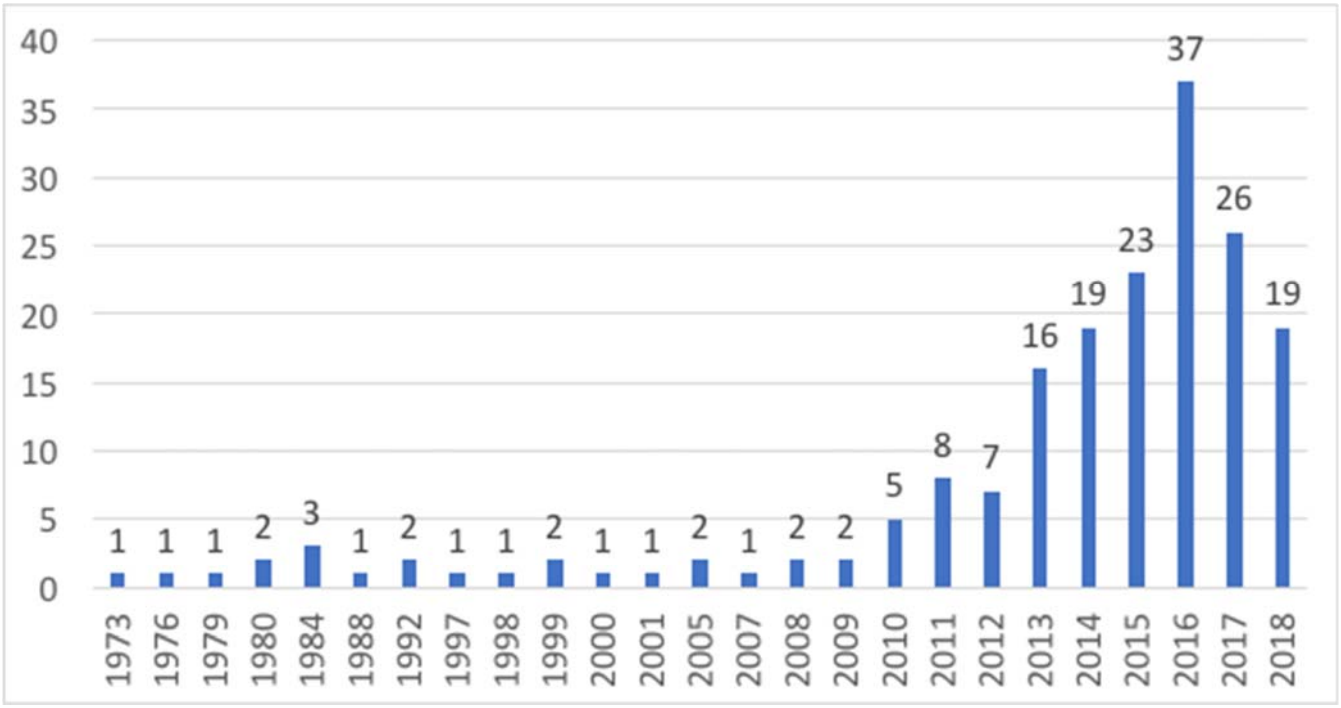
Search Set



Tool : https://timdream.org/wordcloud/

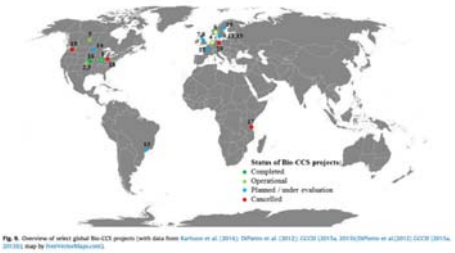
Results on Overview Analysis

Yearly Publication Trends

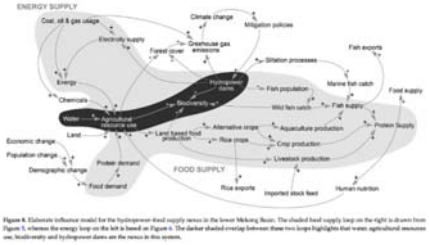


Nexus Research Scope

- ND-1 Global or with no specific research region
- ND-2 Regional (ex. Asian-Pacific area, African region…)
- ND-3 National
- ND-4 Local or specific cities
- ND-5 Facility or specific small area (ex. Oak farm…)



ND-1 (2015) Kemper, J.

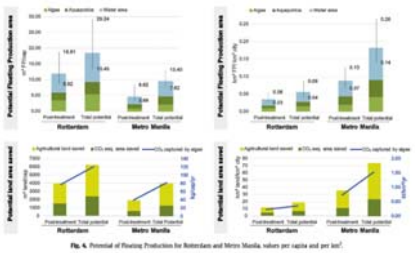


ND-2 (2016) Pittock, J., Dumaresq, D., Bassi, A. M.

Table 1. Input-Output Index System and the Chinese Case (2005–2014).

Types	Indexes		Chinese Case	Units
Input	Total Water Consumption		Total Water Use	100 million m^3
	Total Energy Consumption		Total Energy Consumption	10,000 tons of SCE
	Total Food Consumption		Total Food Consumption Expenditures	10,000 Yuan
	Total Permanent Resident Population		Total Population at Year-end	10,000 people
Output	GDP per capita		GDP per capita	Yuan per person
	Environment Index	Total Waste Gas	Total Volume of Sulphur Dioxide Emissions; Total Volume of Soot and Dust Emissions	10,000 tons
		Total Waste Water	Total Waste Water Discharged	10,000 tons
		Total Solid Waste	Total Industrial Solid Wastes Produced	10,000 tons

ND-3 (2016) Li, G., Huang, D., Li, Y.



ND-4 (2017) Dal Bo Zanon, B. , Roeffen, B., Czapiewska, K. M., de Graaf-Van Dinther, R. E.,

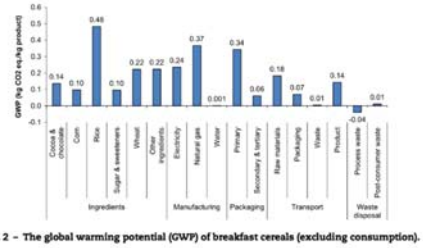
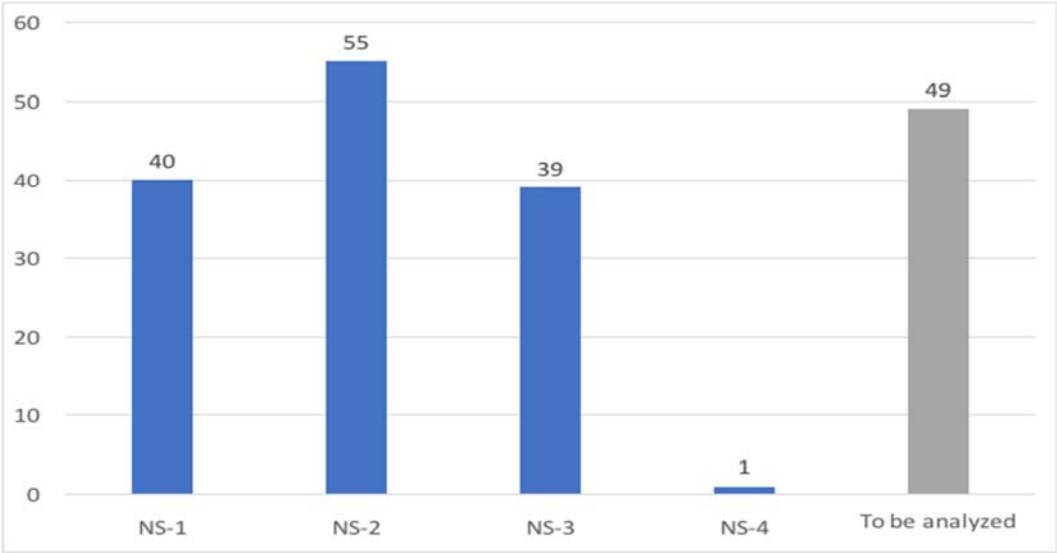


Fig. 2 – The global warming potential (GWP) of breakfast cereals (excluding consumption).

ND-5 (2015) Jeswani, H. K., Burkinshaw, R., Azapagic, A.

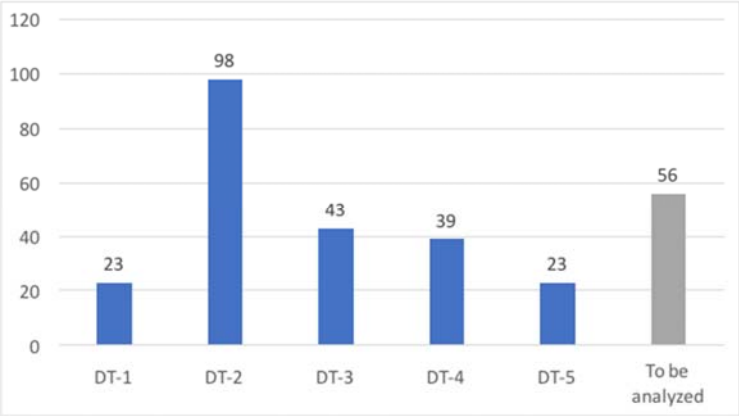
Nexus System Type

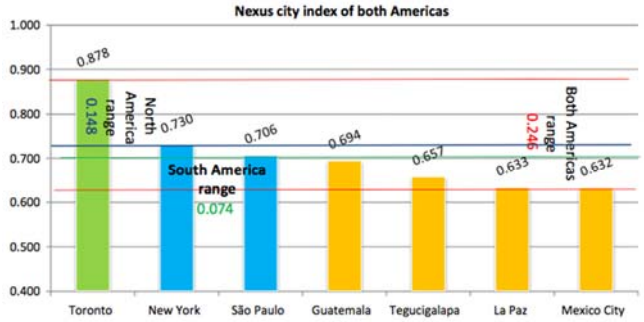
- NS-1 Technical：Research on specific linkage technology, focus more on resource interrelationship or production efficiency (ex. The effect of algae to water resource…)
- NS-2 Integral：Research on linkages between two nexus systems, focus more on resource flow and supply chain management.
- NS-3 Policy-related：Research on nexus system behavior or specific policy proposal on an integrated system (government energy budget policy)
- NS-4 Misc：ex. A discussion on "nexus" definition



Type of Nexus Data Presentation

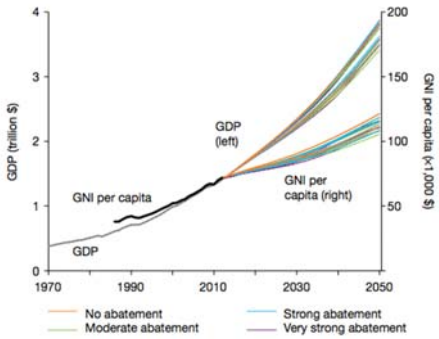
DT-2. The FEW-Nexus city index– Measuring urban resilience





(2018) Schlör, H., Venghaus, S., Hake, J. F.

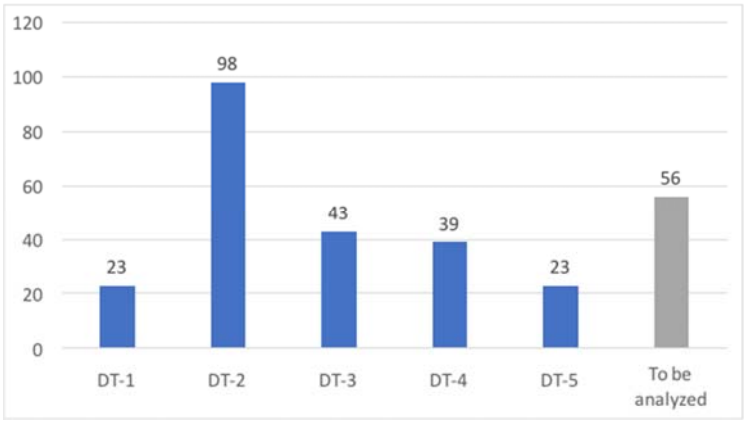
- DT-1 Narrative
- DT-2 Statistical Data Tabulation
- DT-3 Nexus Trends
- DT-4 Spatial Distribution
- DT-5 Numerical model or Empirical Equations



DT-3. Economic activity (GDP) and national income (GNI) Trend

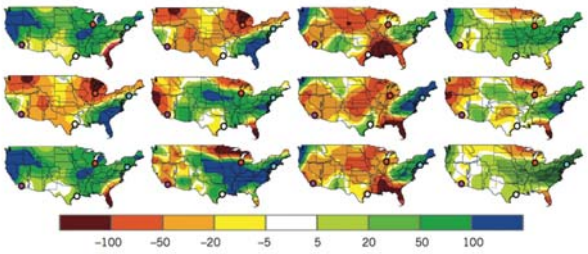
(2015) Hatfield-Dodds, S., Schandl, H., Adams, P. D.

Type of Nexus Data Presentation



- DT-1 Narrative
- DT-2 Statistical Data Tabulation
- DT-3 Nexus Trends
- DT-4 Spatial Distribution
- DT-5 Numerical model or Empirical Equations

DT-4. Spatial patterns of changes in freshwater availability



(2018) Schlör, H., Venghaus, S., Hake, J. F.

Nexus City Index

$$NXI_{city} = \sqrt[w]{\prod_{i=1}^{n} x_i^{w_i}},$$

x = habitat subindices(infrastructure, equity, environment)
w_i = specific weight of the individual city(i) for the equity index

(3)

The exponent of the root is the sum of the city weights.

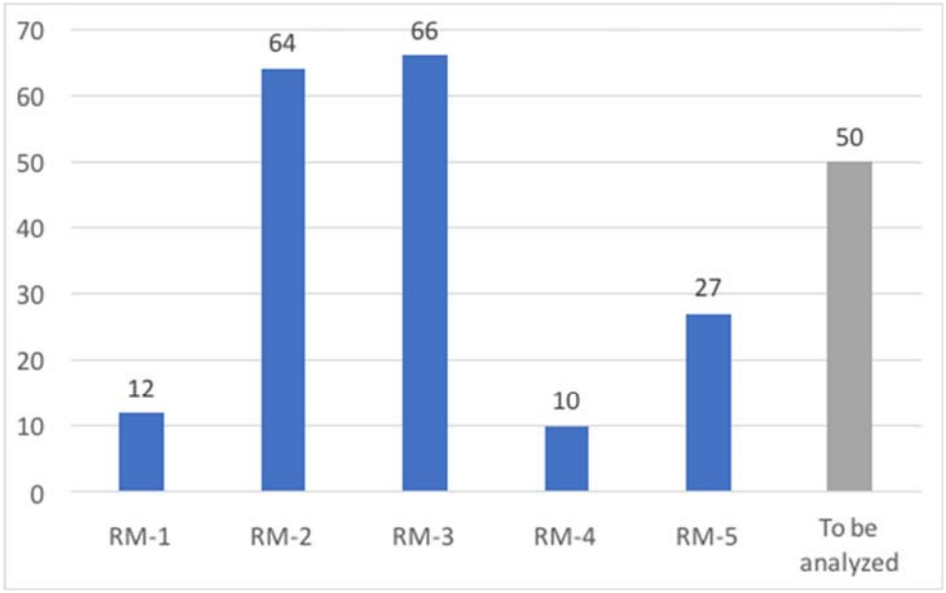
$$w = \sum_{i=1}^{N} w_i,\ i = \text{weights of the individual city} \quad (4)$$

$$w_i = \frac{HDI_{country_i}}{city\ equity\ index_{country_i}} \quad (5)$$

DT-5. The FEW-Nexus city index– Measuring urban resilience
(2015) Hatfield-Dodds, S., Schandl, H., Adams, P. D..

Nexus Research Approaches

- RM-1 Nexus topic review with no specific data analysis
- RM-2 Research framework (qualitative analysis on multiple linkages)
- RM-3 Linkage analysis (quantitative analysis on specific linkage(s))
- RM-4 Nexus system modeling (quantitative modeling on multiple linkages)
- RM-5 Specific methodology. (ex: Life Cycle Analysis ...)



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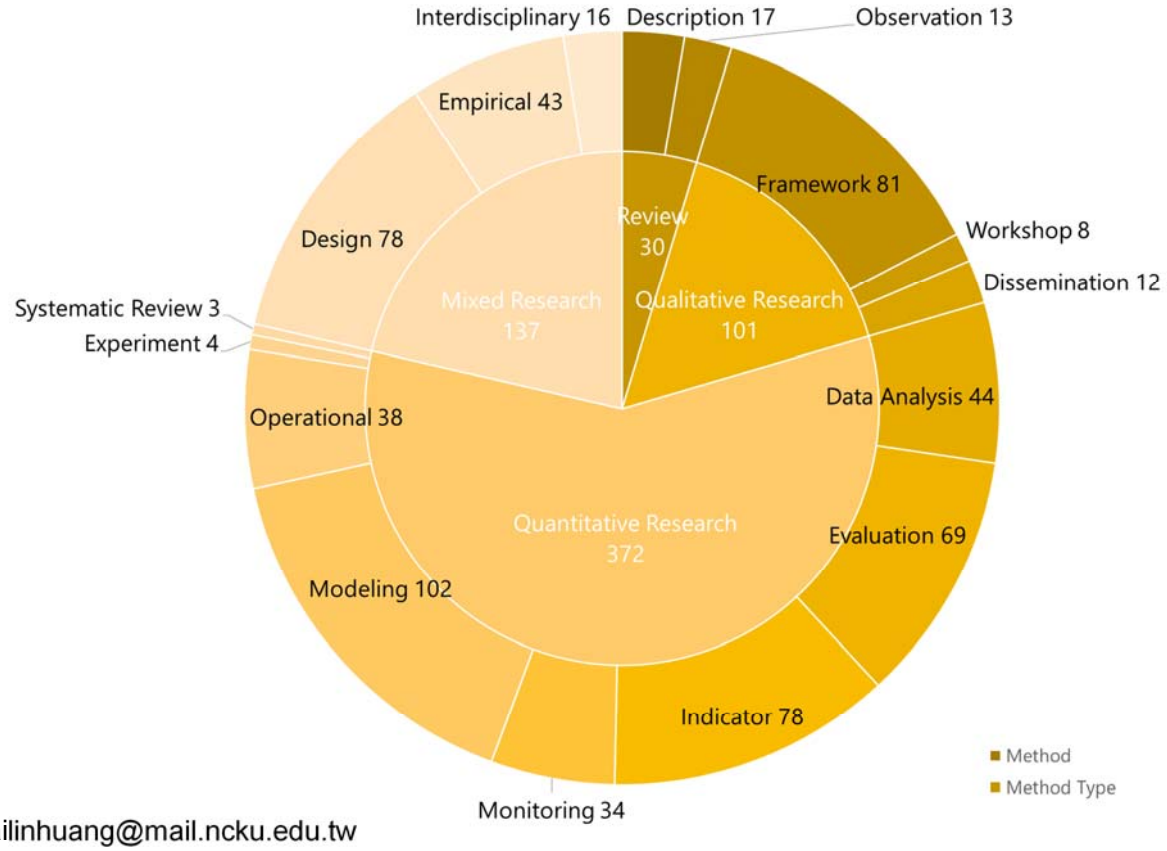
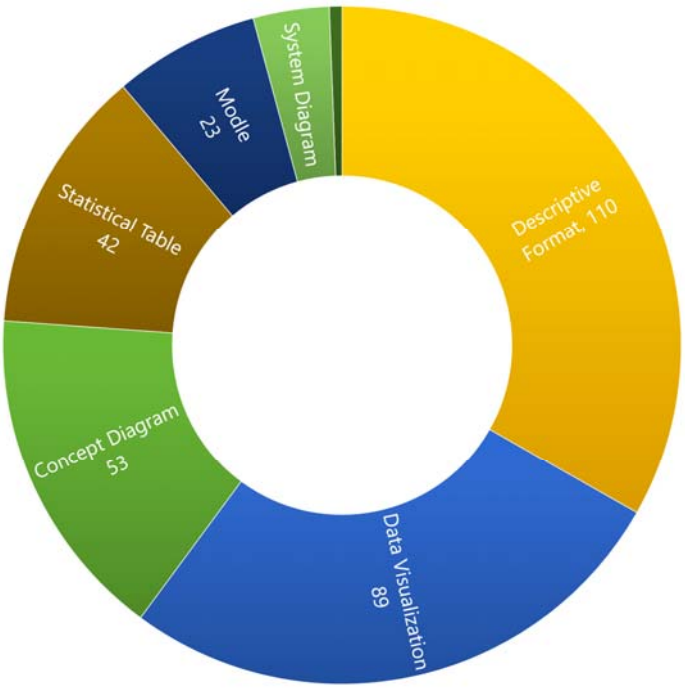
Frequent Methods in WFE Nexus Research

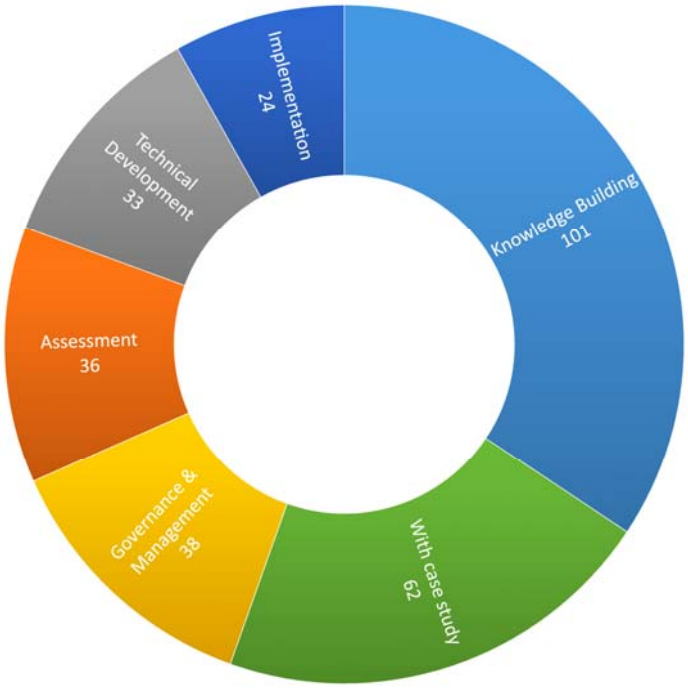


Result Data from Word Frequency



Result data form	Word frequency
Concept Diagram	53
Data Visualization	89
Descriptive Format	110
Formula	2
Model	23
Statistical Table	42
System Diagram	12

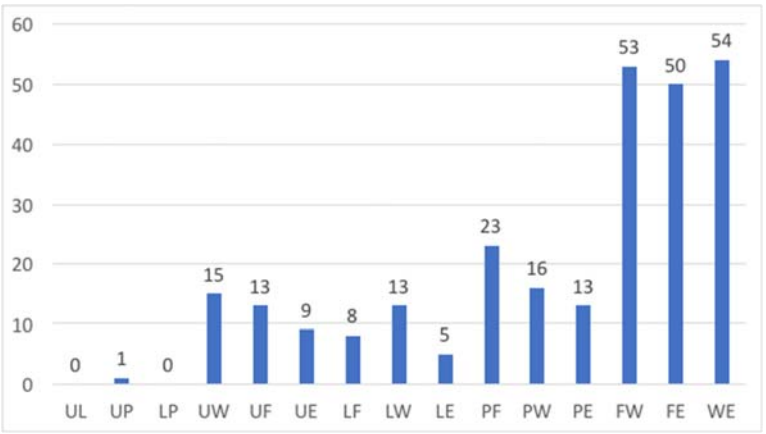
Results Functionality Word Frequency



Results functionality	Word frequency
Knowledge Building	101
Assessment/Evaluation /Monitoring	36
Technical Development	33
Governance & Management	38
Implementation	24
With Case Study	62

Label Analysis

- UL 都市化發展 - 土地
- UP 都市化發展 - 人口
- LP 土地 - 人口
- UW 都市化發展 - 水資源
- UF 都市化發展 - 糧食
- UE 都市化發展 - 能源
- LF 土地 - 糧食
- LW 土地 - 水資源
- LE 土地 - 能源
- PF 人口 - 糧食
- PW 人口 - 水資源
- PE 人口 - 能源
- FW 糧食 - 水資源
- FE 糧食 - 能源
- WE 水資源 - 能源



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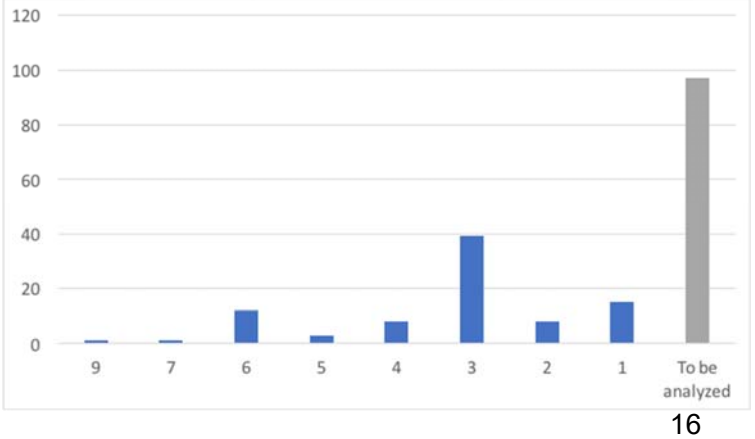
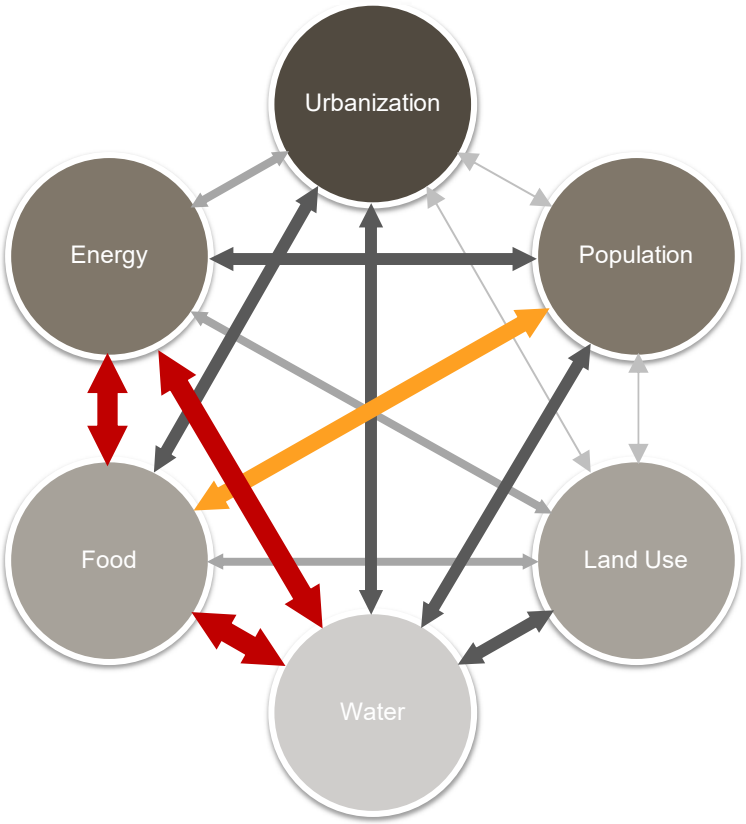
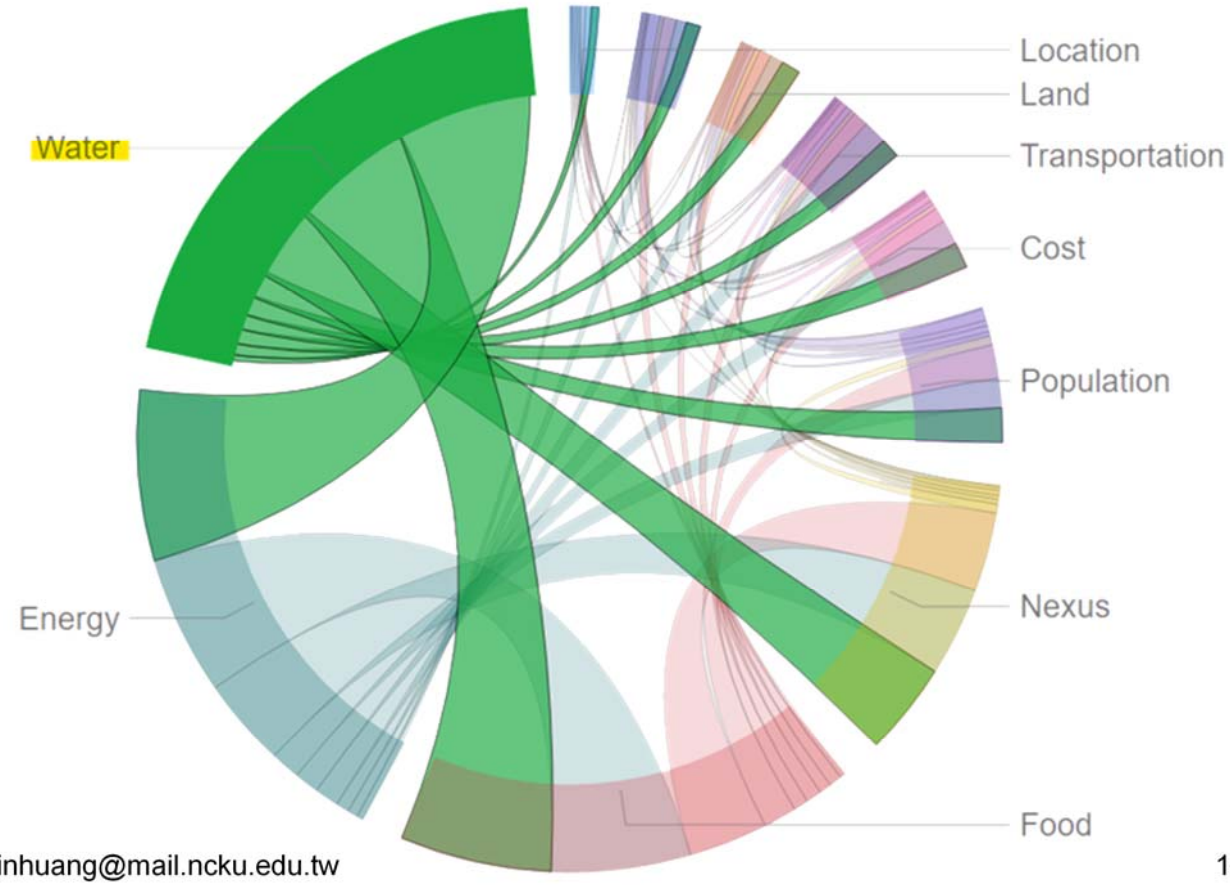


Nexus Linkage Labels

- UL: Urbanization - Landuse
- UP: Urbanization - Population
- UW: Urbanization - Water
- UF: Urbanization - Food
- UE: Urbanization - Energy
- LP: Land Use - Population
- LW: Land Use- Water
- LF: Land Use - Food
- LE: Land Use - Energy
- PW: Population - Water
- PF: Population - Food
- PE: Population - Energy
- FW: Food - Water
- FE: Food - Energy
- WE: Water - Energy

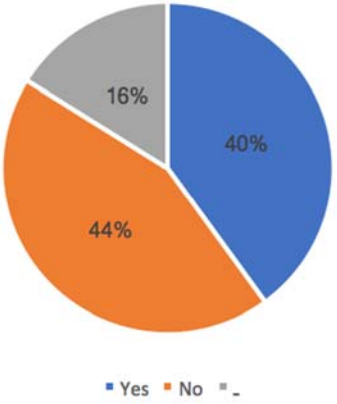


Co-Word Analysis Chord Diagram



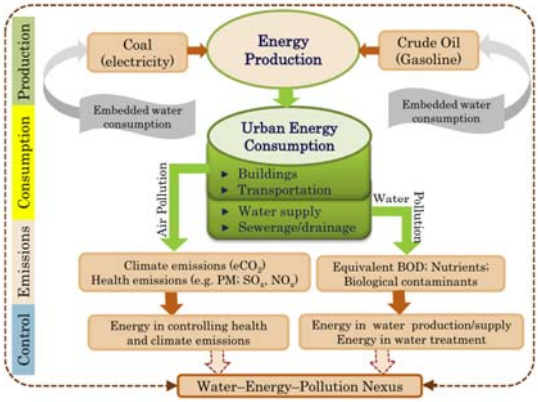
Future Work

A General Picture of Nexus Frameworks

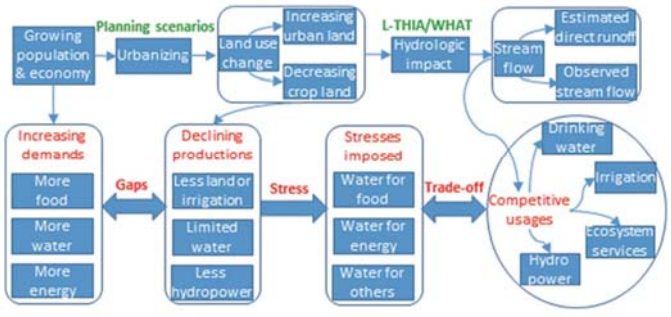


Upper right: Water-energy-pollution nexus for growing cities
Lower left: Analysis of food-energy-water nexus
Lower right: The FEW-Nexus city index – Measuring urban resilience

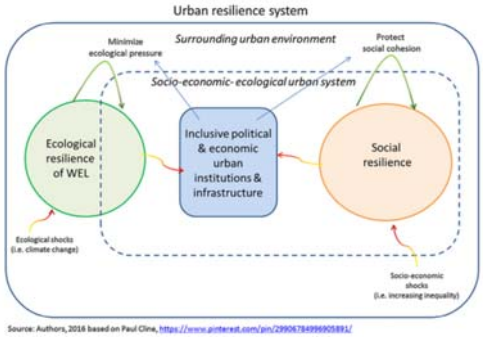
Papers with Nexus Framework Diagram



(2014) Kumar, P. ,Saroj, D. P.

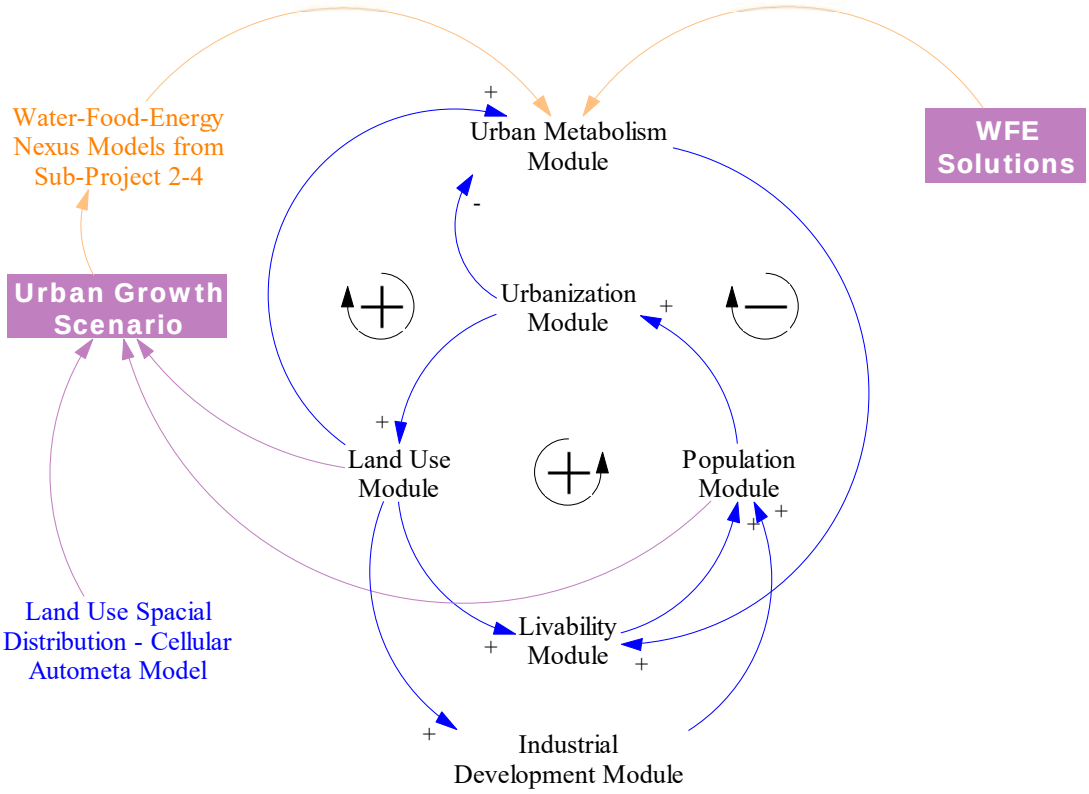


(2018) Zhao, X., Harbor, J., Engel, B.



(2018) Schlör, H., Venghaus, S., Hake, J. F.

Informing the Systems Model Building



Thank you for Your Attention

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